A REVIEW OF THE DISTRIBUTION OF *OTALA PUNCTATA* (O.F. MÜLLER, 1774) (GASTROPODA: STYLOMMATOPHORA: HELICIDAE) OUTSIDE OF ITS NATIVE RANGE

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ABSTRACT

The aim of this contribution is to analyze the diffusion of the terrestrial mollusc *Otala punctata* (O.F. Müller, 1774) outside of its native range. Through this analysis, the importance of historical malacological collections present in natural history museums around the world is highlighted.

Keywords: Malta, Italy, non-indigenous species, Mollusca, museum collection

SINTEŻI

[Id-distribuzzjoni ta' *Otala punctata* (O.F. Müller, 1774) (Gastropoda: Stylommatophora: Helicidae) barra mill-firxa indiġena tagħha.] L-għan ta' din il-kontribuzzjoni hija l-analiżi tat-tixrid tal-mollusk tal-art *Otala punctata* (O.F. Müller, 1774) barra mill-firxa indiġena. Permezz ta' din l-analiżi tingħata xhieda l-importanza tal-kollezzjonijiet malakoloġiċi storiċi f'mużewijiet tal-istorja naturali madwar id-dinja.

Kliem muftieħ: Malta, Italja, speċi mhux indiġena, Mollusca, kollezzjoni tal-mużew

INTRODUCTION

The accidental and deliberate introduction of non-native species is a notable worldwide phenomenon, which has been identified as one of the leading causes of global biodiversity decline (MCKINNEY & LOCKWOOD, 1999; CLAVERO & GARCIA-BERTHOU, 2005; BUTCHART et al., 2010). Moreover, many introduced non-native species are harmful to local and regional economic activities, as well as to human welfare (PIMENTEL et al., 2005; HULME, 2014). The helicid *Otala punctata* (O.F. Müller, 1774) is a western Mediterranean thermophilic species, with a range extending from the north-western tip of Algeria to France (FALKNER, 1990; CLANZIG & BERTRAND, 2001; FALKNER et al., 2002; MAUREL, 2006; HERBERT, 2010; WELTER-SCHULTES, 2012; HOLYOAK & HOLYOAK, 2017). SACCHI (1965) suggests a Ibero-Maghrebian origin for the species, while MARTÍNEZ-ORTÍ & ROBLES (2001) consider the species native to the Iberian Peninsula. Its introduction in non-native environments has the potential to alter local ecosystems (POINTIER & AUGUSTIN, 1999). Owing to its ready establishment in various temperate habitats, *O. punctata* has gained popularity as a delicacy in some countries, for example in France, where it is protected (BARBARA & SCHEMBRI, 2008). In some cases, *O. punctata* has become invasive, and has proliferated to the point of becoming a horticultural and agricultural pest (BORAY & MUNRO, 1998; MIENIS, 1999a) that can be challenging to eradicate (MACDONALD et al., 2003; FRANK, 2010). Although there is no precise documentation of the monetary losses suffered by the agricultural sector due to *O. punctata*, this sector is known to experience high financial losses with respect to the management of invasive species in general (PAINI et al., 2016).

