FIRST LOCATION OF THE INVASIVE SNAIL *XEROLENTA OBVIA* (MENKE, 1828) (STYLOMMATOPHORA, GEOMITRIDAE) IN THE IBERIAN PENINSULA

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Abstract A well–established population of Xerolenta obvia *has recently been discovered for the first time in the east of the Iberian Peninsula, specifically in Linares de Mora, a village in Teruel (Aragon, Spain). It is a land snail native to south-eastern Europe, also considered an invasive species in other countries and other continents. Morpho–anatomical studies of the shell and the reproductive system have been carried out, allowing us to confirm its identity. It is compared with the close–related species* Cernuella neglecta *and* Helicella itala. *The new location is shown relative to its European distribution, and aspects of its ecology and its status as an invasive species and an intermediate host of parasites are discussed.*

Key words Land mollusc, Xerolenta obvia*, invasive species, Aragon, Spain, Iberian Peninsula.*

INTRODUCTION

Recently, a sample with various species of terrestrial molluscs collected by a collaborator in the province of Teruel (Spain), arrived at the laboratory of the Museu Valencià d'Història Natural (MVHN). Examination of the sample revealed the surprising presence of a species of the genus *Xerolenta* Monterosato, 1892 (F. Geomitridae C.R. Boettger, 1909). *Xerolenta*, a predominantly European genus currently has between four and six species, varying according to authors; some clearly require new studies to clarify their taxonomic position (Grossu, 1983; Schileyko, 2005; Fehér, 2011; Welter–Schultes, 2012; Bank & Neubert, 2017): *X. macedonica* (Hesse, 1928) from Bulgaria and Macedonia, *X. obvia* (Menke,1828) widely distributed from southern France to Russia, *X. razlogi* (L. Pintér, 1969) from Bulgaria and Greece, *X. spiruloides* (Hesse, 1916) from eastern Romania, eastern Bulgaria and north-east Greece and *Xerolenta thasia* (Reischütz, 1983) from Greece (Thásos). No species in the genus has been recorded on the Iberian Peninsula, and the population must be considered as an introduction.

Examination of the shell and reproductive system has confirmed its status as *X. obvia.* These characters are compared with the very similar species, *Cernuella neglecta* (Draparnaud, 1805) and *Helicella itala* (Linnaeus, 1758), both cited in areas not far from the location of the new Spanish population of *Xerolenta* (Bech, 1990; Faci, 1991; Puente, 1994). The finding is related to the known distribution of the species in Europe and notes on its ecology and potential impact as an intermediate host of vertebrate-infecting parasites are given.

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MATERIALS AND METHODS

X. obvia specimens were collected by our collaborator, Mr. Luis Colomer Rubio, on a path along the village of Linares de Mora to the Linares river (UTM 30TYK0566; 1,300m altitude), under stones, on soil and among the ruderal vegetation. The population was very abundant and well established; both adults and juveniles were present. The sample collected on December 8, 2019 consists of 16 shells and one alive specimen preserved in 70% ethanol, and it is deposited in the MVHN of Alginet (Spain) with the code MVHN–060320UY04. The images of the specimens of *X. obvia, C. neglecta* and *H. itala* have been made on the Leica M80 stereomicroscope with IC90E camera attached (Figs 1–18), except figures 12 and 13, which have been made by Mr. Adam Broadley from Department of Agriculture Water & Environment of Melbourne (Australia).

RESULTS AND DISCUSSION

Studies of the shell and reproductive system confirm that the species found in Linares de Mora corresponds to *Xerolenta obvia* (Menke, 1828)

(Heath snail, common name); it is thus the first record of both genus and species for any location on the Iberian Peninsula.

