

Gulella io Verdcourt, 1974 and *Oxychilus alliarius* (Miller, 1822): first reports of two greenhouse snails in Italy (Gastropoda: Streptaxidae, Oxychilidae)

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Abstract. Several species new for Italy, including *Gulella io* and *Oxychilus alliarius*, were found during surveys on alien slugs and snails in greenhouses of Italian botanical gardens and scientific museums. *Gulella io* is native to tropical Africa but has been described from specimens collected in European greenhouses since the 1930s. Two shells and a living juvenile specimen of this species were collected in 2019 in the Botanical Garden of Padua. *Oxychilus alliarius* has a wide range in Europe but is absent from Italy: previous records have generally proved to be based on misidentification of other *Oxychilus* species. Several shells and living specimens were found in 2024 in the Aquarium of Genoa; a bleached shell probably belonging to *O. alliarius* had previously been found in the Città Studi Botanical Garden, Milan. Easily transported with plants, this predatory snail has been unwittingly introduced to almost all countries of the world and in some areas is threatening the native fauna. Unlike tropical species, it may escape from greenhouses and acclimatize in Italy, but its impact is likely to be negligible since many members of this genus with a similar ecology are already present and widespread in the country.

Key words. Alien molluscs, introduction, botanical gardens, garlic snail

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INTRODUCTION

Among allochthonous entities found in European countries, an increasing number are reported from botanical gardens, plant nurseries, and tropical greenhouses. Many are soil organisms, including land snails and slugs, that travel with exotic plants (Benocchi *et al.* 2014; Da Sois 2015; Reischütz *et al.* 2018; Kwitt *et al.* 2019; von Proschwitz 2004; Preece and Naggs 2014; Jaskula *et al.* 2019; Richling and von Proschwitz 2021; Cejka *et al.* 2024).

Between 2017 and 2024, 10 facilities in Italy (botanical

gardens in Bologna, Florence, Milan, Padua, Palermo, Pisa, Rome, and Siena; the Aquarium and Biosphere of Genoa; and the Science Museum of Trento) were visited and inspected for alien molluscs as part of the XenoDOMuS project, focused on xenodiversity in tropical greenhouses throughout the country. Some entities never reported before from Italy or Europe were discovered, including an undescribed species belonging to a new genus in the systelomatophoran family Rathouisiidae Heude, 1885 (Manganelli *et al.* 2022, 2024). Here we report the first verified findings of *Gulella io* and *Oxychilus alliarius* in Italy.



Figure 1. Two shells of *Gulella io* Verdcourt, 1974. Padua, Biodiversity Garden (Botanical Garden of Padua), 45°23'52.59"N, 011°52'50.37"E, D. Barbato leg. 6 Mar. 2019 (GMC 57377).

MATERIALS AND METHODS

Snails and slugs were detected by visual search and by collecting leaf litter and surface soil. The visual search detected medium-sized to large species, while collection of litter and soil revealed small and very small species. The litter and soil were dried and sieved through mesh of decreasing sizes. The coarser fraction was sorted visually, and the finer fractions under a stereomicroscope.

Live specimens were drowned in water, then fixed in 70% spirit buffered with sodium carbonate. The bodies were dissected under a light microscope (Wild M5A) using fine-pointed watchmaker's forceps. Anatomical organs were drawn using a Wild camera lucida.

Voucher specimens are kept in the G. Manganelli Collection at the Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, University of Siena (Siena, Italy).

STUDY AREAS

University of Padua Botanical Garden. This botanical garden is considered the world's oldest academic garden still at its original location. Founded in 1545 and managed by the university, it has been named a UNESCO World Heritage Site. In 2014 a new section was added to the historical part: the Biodiversity Garden, consisting of a single, 100 m long greenhouse divided into sections representing ecosys-

tems on all continents. Mollusc sampling was conducted in the sections hosting Mediterranean vegetation and tropical habitats of America, Africa, Asia, and Australia.