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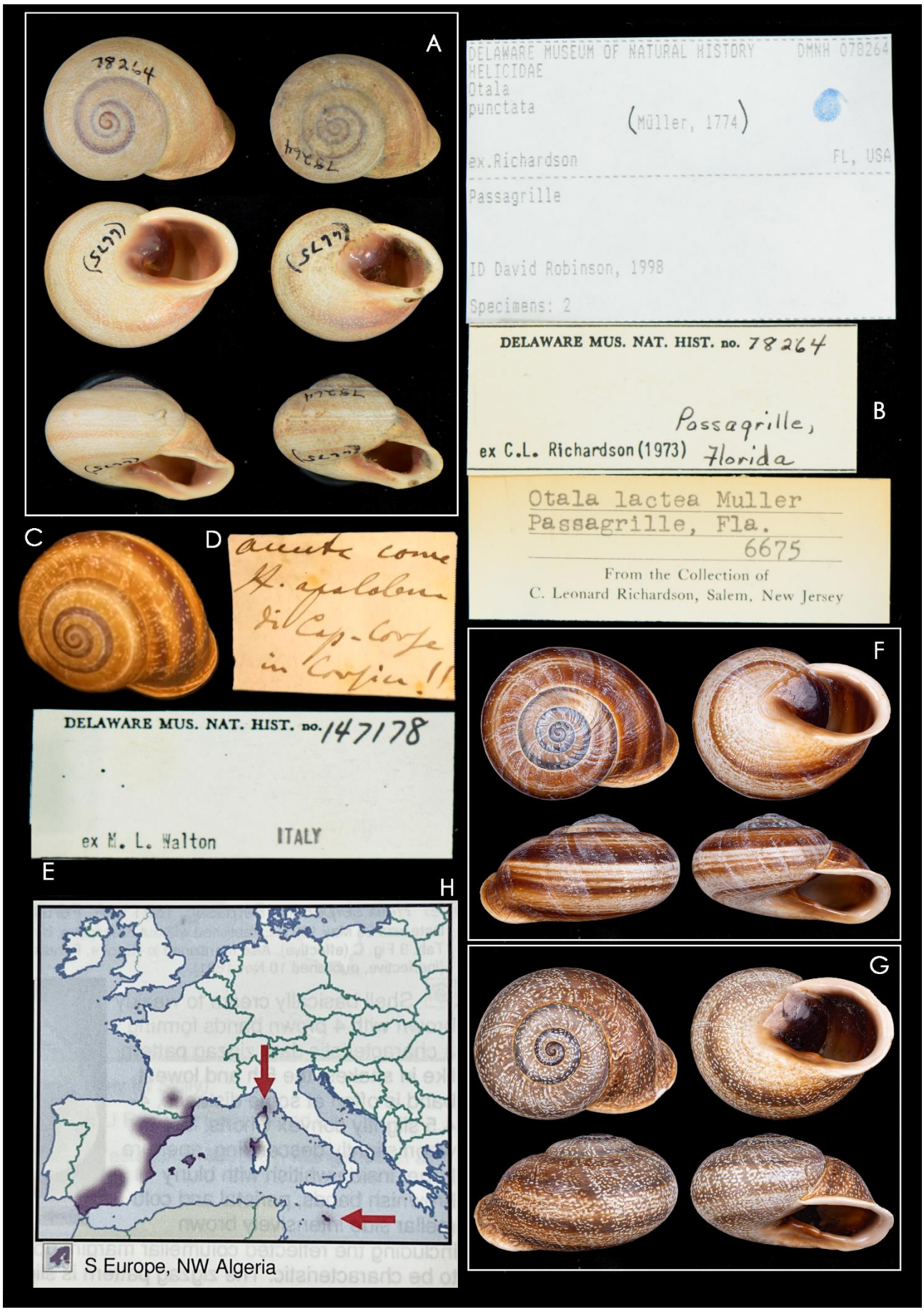

Pl. 1 Figs. A–H: Museum specimens of *Otala punctata* (O. F. Müller, 1774) from outside its native range and related textual information. **A**: Different views of two specimens of *Otala punctata* (O. F. Müller, 1774) from Passagrille, Pinellas County, Florida, U.S.A., lot registered as DMNH 78264. **B**: Three museum labels of lot DMNH 78264. **C**: A

specimen of *Otala punctata* (O. F. Müller, 1774) from Cap Corse, Corsica, France, lot from the collection of Tommaso di Maria ALLERY, marquis of MONTEROSATO (1841–1927) in the Museo Civico di Zoologia, Rome, Italy. **D**: Label with MONTEROSATO's handwriting for the specimen in the preceding figure. *Helix apalolena* Bourguignat, 1867 is a synonym of *Otala punctata* (O. F. Müller, 1774) (photos C & D courtesy of M. APPOLLONI, Museo Civico di Zoologia, Rome, Italy). **E**: Museum label of two specimens of *Otala punctata* (O. F. Müller, 1774) from Italy (no detailed location data), lot registered as DMNH 147178 (photos A, B & E courtesy of Liz SHEA, DMNH). **F**: Different views of a specimen of *Otala punctata* (O. F. Müller, 1774) from Mosta, Malta, from lot registered as NMNH 80-003. **G**: Different views of a specimen of *Otala punctata* (O. F. Müller, 1774) from Baħrija, Rabat, Malta, from lot registered as NMNH 80-004 (figures F & G courtesy of A. NAPPO, Hamrun, Malta). **H**: Range in Europe of *Otala punctata* (O. F. Müller, 1774) according to WELTER-SCHULTES (2012: 624).