It should be noted that the validity of the name has been questioned. Welter–Schultes (2010, 2012) and Welter–Schultes *et al*. (2011) claim that *Helix obvia* Menke, 1828 is a name that is not available and that it should be considered as a *nomen nudum* for breaching several articles of the ICZN. However, Bank (2011) based on works of von Martens (1891) and Gittenberger (1975), confirmed the validity of the taxon name *Xerolenta obvia*. Many authors have referred to the same taxon as *Xerolenta candicans* (L. Pfeiffer, 1841) (Pfeiffer, 1853; Clessin, 1884; Tryon, 1887; Pampiglione *et al*., 1988; Sverlova, 2006; Sysoev & Schileyko, 2009; among others), but this name is considered a junior synonym of *X. obvia* (Germain, 1930; Ehrmann, 1933; Ložek, 1964; Grossu, 1983; Turner *et al*., 1998; Kerney & Cameron, 1999; Bank *et al*., 2001; Welter–Schultes, 2010, 2012; Welter–Schultes *et al*., 2011; Bank & Neubert, 2017; among others).

Morpho–anatomical data (Figs 1–12) Shell medium–sized, more or less depressed above, with 5 to 6 whorls, slightly convex, opaque unbanded white or cream in colour, often with 1 to 5 dark bands of varying intensity, mainly on the periphery and below. Moderate open umbilicus, about ¼ the diameter of the shell. External surface of the protoconch smooth and the teleoconch with ornamentation formed by very fine and irregular radial microsculpture. Subcircular aperture, somewhat oblique, without well–marked internal thickening, which when presented is slightly white (Fechter & Falkner, 1990; Kerney & Cameron, 1999; Schileyko, 2005; Welter–Schultes, 2012; Rosenbauer, 2020; Marzec *et al*., 2020). 17 specimens of Linares de Mora have been measured with dimensions between 13.5mm and 18.2mm in width and between 8.2mm and 11.4mm in height. Different authors give ranges in width between 14 and 20mm and height between 7 and 10mm (Germain, 1930; Ložek, 1964; Kerney *et al*., 1983; Grossu, 1983).