Città Studi Botanical Garden, Milan. This university garden is in the eastern outskirts of Milan. Molluscs were sampled in two greenhouses hosting succulents and tropical plants and in outdoor fountains and pools.

Biosfera and Aquarium of Genoa. The Biosfera is a giant glass sphere in Genoa harbour near the Aquarium. It houses a miniaturized reproduction of a moist ecosystem with tropical plants and animals. The Aquarium is a very large facility containing some terraria and tanks of live fish and other aquatic animals from all over the world. Mollusc sampling was conducted inside the Biosphere and in the sector of the Aquarium housing tropical amphibians and reptiles. In the latter, several shells and living snails were found at the base of a wall bearing a vertical garden of exotic plants growing in soil/loam-filled pockets. Slugs and freshwater snails were also collected in the drains.

RESULTS

Gulella io Verdcourt, 1974

Figure 1

Material examined. Padua, Biodiversity Garden (Botan-

ical Garden of Padua), 45°23'52.59"N, 011°52'50.37"E, D. Barbato leg., 6 Mar. 2019, 2 shells and 1 juvenile specimen (GMC 57377).

Remarks. The very speciose streptaxid genus *Gulella* Pfeiffer, 1856 includes two well-known greenhouse species: *Gulella bicolor* (Hutton, 1834) and *Gulella io* Verdcourt, 1974. The Padua specimens matched the latter, originally described by Verdcourt (1974) on specimens collected in some European greenhouses.

European specimens of this species have been known since the 1930s. Indeed, they were initially found in the Royal Botanic Garden, Edinburgh and assigned to *Gulella devia* Connolly, 1931, a new taxon described from material collected in Uganda (Connolly 1931). Later the European *Gulella* was reported as an unidentified, possibly new, species from Kew Gardens, where a single shell was collected by Adrian Norris of Leeds Museum (Verdcourt 1969). In fact, after comparison of the shell from Kew and those from Edinburgh, Verdcourt concluded that they were conspecific and belonged to an undescribed species that differed in parietal lamellar and upper palatal denticle structure from the Ugandan *G. devia*. After studying additional shells collected by Ivo Flasar in greenhouses in Bratislava, he eventually described it as new species with the name *G. io* (Verdcourt 1974; Flasar & Kroupová 1976a, 1976b). A few years later he also published partial anatomical data of a living specimen found in the Cambridge Botanic Garden (Verdcourt 1979). In the discussion, he revealed that the shell and anatomy of *G. io* matched those of *G. devia* from Liberia by Degner (1934), described in a paper he had not initially seen. Actually, due to some differences in the structure of parietal lamella with respect to the specimen figured by Connolly (1931), Degner was about to describe the Liberian *Gulella* as a new species, *G. styloidea*, but after correspondence with Connolly, accepted his suggestion, albeit with some perplexity, of assigning the Liberian specimens to the Ugandan species. He may unfortunately have changed his mind at an advanced stage of his manuscript as the new name *G. styloidea* remained in the caption of figure 26. As already stressed by Verdcourt, this name cannot be considered valid.

Regrettably, there has been no recent work on the systematics of this species and its possible relationships with *G. devia*. Nor can we add anything because the only living specimen collected in Padua was a juvenile.

Subsequent published records of this species in Europe come from hothouses in France (Le Maire & Gerriet 2014), Austria (Reischütz *et al.* 2018), and Britain and Ireland (Walker 2025), while unpublished records

include observations from Germany (<http://www.gbif.org/species/8973198>; https://en.wikipedia.org/wiki/Gulella_io#/media/File:Gulella_io_shell.jpg). Outside Europe, *G. io* has been introduced into Singapore, where it has spread across wooded areas, open grasslands, and towns, mainly in shaded environments rich in organic debris and decaying plant matter (Chan & Lau 2020). In Africa it has often been reported from Nigeria, where it occurs in different types of disturbed and undisturbed forests and artificial plantations (Oke & Alohan 2006; Oke & Chokor 2011; Oke 2013). High densities have been recorded in cocoa plantations and freshwater forest environments (Oke & Achi 2012; Oke & Omoregie 2012).

