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Alien species and greenhouses: new data from the Botanical Garden of Palermo (Sicily, Italy) (Diplopoda and Mollusca)

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ABSTRACT On the basis of specific research carried out recently at the Botanical Garden of Palermo (Sicily, Italy), a new list of alien species is presented. In particular, two species of millipedes *Choneiulus palmatus* (Němec, 1895) (Julida Blaniulidae) and *Poratia obliterata* (Kraus, 1960) (Polydesmida Pyrgodesmidae), and four species of terrestrial molluscs *Zonitoides arboreus* (Say, 1817) (Gastropoda Gastrodontidae), *Allopeas clavulinum* (Potiez et Michaud, 1838), *Opeas opella* Pilsbry et Vanatta, 1906 (Gastropoda Achatinidae), and an indeterminate species of the familia Charopidae.

KEY WORDS Diplopoda; Mollusca; alien species; Greenhouse; Botanical Garden.

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INTRODUCTION

The dense net of connections developed in recent decades, that led to a rapid globalization, has contributed to the introduction of alien species belonging to the most varied taxonomic groups. In the Mediterranean area, considering the geographical and environmental heterogeneity, the acclimatization and settlement of many species has been allowed (Farina, 2020).

In particular, the human activity are an important factor in the establishment of alien species in greenhouse (Wang et al., 2015). In greenhouses, numerous alien species can establish themselves, creating a synanthropic community that is significantly widespread globally in these cultivation systems, or appear in occasional entities passively introduced with plants and other substrates (Richling & Proschwitz, 2021). The reason for this risk of invasion by alien species is linked to the high availability of resources present in greenhouses (Alpert et al., 2000; Kiritani, 2005), such as sources of often unlimited food, constant temperatures and humidity (Decker et al., 2014).

Alien terrestrial invertebrates represent one of the largest groups of organisms introduced into Europe: in Roques et al. (2009), 1,296 species originating from other continents have settled, to which are added 221 cosmopolitan species of uncertain (cryptogenic) origin. Over the years, numerous other species have recently been found in anthropogenic environments, some occasional and others recently established (Inghilesi et al., 2013; Gilgado et al., 2022; Viviano, 2024), or described as new species (Matzkei & Kocarek, 2015; Manganelli et al., 2024). The taxonomic groups reported in this contribution on alien fauna concern terrestrial molluscs and diplopods (Myriapoda).

Non-native molluscs represent 10% of the total introduced exotic species, which includes one of the largest groups (Gherardi et al., 2008). Currently, there are around fifty alien taxa present on the European continent, while in Italy there are 35 species, of which 12 are freshwater and 23 are terrestrial

(Bodon et al., 2004; Cianfanelli et al., 2007; Gherardi et al., 2008; De Mattia, 2007; Gavetti et al., 2008; Hallgass & Vannozzi, 2010; Evangelista et al., 2013; Manganelli et al., 2025), one of which was recently described of unknown origin (Manganelli et al., 2022).

Many of the known millipede species have low dispersal ability, resulting in small distribution areas and high numbers of endemic and microendemic species (Golovatch & Kime, 2009). However, many species have recently expanded their distribution range, and in some cases, this is clearly due to human transportation and some of these species have become invasive (Stoev et al., 2010). In Europe there are over a hundred species reported as alien in Germany, Great Britain, Austria, Switzerland, France to name a few; generally the species reported come from other continents such as Central and South America, Asia, Australia and Africa (Stoev et al., 2010; Decker et al., 2014; Gilgado, 2020; Gilgado et al., 2022). In Italy, beyond the documented spread of *Oxidus gracilis* Koch, 1847 (Foddai et al., 1995; Zapparoli in Fiacchini et al., 2008; Stoev et al., 2010; Drago et al., 2011; Viviano et al., 2024), there is a lack of updated data on alien myriapods. Another alien species often found in greenhouses and reported for Italy is *Lamyctes coeculus* (Brölemann,1889) (Lithobiomorpha Henicopidae) by Brölemann (1889).

MATERIAL AND METHODS

Methods

Empty shells and live specimens were collected in the field by sight, on the ground and under stones and debris, in daylight, but also by sifting debris samples in the laboratory. Specimens were studied for size, color, external morphology, biology and genitalia. Measurements were taken with a digital caliper and micrometer. Shells were immersed for less than two minutes in a solution of 60% water (H2O) and 40% NaClO and then cleaned with water and a flat-tipped brush with hard bristles. Some specimens were fixed in 80% ethanol and the reproductive system was extracted using scalpels, scissors and needles. Specimens were observed and photographed through the Wild Heerbrugg M3B stereoscope, the Vevor microscope model XSP-36TV and the Leica M2005C stereomicroscope with Flexacam C3 and Planapo 1.0x lens. Photographs of live specimens were taken with a Nikon D3100 18-55 camera and a Nikon F with a Tokina 100 mm lens.