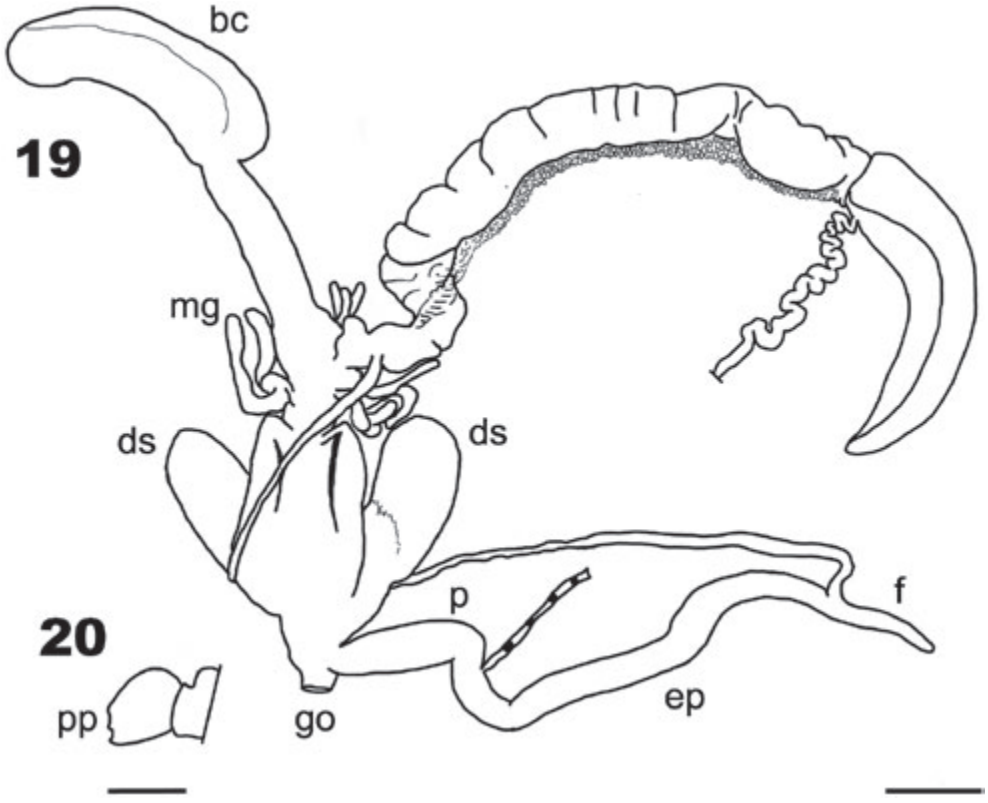
Other geomitrids, such as *Helicella itala* and *Cernuella neglecta*, can be confused with *X. obvia* in Spain (Figs 13–18), and they are cited in localities not far from the new location of Linares de Mora, which can make identification difficult (Clerx & Gittenberger, 1977; Bech, 1990; Faci, 1991; Puente, 1994). The conchological differences between the three species are shown by Ložek (1964) and Rosenbauer (2020). *H. itala* is a species widely distributed in the northern half of Spain, south of France and Andorra (Altonaga *et al*., 1994; Puente, 1994; Borredà *et al*., 2010). *C. neglecta* in Spain has only been confirmed by studying the reproductive system in five localities, some of which may be anthropogenic introductions (Clerx & Gittenberger, 1977; Puente & Prieto, 1991; Altonaga *et al*., 1994; Puente, 1994; Martínez–Ortí, 1999). The rest should be considered doubtful (Clerx & Gittenberger, 1977; Gittenberger *in* Bech, 1990; Puente & Prieto, 1991; Altonaga *et al*., 1994; Puente, 1994; Martínez–Ortí, 1999). The three taxa are also distinguishable by the reproductive system. *X. obvia* is characterized by being provided with two dart sacs, symmetrical one on each side of the vagina, the lower portion of which contains a wide cavity, more or less angular in the higher portion, without accessory sacs and short flagellum in relation to the epiphallus (Fig. 19) (Grossu, 1983; Schileyko, 2005; Rosenbauer, 2020). Rosenbauer (2020) points out that the length of the penis of *X. obvia* and *H. itala* are about half the length of the dart sacs. However, in our observations (Fig. 19) and the figures of Grossu (1983) and Schileyko (2005), the penis of *X. obvia* has from ¾ parts to at least the same length as the dart sacs. The penial papilla of *X. obvia* is short, similar to *H. itala* unlike *C. neglecta* which is long (Fig. 20) (Puente & Prieto, 1991; Puente, 1994; Martínez–Ortí, 1999; Schileyko, 2005). The specimen examined has four tufts of digitiform mucous glands, well branched, with between three and four glands per tuft (3+4+4+3) with a total of 14 glands. Grossu (1983) points to four tufts with two to four mucous glands, with a total of 12. Other distinctive differences in the reproductive system among the three species are shown by Rosenbauer (2020).

Ecological and parasitological data X. obvia is a ruderal and calciphile species, living on roadsides, on soil, uncultivated, calcareous, dry and sunny places, often abundantly aestivating on the stems of low vegetation (Germain, 1930; Wiktor, 2004; Fetcher & Falkner, 1990; Kerney & Cameron, 1999; Welter–Schultes, 2012). It is buried in the soil up to 2cm down during winter. It has a wide ecological amplitude in terms of macroclimate. There are

Figures 1–12 Shell of four specimens of *Xerolenta obvia*: 1–10 Linares de Mora (Teruel, Spain) (MVHN–060320UY04); 10 juvenile specimen; 11–12 Port of Melbourne (Australia) (photos by Mr. Adam Broadley, Department of Agriculture Water & Environment of Melbourne). Scales:=2mm.

two reproduction periods in the year, in spring and autumn. The clutches are composed of between 17 and 95 eggs. It has a life expectancy of just over 2 years. It feeds on a wide range of plants, such as alfalfa, clover, lupine, wheat, barley, fruit trees and weeds (Lazaridou and Chatziioannou, 2005; Welter–Schultes, 2012; Marzec *et al*., 2020). Like other xerophytic species in the summer period, they adopt the strategy of climbing over vegetation, the branches of bushes, fence posts, and other vertical objects to distance themselves from the soil, which reaches high temperatures, sometimes forming aggregations named "grappes". They are held by the calcium-rich epiphragm,

Figures 13–18 Shell of geomitrids which can be confused with *X. obvia* in Spain: 13–15 *Helicella itala*. Puerto de Alisas (Santander, Spain) (MVHN–270320YR02); 16–18 *Cernuella neglecta,* Crevillent (Alicante, Spain) (MVHN–120110XT06). Scale:=2mm.