Oxychilus alliarius (Miller, 1822)

Figures 2, 3

Material examined. Genoa, Aquarium, 44°24'37.05"N, 008°55'33.12"E, D. Barbato, A. Benocci & F. Filipet leg. 13–14 Nov. 2024, 40 shells, 6 specimens (GMC 58740). Milan, Città Studi Botanical Garden, University of Milan, 45°28'28.10"N, 009°14'08.92"E, D. Barbato leg. 25 Oct. 2023, 1 worn shell (GMC 58740).

Remarks. Shell and genital features of the small *Oxychilus* collected in the Aquarium of Genoa match those reported by Giusti & Manganelli (2002). In particular, the internal ornamentation of the proximal penis, consisting of a few straight, slightly wavy longitudinal pleats, is in line with that reported for British, Dutch, Spanish, and Polish specimens (Giusti & Manganelli 2002: figs 6, 8, 10, 12, 14). However, the Genoa specimens have a very long flagellum, longer than that hitherto reported in this species (cf. Riedel 1957; Wütrich 1963; Gittenberger *et al.* 1984; Castillejo Murillo 1985; Barker 1999; Giusti & Manganelli 2002).

A shell very similar to those from Genoa was found in 2023 in a greenhouse of the Città Studi Botanical Garden (Milan, northern Italy), but its identification as *O. alliarius* cannot be confirmed anatomically or molecularly due to the absence of soft parts.

Regarding the proximal penis, slightly different internal ornamentation, consisting of papillate pleats, was illustrated in a specimen from New Zealand (e.g. Barker 1999: fig. 92b), leading to Giusti & Manganelli (2002) raising doubts about its identification. In a review of the species in New Zealand, Salvador *et al.* (2020: 122) stated that the “papillate longitudinal folds” reported by Barker were observed in the specimen dissected by them and that these papillate longitudinal folds “are reminiscent of pleats, each with tiny sequential papillae-like bulges on its ‘summit’”. These ‘papillate longitudinal folds’ are exactly what Giusti and Mangan-