Study area

The Botanical Garden of Palermo is a museum and educational-scientific institution of the Service Center of the Museum System of the University of Palermo (Sicily, Italy). Adjacent to Villa Giulia, it is accessed from via Lincoln, on the border of the Kalsa district of Palermo, and hosts over 12,000 different species of plants. It has an extension of approximately 10 hectares. It is divided into six main sectors in which numerous botanical collections are housed which follow a biogeographical, systematic and sexuality order. Inside the Botanical Garden there are also artificial tanks, including the renowned Aquarium, and numerous greenhouses which include numerous species of plants from hot-arid and hot-humid climates. The latter, hosting plants adapted to hot-humid climates, were investigated to understand and observe the possible introduction of alien fauna, in particular (Fig. 1):

- the Tropical Greenhouse, also called “of the Region”, was donated to the Botanical Garden by the Sicilian government in 1950. Inside it contains a vast collection of tropical plants, largely belonging to the Araceae and Bromeliaceae families. It is the largest greenhouse and was monitored from 2014 until 2021 with random and non-impacting sampling; it measures 23 m long and 10 m wide. Irrigation takes place regularly 2-3 times a week and a boiler imposes a temperature of around 27 °C during the winter period, while in summer the heat is regulated by occasionally opening small side windows. All the plants inside are grown in terracotta pots, some resting on the floor, many others raised on the marginal benches. The first counter on the right, entering from the main entrance, was the most monitored due to the substrate composed exclusively of volcanic lapillus, which compared to the others present, preserved within it the majority of the species reported on the list, less abundant in other points of the same greenhouse; recently, in 2024, the lapillus was replaced with fragments of bark and coconut fibers to standardize the rest of the greenhouse following renovation.

Figure 1. Botanical Garden of Palermo (Sicily, Italy): Orchid Greenhouse (photos by T. Turco).

- Orchid Greenhouse, was opened and inaugurated in 2019; in it, around 350 specimens of 200 species of Orchidaceae are housed and cultivated. It measures 10 meters long, 5 meters wide and is approximately 3.5 m high along the longitudinal axis. The plants are watered three times a week and on the remaining two days the floor and the surface where the pots are placed are watered, so that a constant humidity of 40 to 70 % is maintained at an average T° of 27 °C. The random samplings were carried out by lifting pots, observing the organic debris accumulated underneath, in the central bench under trunks, foliage, coconut fibre, moss, roots, before and after watering, and under the blanket of *Tradescantia zebrina* Bosse. Occasionally, small portions of soil were collected, which was almost composed of organic soil and degraded plant matter. It is currently managed by A.M.A.O. members (Assocciazione Meridionale Amatori Orchidee). The collection of Orchidaceae of the botanical garden of Palermo, despite the first specimens having been purchased only at the end of 2019, today includes about 150 species belonging to 45 different genera. The distribution and habitat of the cultivated species is mainly tropical and subtropical, of Asia, America and Africa. The collection is the result of purchases from specialized Italian nurseries and donations from associations of orchid growers and enthusiasts such as the AMAO (Associazione Meridionale Amatori Orchidee) and the SFO (Società Felsinea di Orchidofilia). The specialized nurseries, from which the specimens in the collection were purchased, are mainly located in northern Italy and precisely Varese, San Giuliano Terme (PI), Camporosso (IM). To satisfy market demands, the plants marketed are mainly the result of imports from abroad (Tiziana Turco personal communication).

Sampling was carried out using special soft tweezers, hard or soft bristle brushes, small spoons for collecting debris, 5x5 cm containers for transporting alien species to the laboratory and 9x13 cm zip bags for the soil. Other non-native species present in the various gardens of the Botanical Garden, already known from the Sicilian territory, are mentioned in the discussions. All listed specimens were collected by the author and deposited in his own collection.

RESULTS

Systematics

Phylum ARTHROPODA Gravenhorst, 1843
Subphylum MYRIAPODA Latreille, 1802
Classe DIPLOPODA Blainville in Gervais, 1844
Ordo JULIDA Brandt, 1833
Familia BLANIULIDAE Koch, 1847
Genus *Choneiulus* Brölemann, 1921

Choneiulus palmatus (Němec, 1895)

MATERIAL EXAMINED. ITALY • 1 male; Sicily, Botanical Garden of Palermo: Orchid greenhouse, 15 Oct. 2021. • 2 females; idem; 12 May 2023. • 3 males and 3 females; idem; 29 Sep. 2023. • 1 male, 1 female, 3 subadult; idem; 20 Feb. 2024. • 5 females; idem; 11 Dec. 2024 (Figs. 2-5).

DESCRIPTION. Length: 5–15 mm, wide: 0.3-0.5 mm, segments: 30–59; body grayish-brown, thin, with almost black defense glands, each metazonite is covered with 14–20 long bristles, longer than the metazonites themselves; adults have 7–8 ocelli; cheek lobes of males extend into 2 teeth, separated by a crescent-shaped cleft (Blower, 1985). Coxal processes of anterior gonopods with smooth mesal margins; posterior gonopods with branched fringes (Enghoff, 2001).