Figures 19–20 Reproductive system of *Xerolenta obvia:* 19 Specimen from Linares de Mora (Teruel, Spain) (MVHN–060320UY04); 20 Penial papilla (abbreviations: bc=bursa copulatrix; ds=dart sac; ep=epiphallus; f= flagellum; go=genital opening; mg=mucous glands; p=penis; pp=penial papilla). Scales: 19,=2mm; 20,=1mm.

which is quite thick (Bigot, 1967; Martínez–Ortí *et al.*, 1991). In Central Europe *X. obvia* is an annual species, with two breeding periods in spring and autumn. It hatches mainly in the autumn, they overwinter as juveniles, they grow in spring and summer, and finally reproduce in autumn. However, in the Mediterranean area juveniles can be found from April to August and some adults can survive more than one cycle. Annual growth rates and length of life cycle vary in response to climatic conditions (Lazaridou & Chatziioannou, 2005; Welter–Schultes, 2012; Marzec *et al.*, 2020). *X. obvia* lives up to 2,000m in the Alps and up to 1,900m in Bulgaria (Turner *et al*., 1998; Kerney & Cameron, 1999; Welter–Schultes, 2012), and in the Spanish location of Linares de Mora at 1,300m. It has been found living with others land snails as *Xerosecta arigonis* (Schmidt, 1853), *Monacha cartusiana* (O.F. Müller, 1774) and *Euomphalia strigella* (Draparnaud, 1801).

From the parasitological–veterinary point of view *X. obvia* is an intermediate host of rhabditid nematodes *Cystocaulus ocreatus* (Railliet et Henry, 1907), *Muellerius capillaris* (Mueller, 1899), *Neostrongylus linearis* (Marotel, 1913) and *Protostrongylus rufescens* (Leuckart, 1865), that cause broncho–pulmonary strongylosis in small ruminants and leporidae (Edwards *et al*., 1980; Pampiglione *et al*., 1988). It is also an intermediate host of the cestode *Davainea proglottina* (Davaine, 1860), which causes avian cestodiosis and the fluke digenea *Dicrocoelium dendriticum* in Turkey and Europe, which can cause dicrocoeliasis in humans as well as *Brachylaema* sp. (Kalkan, 1971; Cordero & Manga, 1976; Ismail & Gürelli, 2018; Yildirum *et al*., 2018). It is also vector of fungal pathogens (e.g., *Alternaria* spp., *Fusarium* spp., *Phytophthora* spp.).

Geographical distribution, global expansion and impacts (Figs 21–22) X. obvia is a species native to Eastern and Balkan Europe, which has colonized most of Europe anthropically, now known from a total of 30 countries. It is distributed from Asia Minor to France and north and east of Europe, from Germany, Ukraine, Poland, Belarus, Russia and the Baltic Sea, to southern Sweden and Norway (Fig. 22) (Germain, 1930; Grossu, 1983; Kerney *et al*., 1983; Falkner *et al*., 2002; Schileyko, 2005; Fehér, 2011; Welter–Schultes, 2012: Egorov, 2008; Gederaas *et al*., 2012; Balashov & Gural–Sverlova, 2012; Zemoglyadchuk, 2019). Almost certainly, introduction has been accidental; in Switzerland it was introduced by fodder for farm animals (Germain, 1930).