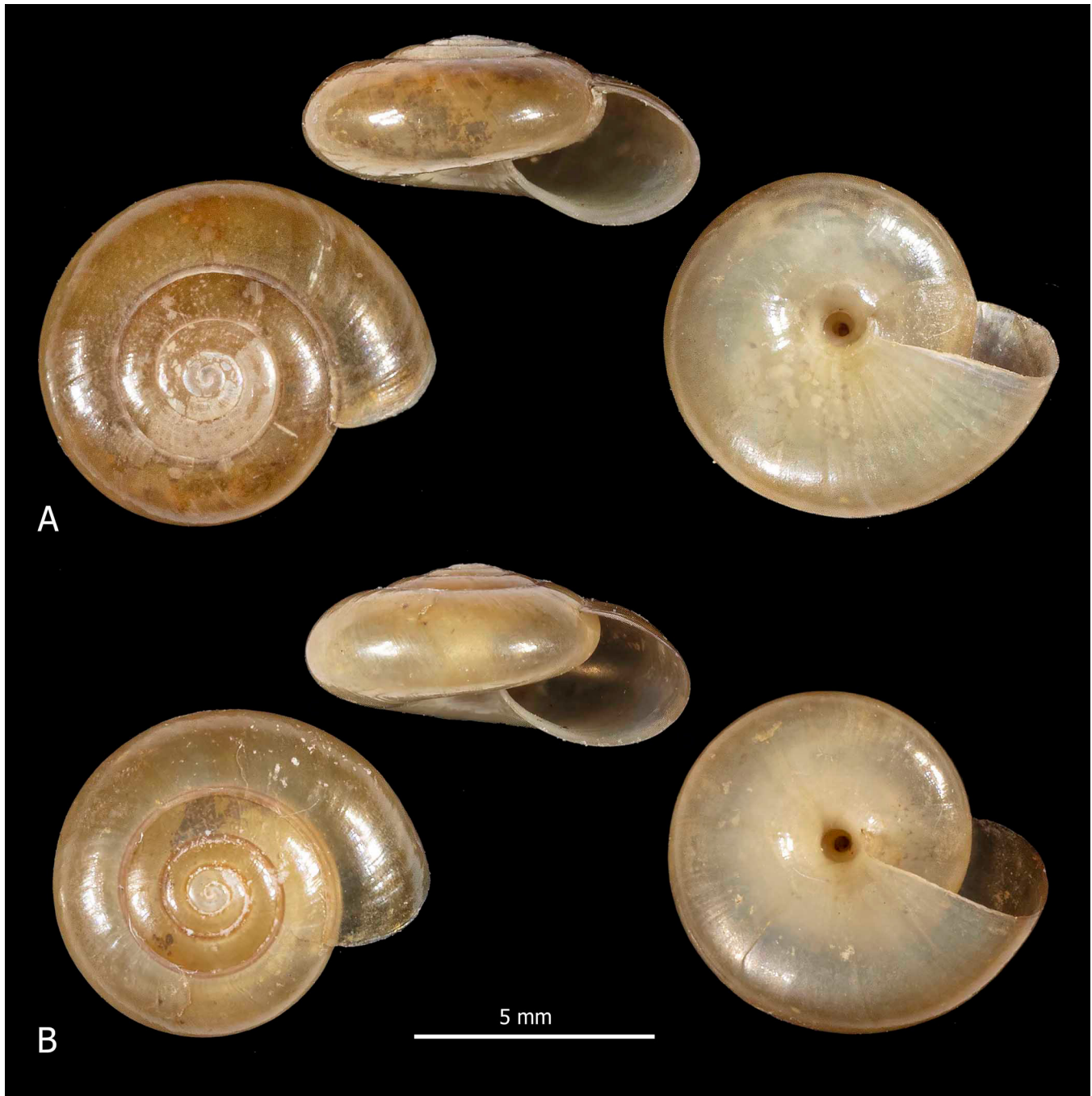


Figure 2. Two shells of *Oxychilus alliarius* (Miller, 1822). Genoa, Aquarium, 44°24'37.05"N, 008°55'33.12"E, D. Barbato, A. Benocci & F. Filipet leg. 13–14 Nov. 2024 (GMC 58740).

elli observed, though their illustration (fig. 6) is less detailed than that of Barker (fig. 92)". Unfortunately, since Salvador *et al.* (2020) did not illustrate the specimen they examined, we cannot comment on its anatomy. We can only stress that all the specimens studied by us from different European sites have internal ornamentation of the proximal penis consisting of a few slender wavy longitudinal pleats; some minor

fragmented pleats may only be found around the opening of the epiphallus into penis.

This generalist species, also known with the vernacular name of garlic snail, lives in a wide range of habitats (swampy meadows, natural forests, plantations, humid and shady rocky environments, gardens, and cultivated areas), seeking shelter under logs, stones, and moss or in leaf litter.