MATERIALS AND METHODS

The research on museum collections was carried out by consulting catalogues available online. In some cases, curators of the collections were contacted directly.

Abbreviations:
ANSP: Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, U.S.A.
CAS: California Academy of Sciences, San Francisco, California, U.S.A.
CM: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.
DMNH: Delaware Museum of Nature & Science, Wilmington, Delaware, U.S.A.
DMNS: Denver Museum of Nature and Science, Denver, Colorado, U.S.A.
FML: Fundación Miguel Lillo, Tucumán, Argentina
FMNH: Field Museum, Chicago, Illinois, U.S.A.
HNS: Haus der Natur, Salzburg, Austria
INHS: Illinois Natural History Survey, Champaign, Illinois, U.S.A.
LACM: Natural History Museum of Los Angeles, Los Angeles, California, U.S.A.
MACN: Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina
MMK: Malacological Museum Malakos, Città di Castello, Perugia, Italy
MNCB: Museu de Ciències Naturals de Barcelona, Barcelona, Spain
MNRJ: Museu Nacional, Rio de Janeiro, Brazil
MZUC: Museo de Zoología de la Universidad de Concepción, Biobío, Chile
MZUF: Museo Zoologico 'La Specola', Firenze, Italy
NHMA: Naturhistorisk Museum Aarhus, Aarhus, Denmark
NMNH: National Museum of Natural History, Mdina, Malta
RBINS: Royal Belgian Institute of Natural Sciences, Brussels, Belgium
RMNH: Naturalis Biodiversity Center, Leiden, The Netherlands
SNSD: Senckenberg Naturmuseum Frankfurt, Frankfurt am Main, Germany
UF: Florida Museum of Natural History, Gainesville, Florida, U.S.A.
UMMZ: Museum of Zoology, University of Michigan, Michigan, U.S.A.

SYSTEMATICS

Stylommatophora Schmidt, 1855
Helicoidea Rafinesque, 1815
Helicidae Rafinesque, 1815
Helicinae Rafinesque, 1815
Thebini Wenz, 1923
Otala Schumacher, 1817

> (*Helix*) *Otala* SCHUMACHER, 1817: 58, 191. [type species *Helix lactea* O.F. Müller, 1774, by subsequent designation in PILSBRY, 1895: 323]

Otala punctata (O. F. Müller, 1774) (**Pl. 1 Figs. A–G**)

> *Helix punctata* O. F. MÜLLER, 1774: 21. [*locus typicus* given as '*Italy*', but probably from North Africa (see PALLARY, 1914)].

Remarks: The general appearance of the shell alternates dark and light brownish spiral bands, covered with numerous tiny white spots, rather similar to snowflakes. Whorls feature a dark grey-brown band above the suture. Interior of aperture covered with a dark brown to almost black enamel, which obscures the underlying color pattern. Flared edge of the outer lip is pale. Diameter may be up to 40 mm (HERBERT, 2010).
In parts of the Iberian peninsula to where it is indigenous, *O. punctata* is often sympatric with *Otala lactea* (O.F. Müller, 1774), and both species show similar life cycle patterns (ROBINSON et al., 1998). However, *O. lactea* is distinguished from *O. punctata* by the colour of the peristome, which is very dark brown to black in the former, but light brown to whitish in the latter (SEBBAN et al., 2022).
The habitat of *O. punctata* is highly variable. It is known to thrive on rocky slopes (KERNEY et al., 1983), coastal zones (FRANK, 2010), gardens (MIENIS, 1999a; GRANO & SPARACIO, 2023), wasteland, industrial land, disturbed land, docks (HERBERT & SIRGEL, 2001), rural environments (DE MATTIA & MASCIA, 2011), vineyards, and walls (HERBERT, 2010; CILIA, 2012). The species is mostly nocturnally active (BARBARA & SCHEMBRI, 2008), particularly with dewfall, which facilitates mobility. In aestivation, *O. punctata* seals its aperture with an epiphragm (BARBARA & SCHEMBRI, 2008). During its active season, the snail feeds on foliage, favouring dense ruderal vegetation for grazing.
Despite the literature cited above, the biology of *O. punctata* is not well documented; much more has been published on the similar helicids *O. lactea* and *Eobania vermiculata* (O. F. Müller, 1774) (BOUAZIZ-YAHIATENE et al., 2017; HOLYOAK & HOLYOAK, 2017; EKIN, 2023), both thermophilic Mediterranean species sharing similar morphologies, ecology, and life cycles (BARBARA & SCHEMBRI, 2008).