It has also been introduced in the American continent, reaching Canada and from there to the United States, through shipping container rail yards. In Canada it has been known since 1969 in south–central Ontario and in the USA, from 2001–2002, in Michigan and since 2012 in Montana (Robinson & Slapcinsky, 2005; Grimm *et al*., 2009; Forsyth *et al*., 2015). Ehrmann (1933) notes that it was introduced in Australia and New Zealand. Its arrival at a port in Australia has recently been detected, through car shipping containers from Europe, although there is no record of their dispersion or of their current presence in the country (Nathan Luke, *pers. comm*.) (Figs 11–12). The new population in Spain was probably introduced accidentally, with ornamental plants (Fig. 21). The great abundance of specimens, both adults and juveniles, and its dispersion throughout the area in Linares de Mora, indicates that the population is well established and allows us to assume that it was introduced several years ago (Forsyth *et al*., 2015).

Like a number of other grassland snail species, *X. obvia* can become a pest; Cowie *et al.* (2009) rate it as presenting a moderately high risk when introduced. Aside from parasitological considerations, it can damage crops and impede harvesting (Cowie, 2005). In U.S.A. losses caused by *X. obvia* in agriculture have led to an eradication attempt, but these costs are high in excess of $100,000 (Robinson & Slapcinsky, 2005). *X. obvia* was included in an eradication program in Detroit for nine years, being eradicated, although it was later detected again in other areas of Michigan (Robinson, 2018). Luke (2020) points out the importance of border surveillance to prevent the entry of exotic species such as *X. obvia* in Australia. Hence, a control and eradication plan is going to be proposed to the Biodiversity service of the General Directorate of Natural Environment and Forest Management of Aragon, to prevent its dispersion throughout the rest of the province of Teruel and other nearby provinces, which may cause severe damage to agriculture and seriously affect Spanish biodiversity.

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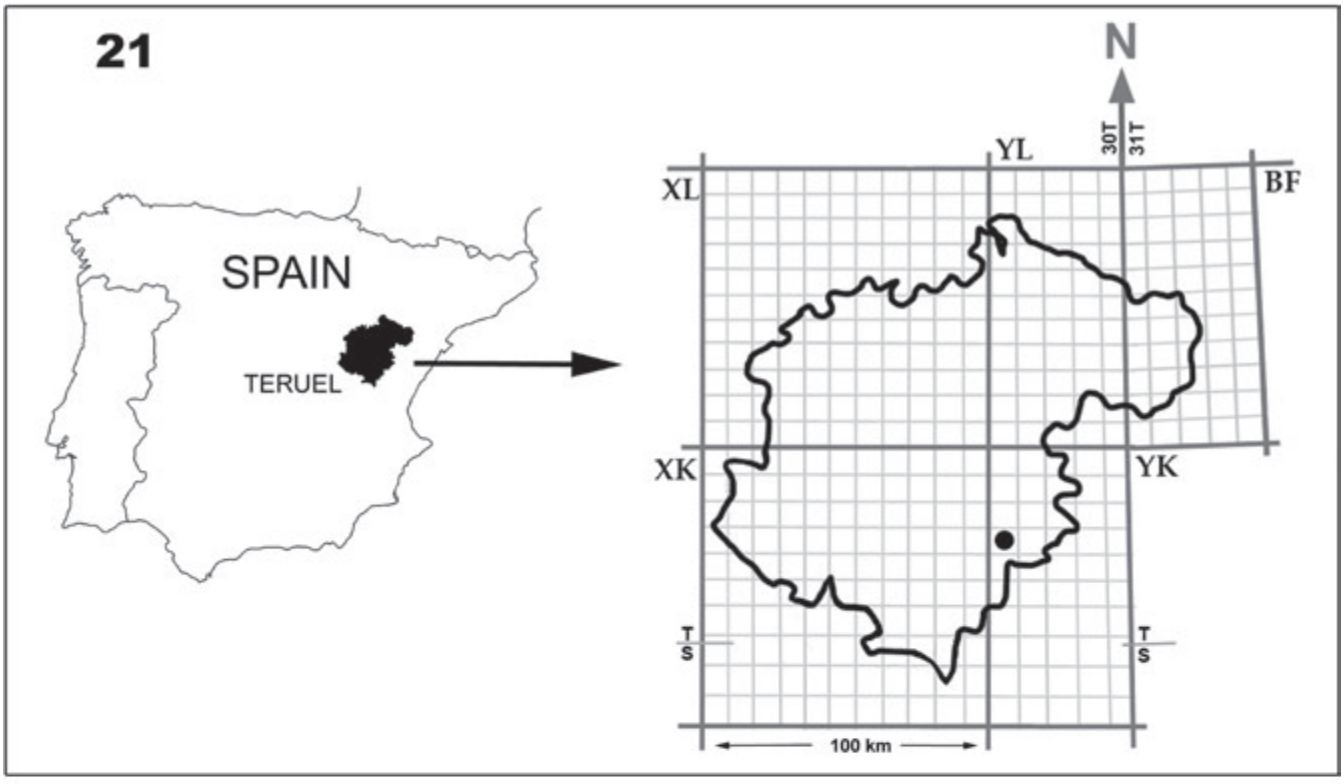