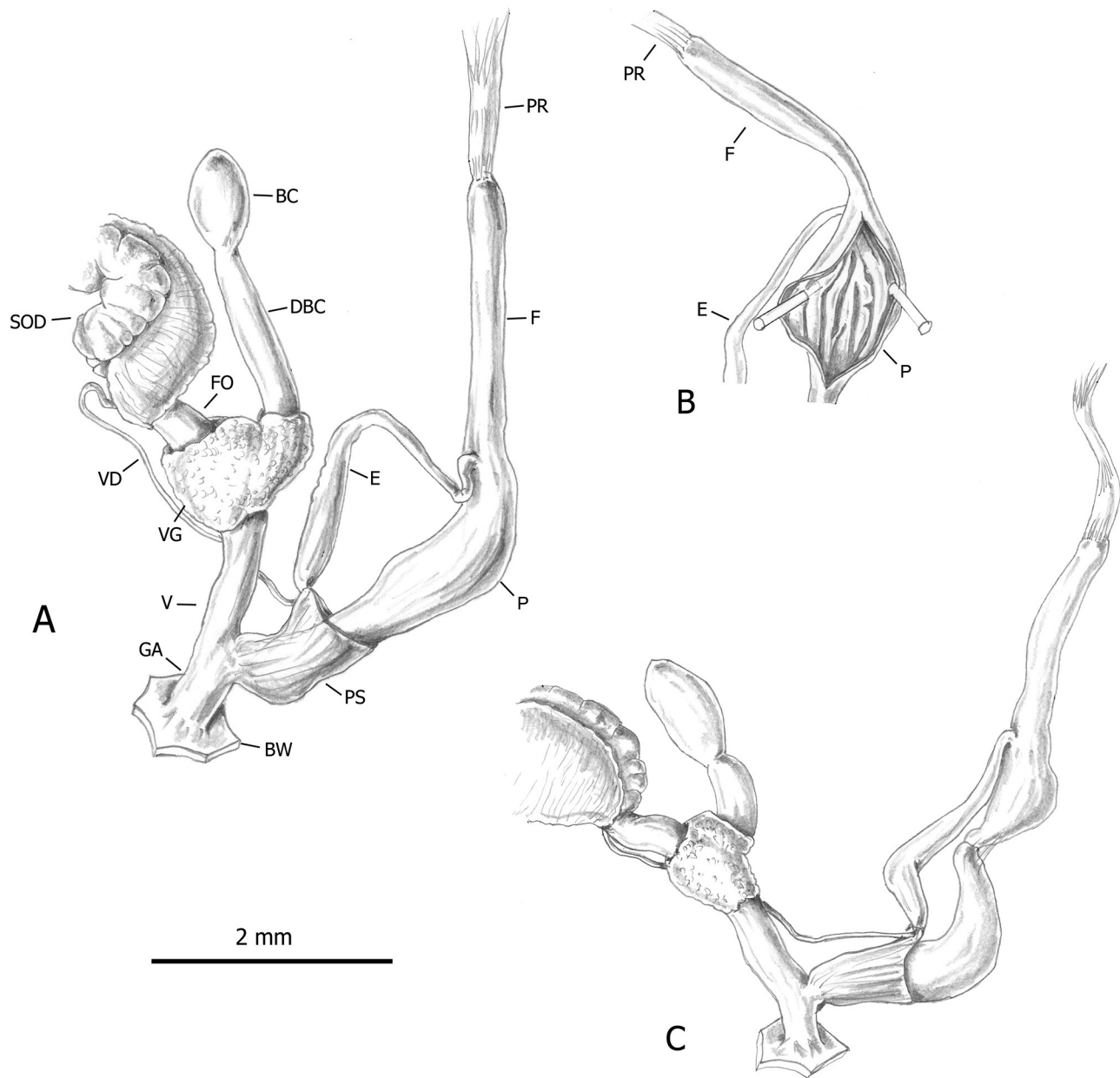


Figure 3. Genitalia of *Oxychilus alliarius* (Miller, 1822) from Genoa, Aquarium, 44°24'37.05"N, 008°55'33.12"E, D. Barbato, A. Benocci & F. Filipet leg. 13–14 Nov. 2024 (GMC 58740). **A, C**, distal genitalia. **B**, internal structure of the proximal penis. Abbreviations: BC = bursa copulatrix, BW = body wall, DBC = duct of bursa copulatrix, E = epiphallus, F = flagellum, FO = free oviduct, GA = genital atrium, P = penis, PR = penial retractor muscle, PS = penial sheath, SOD = spermoviduct, V = vagina, VD = vas deferens, VG = vaginal gland.

Oxychilus alliarius is strongly synanthropic: it is considered a common greenhouse species (Kerney & Cameron 1979; Welter-Schultes 2012) and as an introduced species, it is mainly found in disturbed areas (Barker 1999; Herbert 2010).