RESULTS

Through synanthropic dispersal, this species is known to have spread to other areas within the Mediterranean, such as Italy (DE MATTIA & MASCIA, 2011; GRANO & SPARACIO, 2023) and Malta (MIFSUD et al., 2003 sub *Otala lactea*; BARBARA & SCHEMBRI, 2008; CILIA, 2012; CAMILLERI et al., 2021), but also to more distant locations such as South Africa (HERBERT & SIRGEL, 2001), Argentina, Brazil, Chile, Uruguay (MIENIS, 1999a; ARAYA, 2015), and the U.S.A. (MIENIS, 1999b, 2001; ALBRECHT, 2001; COWIE et al., 2009).

Italy: In Italy, *O. punctata* was recorded for the first time by MALATESTA & SETTEPASSI (1954 sub *Archelix apalolena* (Bourguignat, 1867)) from Alghero in Sardinia. Its presence in the same area was confirmed CARRADA et al. (1967). Significantly, both papers reported finding badly preserved shells only, with no living specimens found. More recently, the presence in Sardinia was confirmed by DE MATTIA & MASCIA (2011). The species is present exclusively in the southern surroundings of the city of Alghero (Sassari), along the southern rocky coastal area of the city, from sea level to 40 m altitude. Populations cover an area of approximately 0.4 km^2. CARRADA et al. (1967) stressed the presence of fossil shells of *O. punctata* in travertines from Alghero, but this has not been confirmed. Preliminary field research revealed that, in the surroundings of Alghero, Quaternary deposits do not show a presence of *O. punctata* (DE MATTIA & MASCIA, 2011). BALDINO et al. (2008) and WILKENS (2004) did not cite the species from the archaeological sites of Northwestern Sardinia. In addition, PAULUCCI (1882) did not cite *O. punctata* for Sardinia. The introduction in Sardinia of *O. punctata* may be referred to the Aragonese occupation during the 14th century C.E. The traditional local denomination of this species, '*caragol español*' [*Spanish snail*], could support this hypothesis (DE MATTIA & MASCIA, 2011). The second (and most recently documented) population is that in the city of Rome (GRANO & SPARACIO, 2023). Here, the population is present in a very narrow area of one of the city's historic parks, Villa Torlonia, which has a total area of 0.132 km^2. The presence of *O. punctata* in Rome is almost certainly attributable to anthropochory, with two leading hypotheses. The first is related to trade in molluscs for food purposes, practiced

by man since ancient times with the dispersal of living populations from one region to another. In Rome, consumption of terrestrial molluscs is widespread and a part of traditions consolidated since historical times (GRANO, 2021). Introduction of *O. punctata* linked to human consumption has already been documented, for example, in France (CLANZIG & BERTRAND, 2001). DE MATTIA & MASCIA (2011) state that *O. lactea* and *O. punctata* were commonly farmed in heliciculture plants in Sardinia. SPARACIO (2020) reports the presence, in 2015 and 2018, of *Otala* sp., in bags containing *Theba pisana* (O.F. Müller, 1774) for sale in the markets of Palermo. A report of *O. lactea* in Tuscany refers to specimens escaped from a heliciculture plant in Campagnatico, in the province of Grosseto (BODON et al., 2021).
The second hypothesis to take into consideration could be that of passive transport with 15 palm trees planted in Villa Torlonia in May 2022. These palm trees were planted to replace, albeit partially, 29 specimens of *Phoenix canariensis* H.Wildpret, removed due to infestation with *Rhynchophorus ferrugineus* (Olivier, 1790).
Museum specimens of *O. punctata* from Italy recovered during the present research are listed in **Table 1.**