DISTRIBUTION AND BIOLOGY. It is a european species, introduced in various european countries and in other countries, such as Canada, USA, Australia (Shelley & Enghoff, 2004; Kime & Enghoff, 2017) and Iraq-Baghdad (Al-Door et al., 2020). Reported for mainland Italy in Piemonte (Strasser & Minelli, 1984; Foddai et al. in Minelli et al., 1995; Kime & Enghoff, 2017; Minelli in Bologna et al., 2021). Its natural habitat may be woodland on base-rich soils. Also widespread in gardens, parks, orchards, vineyards, cemeteries, quarries, mining tunnels, disused railway areas, waste heaps and frequently in greenhouses (Kime & Enghoff, 2017). It is a new report for Sicily. Not very common inside the orchid greenhouse, absent in the large tropical greenhouse. Usually single or small nuclei of 3–4 specimens are found under stones and in rotting debris. Like other diplopods, it feeds on decomposing substances that accumulate in the interstices and under large objects.

REMARKS. In Sicily, this genus is known only for the description of a endemic species to the Trapani area, *Choneiulus faunaeuropeae* Enghoff, 2001, known exclusively for the hypogean environments of the Santa Ninfa cave. This species differs from *C. palmatus* for posterior gonopods not tapering and length of metazonal setae 27–34% of body diameter (Enghoff, 2001).

Ordo POLYDESMIDA Leach, 1815
Familia PYRGODESMIDAE Silvestri, 1896
Genus *Poratia* Cook et Cook, 1894

Poratia obliterata (Kraus, 1960)

MATERIAL EXAMINED. ITALY • 4 females; Sicily, Botanical Garden of Palermo: Orchid greenhouse; 15 Oct. 2021. • 4 females; idem; 12 May 2023. • 10 females, 4 juveniles; 9 Aug. 2023. • 16 males, 1 females, 4 juveniles; idem; 29 Sep. 2023. • 12 females, 5 juveniles; idem; 20 Feb. 2024. • 31 females, 7 subadults; idem; 11 Dec. 2024 (Figs. 6-12).

DESCRIPTION. The determination of this species was supported by anatomical examination of the gonopods of the single male and by the identification keys of the *Poratia* species reported in Golovatch & Sierwald (2000: figs. 8, 16, 17). *Poratia obliterata* is very similar to *Poratia digitata* (Porat, 1889) from which it differs in the following characters: 20 segments in adult specimens, from the 16th to the 19th paratergite there are 4 lobulations. In the male, the gonopods are located on the 7th sternite: gonopod telopodite as an elongated, thin, flattened and slightly wider at the apex stem, absence of solenomerite (for further details see Golovatch & Sierwald, 2000). Females larger than males (Figs. 7–12).

DISTRIBUTION AND BIOLOGY. Originally described from Perù (Kraus, 1960), it is also reported in Brazil, Colombia and Costa Rica (Golovatch & Sierwald, 2000; Adis et al., 2001), subsequently introduced in North America (Shelley & Golovatch, 2001) and in Europe: Germany (Wilck, 2000; Golovatch & Sierwald, 2000; Adis et al., 2001; Decker et al., 2014), France (Golovatch & Sierwald, 2000) and Switzerland (Gilgado et al., 2022). Kime & Enghoff (2011) also cites it for Austria, Danish mainland, Great Britain, The Netherlands, Norwegian and Sweden. It is a new alien species for the Italian

Figures 2–5. *Choneiulus palmatus* from Botanical Garden of Palermo (Sicily, Italy). Fig. 2: live specimen. Fig. 3: specimen in laboratory after alcohol fixation, scale bar: 5 mm. Fig. 4: anterior gonopods, aboral view. Fig. 5: apex of the left posterior gonopod, aboral view.

Figure 6. Live specimen of female *Poratia obliterata* from Botanical Garden of Palermo (Sicily, Italy).

territory. In the originary countries it is frequently found with separate sexes, but in Europe a parthenogenetic form has been introduced (Adis et al., 2001; Shelley & Golovatch, 2000). However, sampling at the botanical garden of Palermo revealed the presence of both sexes, with almost exclusively female specimens except for a single male, confirming the sexual disparity of this species in European territory. Ecological and biological observations of this species in nature (Amazon, Brazil) and in the laboratory are provided in depth by Bergholz (2006).

REMARKS. In the greenhouse of Botanical Garden of Palermo it lives (Fig. 6) in numerous colonies under the orchid pots where organic material accumulates, under boulders and in the foliage deposited in the corners and under material used to support some orchids. Very common after watering, it tends to retreat in its shell if watering is delayed by a few days.