Its native range encompasses Western, Central, and Northern Europe (probably from the northern Iberian Peninsula

to Scandinavia; Welter-Schultes 2012; Bank & Neubert 2017). Isolated populations also occur in Poland, Czechia, Portugal, and Greece, but their autochthony is debated in the case of the latter two countries (Maczey 2016). The garlic snail has been introduced to almost every country in the world: published reports of established populations come from North America (Canada, USA, and Mexico),

South America (Colombia, Chile, and the Juan Fernández Islands), Atlantic islands (Greenland, Macaronesia, Tristan da Cunha, and Saint Helena), Africa (South Africa), eastern Europe (the Balkans including Greece), the Mascarene Islands (Réunion), Asia (Sri Lanka), and Oceania (Australia, including Tasmania, New Zealand, and Hawaii) (Cádiz *et al.* 2013; Salvador *et al.* 2020; Trujillo-Díaz *et al.* 2025), but online archives include unverified observations from several other regions including China and Antarctica (Maczey 2016).

The species has occasionally been recorded in Italy in the past. Taylor (1907: 64) mentioned it in Tuscany, and Alzona (1971: 127) in Liguria and Venetum. Taylor's report is based on a record of "*Hyalina aquitanica* Charp." by Bonelli (1873: 403), a taxon regarded as a variety of *O. alliarius* by Westerland (1876: 20) (a taxonomic re-allocation subsequently dismissed, see Westerland 1886: 61). Alzona's report for western Liguria seems based on records of "*Hyalinia macei*" by Caziot (1910: 36–37, pl. 4 figs 50, 52, 53), a taxon that Germain (1930: 145) considered to be a form of *O. alliarius*, collected in sites just outside the Italian borders. On the contrary, Alzona's report from Venetum seems based on unpublished records, evidently misidentified since *O. alliarius* has never actually been reported from this region.

More recent Italian records are based on misidentification of *O. meridionalis* (Paulucci, 1881) (e.g. Giusti 1969) and probably of small *O. draparnaudi* (Beck, 1837) (e.g. Piazzzi & Pedroni 2023). Indeed *O. meridionalis* and *O. alliarius* both emit a garlic-like scent when disturbed, which is presumably an anti-predatory response. However, *O. meridionalis*—a narrow-range Italian endemic restricted to a small area between Tuscany, Emilia Romagna, and Liguria—is larger and anatomically distinct from *O. alliarius* (Manganelli & Giusti 2001).

At least 12 observations from Italy have been uploaded to iNaturalist by users not trained in mollusc identification and who probably relied on suggestions offered by the algorithm (Barbato *et al.* 2021). Some of the photographs seem to depict different species (an unidentified species of *Zonitoides* Lehmann, 1862, possibly *Oxychilus mortilleti* (Pfeiffer, 1859), and *O. draparnaudi*) while others cannot be verified. Indeed, without genital examination or a molecular barcode, species identification is uncertain since shell characters alone cannot tell it apart from some of its congeners, especially small specimens of *Oxychilus cellarius* (Müller, 1774) and *O. draparnaudi* (Giusti & Manganelli 2002).

The specimens found in Genoa could hardly spread outside the Aquarium, which is situated in an unvegetated urban area surrounded by sea. However, given the species'

high potential for dispersal via plant transport, future colonization of natural habitats in Italy can be expected: other populations could indeed establish and then escape from greenhouses and nurseries, and unlike alien species native to tropical areas, they could easily adapt to local environments.

Oxychilus alliarius regularly feeds on smaller snails (Meyer 2005), thus becoming a potential threat to native species outside its range. For instance, in the Hawaiian archipelago it can reach very high densities, and it may have contributed to driving a passerine bird to extinction, out-competing it in preying on local snails (Howarth *et al.* 2003; Cádiz *et al.* 2013). In Italy and other European countries a negative impact seems unlikely, since many members of this genus with similar ecology are already present and widespread, and as the native fauna is adapted to such predators, the impact of *O. alliarius* would probably be negligible.

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