Malta: There are no native species of *Otala* on the Maltese Islands (GIUSTI et al., 1995). Reports of the similar *O. lactea* exist: FEILDEN (1879) collected a number of beached specimens, presumably transported by the sea, while MACHIN (1972) claimed to have obtained a culture of *O. lactea* from Malta, although it is more likely that these were the common *E. vermiculata*, which superficially resembles *O. lactea*. After, MIFSUD et al. (2003) claimed to have recorded *O. lactea* within a plant nursery in central Malta. However, it is highly likely that the records by FEILDEN (1879) and MIFSUD et al. (2003) are misidentifications of *O. punctata*. In fact, BARBARA & SCHEMBRI (2008), visiting the surrounding areas of the same nursery, found a substantial population of *O. punctata*. BARBARA & SCHEMBRI (2008) state that this species has established itself in an estimated area of 50,000 m² in the immediate vicinity of the Mosta nursery, occupying various sites and habitats around the nursery. The snails did not have particular substratum preferences and individuals were found on dry-stone walls, under stones, and on a variety of ubiquitous flora, including wild carrot *Daucus carota* L., *Diplotaxis tenuifolia* (L.) DC., *Ferula melitensis* Brullo, C. Brullo, Cambria, Giusso, Salmeri & Bacch., *Foeniculum vulgare* Mill., *Lavatera arborea* L., *Galactites tomentosus* Moench, and *Glebionis coronaria* (L.) Cass. ex Spach.
Museum specimens of *O. punctata* from Malta recovered during the present research are listed in **Table 1.**

South Africa: The first population of *O. punctata* in South Africa was found at Tygerberg Hospital, near Cape Town, in December 1986, and the second population at the Cape Town docks, in January 1987 (HERBERT & SIRGEL, 2001; DAVIES ET AL., 2020; JANION-SCHEEPERS & GRIFFITHS, 2020). An eradication programme was started promptly, and the two populations were targeted from 1987 to 1989 and monitored through to Aug. 1990, with no further presence of the species detected thereafter (HERBERT & SIRGEL, 2001). Control techniques included manual collection of snails and baiting with molluscicide. Dense vegetation such as patches of grass were removed using herbicide and flame throwers, so that snails could be detected more easily.
HERBERT & SIRGEL (2001) estimated that the Tygerberg colony initially covered about 40,000 m², and that over 22,000 snails were removed from the area. The eradication project was justified because no species of *Otala* had ever been reliably recorded in South Africa prior to 1986, and they were known to be invasive elsewhere. Since this is a relatively large polyphagous herbivore, there is a possibility it could be reintroduced in future, either for cultivation or by accident (DAVIES et al., 2020).

South America: In Chile, the first record of *O. punctata* is from Buin, Santiago (33°43’59” S; 70°45’00″ W) and refers to two specimens collected attached to fence-posts in a vineyard (ARAYA, 2015).
Museum specimens of *O. punctata* from South America recovered during the present research are listed in **Table 1.**

U.S.A.: MIENIS (1999b) reports that Harry G. LEE (1940–2024) sent him a specimen of *O. punctata* that he collected at Fernandina Beach, Nassau County, Florida. Currently, this species is found in the same locality, although it shows no sign of expanding its range. In this location it feeds on some

ornamental plants, but does not constitute a serious problem (CAPINERA & WHITE, 2011). In research through museum collections, numerous specimens of *O. punctata* were found, collected in Georgia (FELIX et al., 2018).
Museum specimens of *O. punctata* from the U.S.A. recovered during the present research are listed in **Table 1.**

Table 1: Museum specimens of *Otala punctata* (O.F. Müller, 1774) from outside of its native range traced for the present paper, sorted alphabetically by country and location. Unknown years of collection are intentionally left blank.