Phylum MOLLUSCA Linnaeus, 1758
Classis GASTROPODA Cuvier, 1795
Ordo STYLOMMATOPHORA Schmidt, 1855
Familia GASTRODONTIDAE Tryon, 1866
Genus *Zonitoides* Lehmann, 1862

Zonitoides arboreus (Say, 1817)

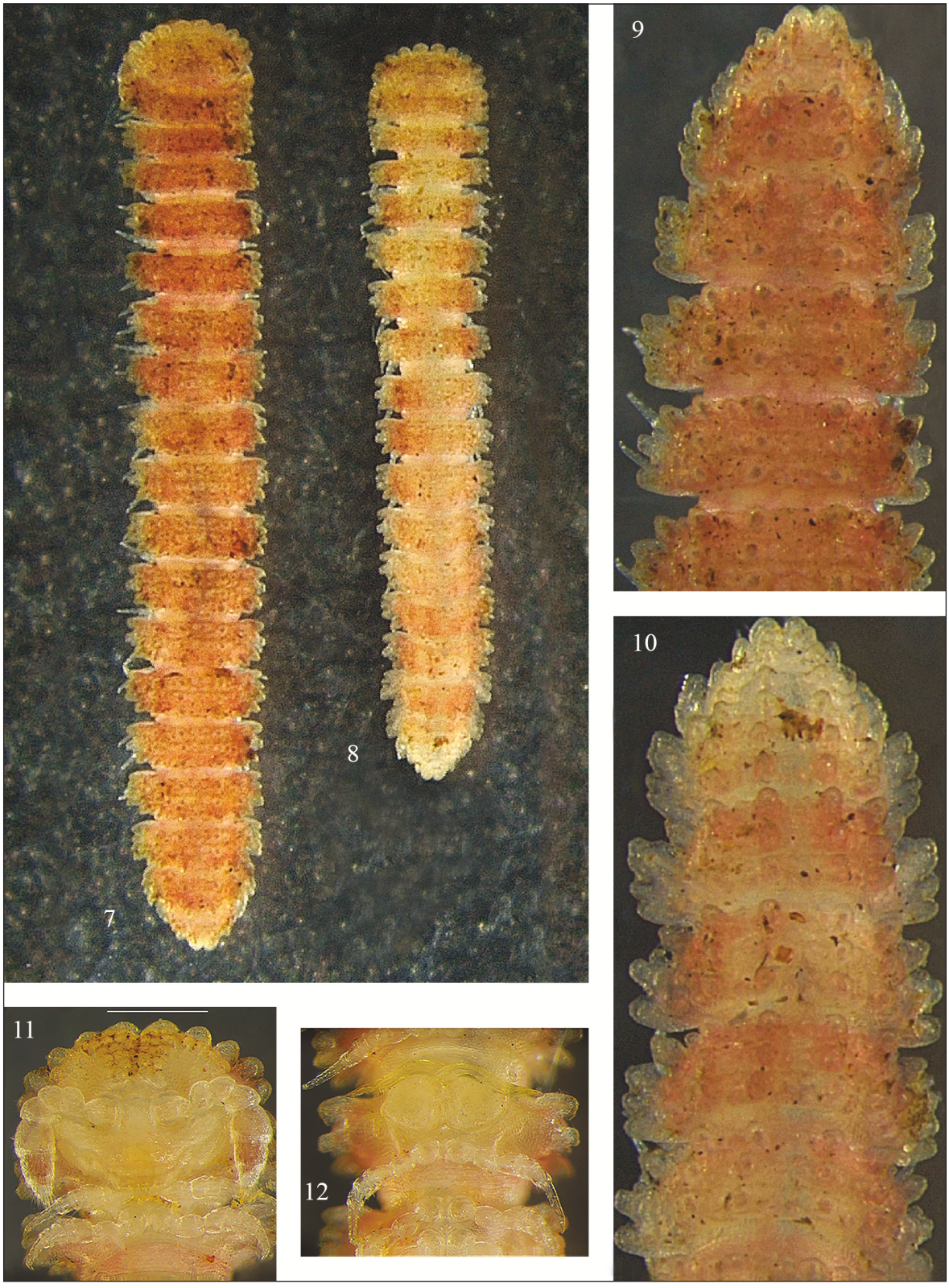
MATERIAL EXAMINED. ITALY • 14 shells; Sicily, Botanical Garden of Palermo: Tropical greenhouse; 23 Mar. 2013. • 16 shells; idem; 30 Mar. 2014. • 2 shells, 1 specimen; idem; 25 Mar. 2023. • 18 shells; idem; 5 Apr. 2017. • 11 shells; idem; 24 Dec. 2019. • 13 shells; idem; 1 Mar. 2021. • 17 shells, 5 specimens; idem: Orchid greenhouse; 15 Oct. 2021. • 4 specimens; idem; 11 Mar. 2023. • 9 shells, 1 egg; idem; 12 May 2023. •1 shell; idem; 20 Feb. 2024. •2 shells, 2 specimens; idem; 11 Dec. 2024 .

DESCRIPTION. *Zonitoides arboreus* (Figs. 16, 20) is morphologically similar to *Z. nitidus* (O.F. Müller, 1774) from which it differs for having a smaller shell in diameter (max 5 mm) and height (max 2.5–2.7 mm), a more flattened opening, a generally light brown color and a gray-cerulean body compared to the dark brown shell and gray-black body of *Z. nitidus*. The genital organ differs for the preapical portion of the stylophore which has a bilobed coronal gland (Fig. 19); in *Z. nitidus* this coronal gland is absent or unilobed (Evangelista et al., 2013: fig. 4).

DISTRIBUTION AND BIOLOGY. This alien species, native to the Nearctic Region (Pilsbry, 1946; Riedel, 1980; Abbott, 1989; Seddon, 2008), has been spread by humans in many areas of the world through greenhouse cultivation. In Italy, it is known in Liguria, Piedmont, Tuscany (Evangelista et al., 2013) and Campania (Naples) (Maio et al., 2017). It is reported for Sicily by Maio et al. (2017) based on the data of Evangelista et al. (2013), but in this last work no locality or personal communication by the authors is cited. This new record from Botanical Garden of Palermo confirms its presence in Sicily.

In 2013, in the laboratory, by observing some phases of the biological cycle, it can be noticed: at the beginning of April, some eggs are laid in the soil, roundish in shape, flattened at the poles, whitish in color with a calcareous casing and a diameter of 0.8 mm. At birth, the young specimens have a shell of 0.85 mm, yellowish-white in color, faded and with a very light blue body; the more they grow, the darker they become

REMARKS. From 2013 to 2021, shells and occasional live specimens were found in the Tropical Greenhouse. In 2013, some specimens were in



Figures 7–9. *Poratia obliterata* from Botanical Garden of Palermo (Sicily, Italy). Fig. 7: female length = 5.2 mm. Fig. 8: male length = 4 mm. Fig. 9: last six segments of the female. Fig. 10: last six segments of the male. Figs. 11, 12: particular of the male *Poratia obliterata*. Fig. 11: head, scale bar: 250 µm. Fig. 12: left gonopods, mesal view.

close contact with a tank full of water in which pots hosting specimens of *Rhizophora mangle* L., 1753 were immersed. In the following years, following the emptying of the same tanks, sampling confirmed further shells but fewer and fewer sporadic specimens. It is currently presumably absent given the negative results of the research. From 2021 to today, an undisturbed colony lives inside the Orchid Greenhouse, where it finds refuge among the hundreds of shelters above the benches.

Familia ACHATINIDAE Swainson, 1840
Genus *Allopeas* H.B. Baker, 1935

Allopeas clavulinum (Potiez et Michaud, 1838)

MATERIAL EXAMIDED. ITALY • 28 shells; Sicily, Botanical Garden of Palermo: Tropical greenhouse; 30 Mar. 2014. • 30 shells; idem; 13 Dec. 2016. • 18 shells; idem; 5 Apr. 2017. • 11 shells; idem; 24 Dec. 2019. • 17 shells; idem; 1 Mar. 2021. • 3 shells, 5 specimens; idem: Orchid greenhouse; 11 Mar. 2023. • 1 shell; idem; 12 May 2023. • 2 shells (originally 2 specimens), 5 juveniles born in laboratory, 1 egg; idem; 29 Nov. 2023. • 4 shells, 5 specimens; idem; 20 Feb. 2023. • 1 shells, 3 specimens; idem; 11 Dec. 2024.

DESCRIPTION. For a recent and detailed diagnosis of this species (Figs. 13, 17) see Manganelli et al. (2024).

DISTRIBUTION AND BIOLOGY. It has a tropical distribution including territories such as Asia, Oceania, Africa and South America; outside these countries, it is found exclusively in synanthropic contexts within gardens and greenhouses, and is known for New Zealand, the United Kingdom, the Czech Republic, and recently also Spain (Horsák et al., 2020; Serna & Martinez, 2023). Recently, this species has been reported for northern Italy from botanical garden greenhouses (Manganelli et al., 2024). In laboratory (Fig. 18), in 2023, two specimens mated in a shell-mounting position and several eggs were laid, whitish with calcareous casing and diameter of 0.9 mm. Young specimens at birth with diameter of 0.7-0.8 mm, pale yellow body.

REMARKS. *Allopeas clavulinum* was initially only found in numerous empty shells from March 2014, where it lay in abundance on the compost used as a base for the numerous pots in the Tropical Greenhouse. Over the years, despite numerous in situ observations, it has never been found alive in this greenhouse. Only recently, in March 2023, a living population was found for the first time and subsequently confirmed several times in the adjacent Orchid Greenhouse, where it reproduces and abounds due to the constant microclimatic conditions. Eggs and specimens of all life stages have been observed. The identification is supported by the anatomy of the genitals, which, when compared with the tables of Schileyko (1999), match overall, both in the vaginal and penial tract.