Country	Location	Year	Registration
Argentina	Buenos Aires		MCNB 78-0231
Argentina	Buenos Aires		MCNB 79-4221
Argentina	Buenos Aires		CAS 41613
Argentina	Buenos Aires		FMNH 37340
Argentina	Buenos Aires		FMNH 54757
Argentina	Buenos Aires		FMNH 57457
Argentina	Buenos Aires		FMNH 65236
Argentina	Buenos Aires		FMNH 69210
Argentina	Buenos Aires		FMNH 94484
Argentina	Buenos Aires		FMNH 147368
Argentina	Buenos Aires		ANSP1462
Argentina	Buenos Aires		ANSP 5785
Argentina	Buenos Aires		ANSP 32738
Argentina	Buenos Aires		MMK 17183
Argentina	Buenos Aires		UF 97647
Argentina	Buenos Aires	1938	FMNH 125480
Argentina	Buenos Aires	1939	FMNH 191980
Argentina	Buenos Aires, Bahia Blanca		FML 15424
Argentina	Buenos Aires, Mar del Plata		FML 681
Argentina	Buenos Aires, Mar del Plata		FML 10306
Argentina	Buenos Aires, Mar del Plata		FML 15421
Argentina	Buenos Aires, Miramar		MACN 35640
Argentina	Buenos Aires, Monte Hermoso	1982	RMNH 55632
Argentina	Buenos Aires, Necochea		FML 12780
Argentina	Buenos Aires, Port of Lading	1997	UF 528499
Argentina	Buenos Aires, San Pedro		UF 222553
Argentina	Buenos Aires, Sierra de Los Padres		FML 15427
Argentina	Buenos Aires, Tres Arroyos		DMNH 137735
Argentina	Buenos Aires, Villa Gesell	1980	MMK 39200
Argentina	Cordoba, Rio Quarto		UMMZ 153575
Argentina	La Pampa	2009	UF 519406
Argentina	Mar del Plata	1963	FMNH 217354
Argentina	Mendoza, La Consulta		MMK 39366
Argentina	Mendoza, Parque Gral San Martin		FML 15958
Argentina	Sa. De Cordoba, Rio Primero		RMNH 65840
Argentina	Tierra del Fuego		SNSD 46837
Brazil	Brazil		NHMA 29956
Brazil	Rio Grande do Sul		MNRJ 53879
Chile	Buin, Santiago		MZUC 39632
Cuba	not specified		MCNB 79-4258
Italy	not specified		CM 62.30325
Italy	not specified		DMNH 147178
Italy	not specified		INHS 94102
Italy	not specified		LACM 103017
Italy	Isolotto Argentarola, Grosseto	1885	MZUF 2764
Italy	Potenza		CM 144814
Italy	Sardinia		DMNH 146640
Italy	Siracusa, Vendicari	2002	CM66224
Malta	Baħrija, Rabat	2008	NMNH 80-004
Malta	Mosta	2005	NMNH 80-003
Malta	Ta' Qali, Attard/ Mosta	2003	NMNH 80-005
Malta	Ta' Qali, Attard/ Mosta	2003	NMNH 80-001
Malta	Ta' Qali, Attard/ Mosta	2003	NMNH 80-002
U.S.A.	California, San Diego, Miramar		CM 154275
U.S.A.	Florida, Nassau County, Fernandina Beach	1993	UF 208929
U.S.A.	Florida, Nassau County, Fernandina Beach	1993	UF 529835
U.S.A.	Florida, Nassau County, Fernandina Beach	2002	UF 528458
U.S.A.	Florida, Pinellas County, Passagrille		DMNH 78264

U.S.A.	Georgia, Chatham County		UF 223235
U.S.A.	Georgia, Chatham, 15 miles below Savannah	1930	FMNH 364261
U.S.A.	Georgia, Chatham, 2 miles west of Savannah	1959	FMNH 267831
U.S.A.	Georgia, Chatham, 2 miles west of Savannah	1959	FMNH 267833
U.S.A.	Georgia, Chatham, Cockspur Island		FMNH 118694
U.S.A.	Georgia, Chatham, Cockspur Island		ANSP 170287
U.S.A.	Georgia, Chatham, Cockspur Island		UF 27678
U.S.A.	Georgia, Chatham, Cockspur Island		UF 97613
U.S.A.	Georgia, Chatham, Cockspur Island		UF 223236
U.S.A.	Georgia, Chatham, Cockspur Island	1937	FMNH 118413
U.S.A.	Georgia, Chatham, Cockspur Island	1954	FMNH 109754
U.S.A.	Georgia, Chatham, Cockspur Island	1959	FMNH 267832
U.S.A.	Georgia, Chatham, Savannah Beach	1959	FMNH 267830
U.S.A.	Georgia, Chatham, small island near mouth of Savannah River		UF 97619
U.S.A.	Georgia, Chatham, Tybee Island	2004	FMNH 307861
U.S.A.	Georgia, Glynn, St. Simon Island		FMNH 83170
U.S.A.	Texas, Waco		FMNH 168164
Uruguay	Cerro de Montevideo		FMNH 159426
Uruguay	Ciudad de Salto		DMNH 78268
Uruguay	Garriti Island, Maldonado Bay	1892	ANSP 118953
Uruguay	Ioma de Montevideo		MCNB 79-4274
Uruguay	Maldonado		DMNH 25948
Uruguay	Maldonado	1960	FMNH 159435
Uruguay	Maldonado, Punta del Este		DMNH 158344
Uruguay	Mar del Plata, Punta Mogotes	1990	ANSP 447732
Uruguay	Montevideo		RBINS 143162
Uruguay	Montevideo		MCNB 77-8303
Uruguay	Montevideo		MCNB 79-4277
Uruguay	Montevideo		DMNH 25950
Uruguay	Montevideo		DMNH 34585
Uruguay	Montevideo		ANSP 30493
Uruguay	Montevideo		ANSP 67401
Uruguay	Montevideo		UF 97606
Uruguay	Montevideo	1948	FMNH 93242
Uruguay	Montevideo	1948	FMNH 107589
Uruguay	Montevideo	1967	RMNH 65839
Uruguay	Montevideo	1997	CAS 112582
Uruguay	Montevideo	1997	CAS 229193
Uruguay	Montevideo, Punta Gorda	1969	UF 128907
Uruguay	not specified		SNSD 44705
Uruguay	Punta del Este	1950	ANSP 251824
Uruguay	Rocha	1996	UF 529150
Uruguay	Rocha	1996	UF 534055
Uruguay	Rocha, La Paloma	1998	DMNS 34006
Uruguay	not specified		HNS 1901790
Uruguay	not specified		HNS 1902052

CONCLUSION

Alien species, particularly those that become invasive, have enormous economic and environmental consequences. PIMENTEL et al. (2005) estimated that the annual economic costs resulting from invasive alien species in the U.S.A. alone are approximately $120 billion (around €110 billion as of the time of writing). Biodiversity-related costs can also be considerable, and introduced species are recognized as one of the most significant threats to terrestrial biota (CLOUT, 1995, 2002), resulting in the homogenization of once diverse faunas (MCKINNEY & LOCKWOOD, 1999; COWIE, 2004). In addition, the economic impact of many slug and land snail pests on the agricultural sector is well known (BARKER, 2002).

All members of the genus *Otala* are edible and have been exploited as a cheap food source since historical times. This also led to introduction of *Otala* to other areas (MIENIS, 1999b). Traditional harvesting of these terrestrial molluscs directly from the wild has declined in recent decades, and sales from farmed populations (even as imports) have increased, especially in North Africa (SPARACIO, 2020). Internationally, Morocco is the topmost exporter in the world of edible snails (15.7%), followed by Romania (7.42%), Turkey (5.94%), France (5.93%), and Indonesia (5.71%)

(SEBBAN et al., 2022). Therefore, it is absolutely possible that *O. punctata* could expand its distribution areas, even in a relatively short time.

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