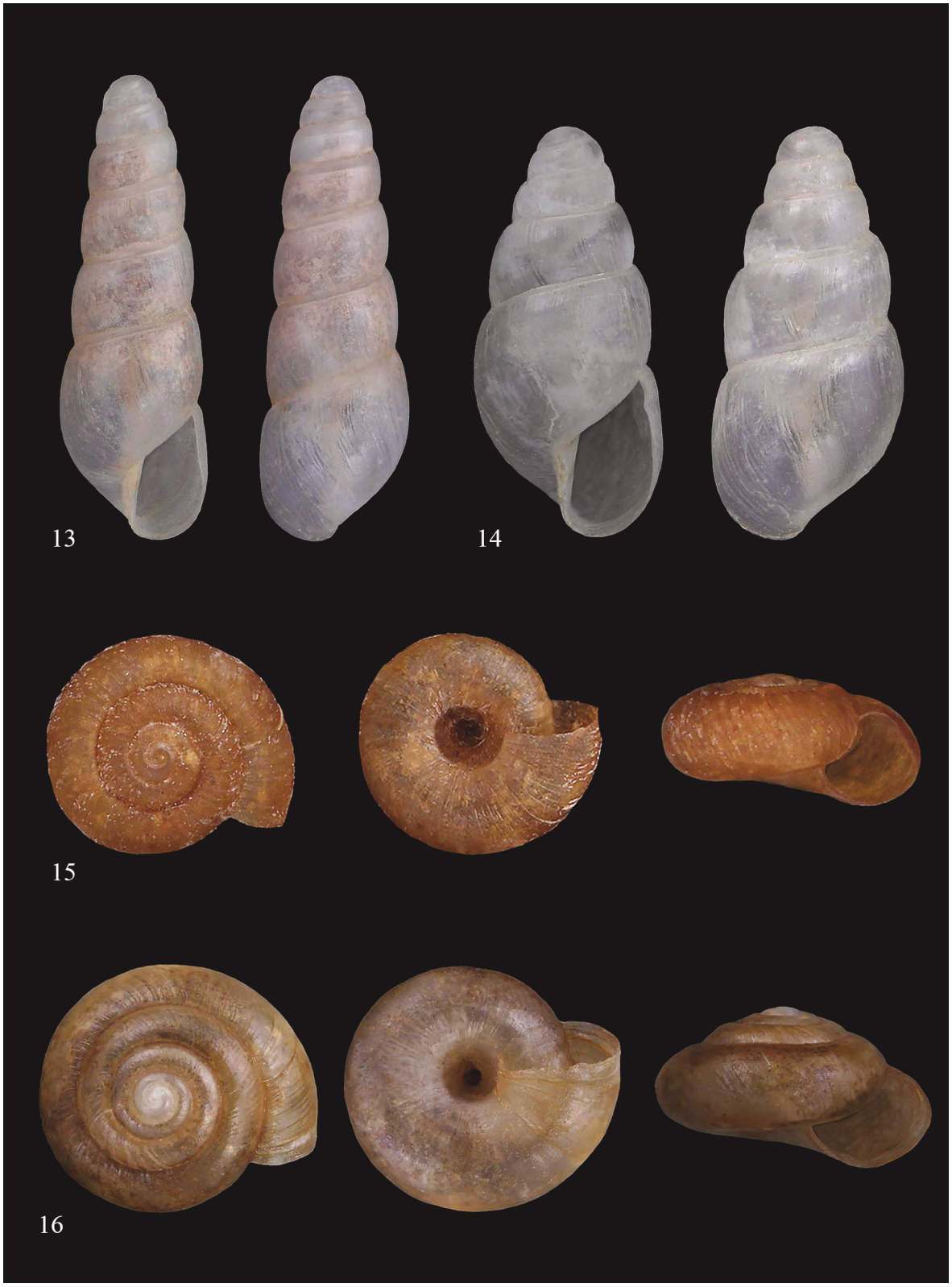
Genus *Opeas* Albers, 1850

Opeas opella Pilsbry et Vanatta, 1906

MATERIAL EXAMINED. ITALY • 1 shell; Sicily, Botanical Garden of Palermo: Tropical greenhouse; 1 Mar. 2021 (Fig. 14).

DESCRIPTION. The shell is squat, translucent, with wider whorls and curved radial striae, obtuse apex, drop-shaped opening with columellar wall provided with thin callosity and rounded lower margin. Compared on web to *Allopeas brevispira* (Pilsbry et Y. Hirase, 1904), it differs in its slightly larger size and slightly more elongated shape and longer aperture. However, considering the single specimen studied, a minimal uncertainty in the determination of this species could arise, especially related to the high intraspecific variability of this family.

DISTRIBUTION AND BIOLOGY. Species originally described for Honolulu and Hilo (Hawaii) (Pilsbry & Vanatta, 1906), will be considered shortly after non-native to Hawaii and accidentally introduced from the East Indies and Asia (Pilsbry, 1906). Cowie (1997; 1998) reports it as an introduced species for other Hawaiian islands. It is also known to be a non-native species in Brazil (Baker, 1913; Agudo-Padròn & Lenhard, 2010; Silva et al., 2021), but Salvador et al. (2024), who also report this species in Brazil, do not specify whether it is an alien or native species. This species has also been introduced in New Caledonia (Cowie, 2001). *Opeas opella* is a new report for European territory.



Figures 13–16. Alien land snails from Botanical Garden of Palermo (Sicily, Italy). Fig. 13: *Allopeas clavulinum*, measure: height = 8 mm, wide = 2.6 mm. Fig. 14: *Opeas opella*, height: 6 mm, wide: 2.9 mm. Fig. 15: unidentified species of Charopidae, height = 0.45 mm, wide = 1.9 mm. Fig. 16: *Zonitoides arboreus*, height = 2.7 mm, wide = 5 mm.

REMARKS. Only one specimen together with many *Allopeas clavulinum*. Probable isolated case through the transport of plants.

Familia CHAROPIDAE Hutton, 1884

Unidentified species (Fig. 15)

MATERIAL EXAMINED. ITALY • 2 shells; Sicily, Botanical Garden of Palermo: Tropical greenhouse; 30 May 2015. Mar. 2021. • 8 shells; idem; 5 Apr. 2017. • 5 shells; idem; 24 Dec. 2019. • 5 shells; idem; 1 mar. 2021. • 7 shells; idem; 10 Mar. 2022.

DESCRIPTION. Adult specimens with 2–2.4 mm of diameter and 1–1.2 mm of height, rusty brown periostracum, medium deep sutural groove, also visible in apertural view, shell adorned with numerous radial ribs in a sinuous pattern, smooth protoconch. Sub-rounded aperture, simple peristome with upper margin more forward than the lower one. Umbilicus as wide as 1/3 of the diameter of the shell, deep.

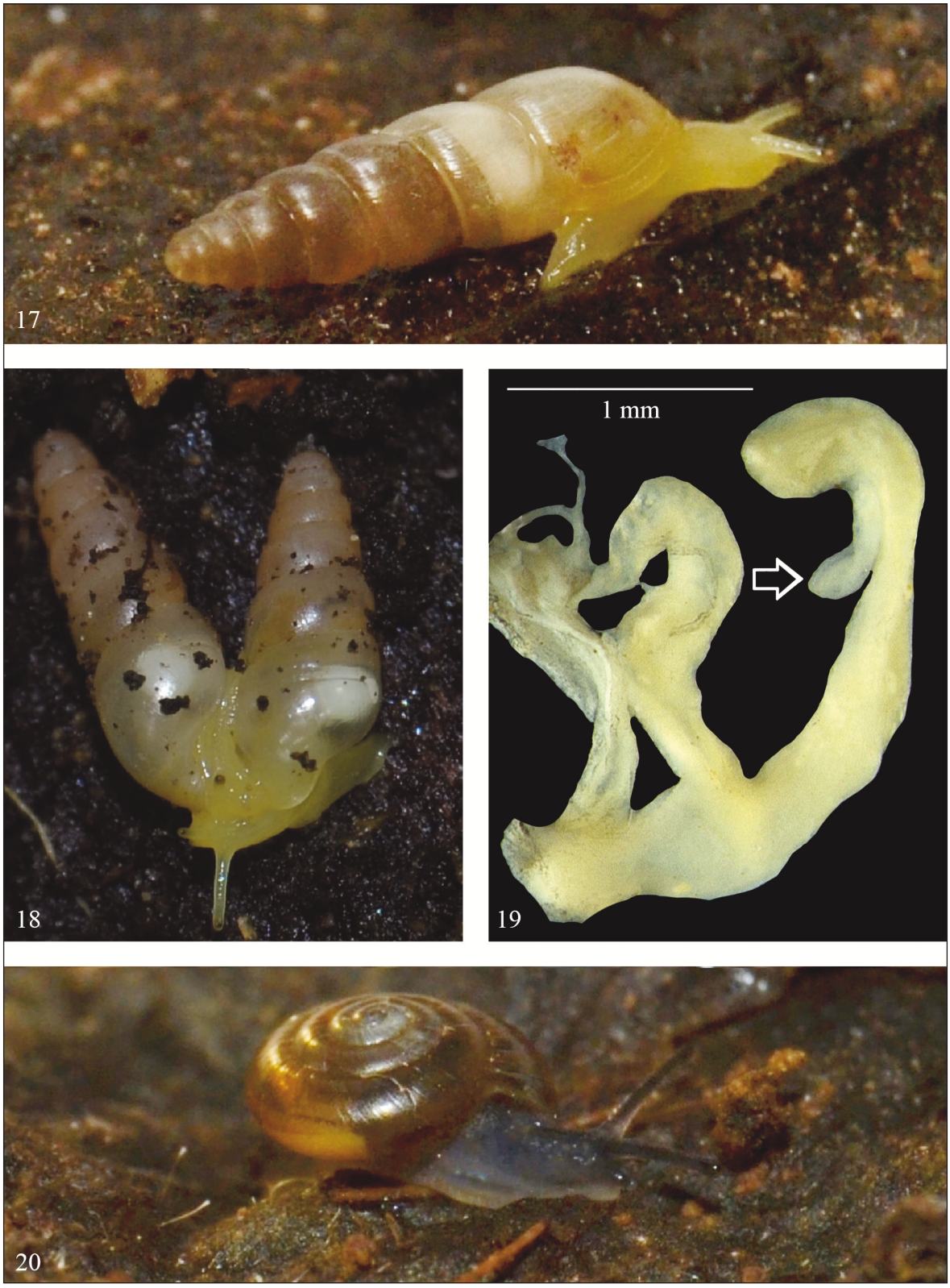
DISTRIBUTION AND BIOLOGY. Charopidae is a family of small terrestrial molluscs widely distributed on land masses in the Southern Hemisphere (Australia, New Zealand, South Africa and South America) and some Pacific islands (https://factsaboutsnails.com/), that counts 106 genera and 725 species (Proios et al., 2021). In Japan, this family was found in greenhouses, introduced with horticultural plants (Ueshima et al., 2014). Recently, at the Botanical Garden of Leiden (The Netherlands), four unidentified species of Charopidae were collected from a banana leaf and in the orchid greenhouse (Da Sois, 2016). This is the first report of this family for Italy.

REMARKS. Only a few shells - many calcined, others with a fresher periostracum - have been found on the debris composed of organic soil and volcanic lapilli of the elevated bank on the right in the Tropical Greenhouse, until 2022. It is probably a small group of specimens that survived for a short time. The shell, due to the following external characteristics, could belong to the genus *Paracharopa* Climo, 1983.

DISCUSSION

Once again Sicily proves to be a fertile territory for the settlement of exotic species. It is sufficient to point out the historical presence in Sicily of the *Phoracantha semipunctata* (Fabricius, 1775) (Romano & Carapezza, 1975) Australian cerambycid beetle, which infests *Eucalyptus* trees, and the damaging colonisation of the red weevil *Rhynchophorus ferrugineus* (Olivier, 1970) in particular on *Phoenix canariensis* Hort. ex Chabaud (Longo & Tamburino, 2005; Lo Verde & Massa, 2007). Recently, two diurnal lepidoptera, *Siproeta epaphus* (Latreille, 1813) and *Amauris hecate hecate* (Butler, 1866), were found in the city of Palermo (Viviano, 2024). As the case of these lepidoptera, which are assumed to have been passively introduced through plants or actively for terrarium purposes, these invertebrates are also linked to the transport and cultivation of the numerous orchid species hosted in greenhouses. Other arthropod taxa known from Sicily, were also recorded inside the greenhouse: the Isopoda *Haplophthalmus danicus* Budde-Lund, 1880 (Trichoniscidae), *Agabiformius lentus* (Budde-Lund, 1885) (Porcellionidae), followed by miriapods *Brachydesmus proximus* (Latzel, 1889) (Diplopoda Polydesmidae), *Pachyiulus flavipes* (Koch, 1847) (Diplopoda Julidae), *Hanseniella* sp. (Symphyla Scutigerellidae) and the Formicidae *Hypoponera* sp. (personal data).

In addition, to the Orchid greenhouse and the Tropical greenhouse, the Botanical Garden itself offers large spaces that over time have proven to be populated by numerous other species of invertebrates, not only indigenous, but also exotic, already known to the Sicilian territory: the flatworms *Diversibipalium multilineatum* (Makino & Shirasawa, 1983) and *Caenoplana* spp. (Mori et al., 2022), the millipedes *Oxidus gracilis* (Koch, 1847), and the terrestrial molluscs, such as *Ambigolimax valentianus* (Férussac, 1823) (Limacidae), *Ferrissia californica* (Rowell, 1863) (Planorbidae), *Hawaiia minuscula* (Binney, 1841) (Pristilomatidae), *Lucilla scintilla* (Lowe, 1852) and *Lucilla singleyana* (Pilsbry, 1889) (Helicodiscidae), *Paralaoma servilis* (Shuttleworth, 1852) (Punctidae), *Planorbella duryi* (Wetherby, 1879) (Planorbidae), *Physella acuta* (Draparnaud, 1805) (Physidae) and *Radix auricularia* (Linnaeus, 1758) (Lymnaeidae), the latter two probably of ancient introduction (Villa & Villa, 1841; Aradas & Maggiore, 1842; Philippi, 1844; Cassarà, 1948; Bodon et al., 2004; Reitano et al., 2007; Marrone et al., 2011; Vecchioni et al., 2017;



Figures 17, 18. Living specimens and anatomical particular of the alien land snails from Botanical Garden of Palermo (Sicily, Italy). Fig. 17: *Allopeas clavulinum* living specimen. Fig. 18: *Allopeas clavulinum* in mating. Fig. 19: *Zonitoides nitidus* anatomical complex with detail of the two lobes of the stylophore. Fig. 20: *Zonitoides nitidus* living specimen.

Sparacio et al., 2017; Sparacio et al., 2018; Bank & Neubert, 2020; Bodon et al., 2021 in Bologna et al., 2021; Sparacio et al., 2024; Viviano et al., 2024; Viviano personal data).

CONCLUSIONS

This study confirms once again that man is the main cause of the introduction of numerous alien species. This greenhouse represents a true example of how the exchanges and transports of exotic plants can bring with them small organisms new to the host territories, often coming from distant continents or from geographically more or less close regions. The Botanical Garden of Palermo, with its numerous exchanges and planting of new plants, will always represent an interesting place where research on alien and even local fauna can be carried out. It is not to be excluded that further species collected in this urban context may be reported, which has so far proven to have a very high bioecological importance.

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