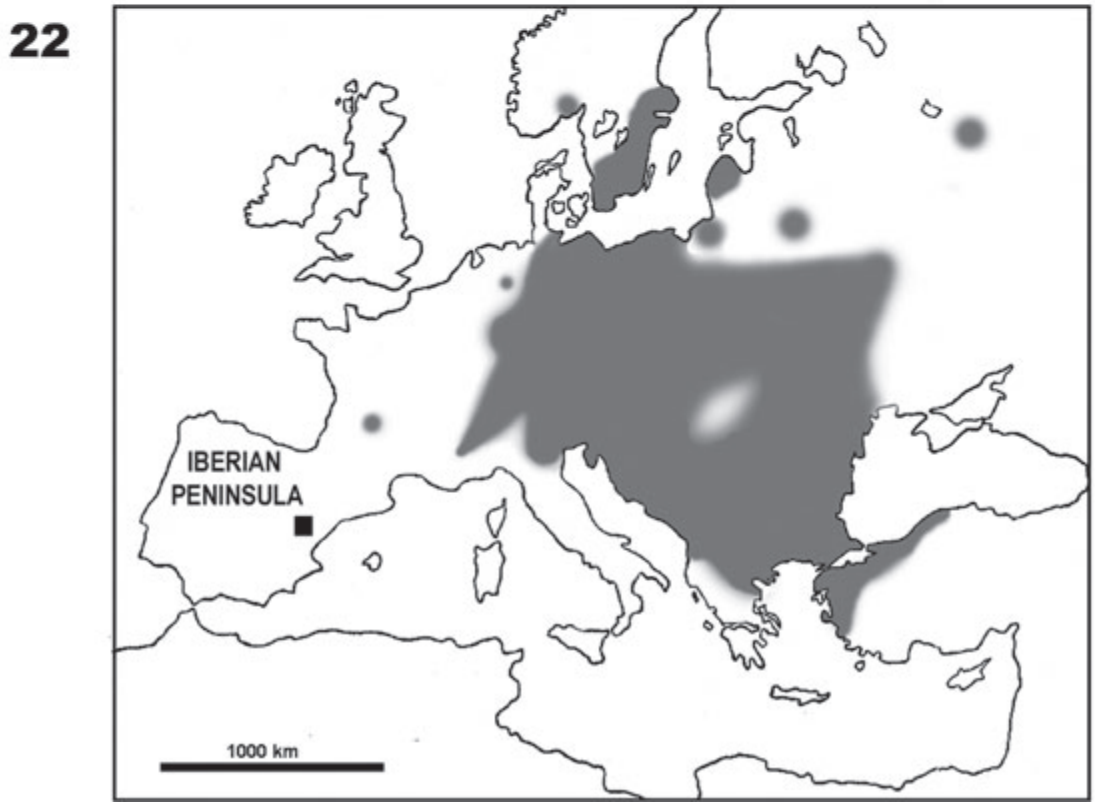

Figures 21–22 Map of geographical distribution of *Xerolenta obvia*: 21 Spain; 22 Europe [Adapted from Kerney *et al*. (1983) and Welter–Schultes (2012)].

Water & Environment of Adelaide (Australia), for sending pictures of shells and the reproductive system of *Xerolenta obvia* from Australia (Figs 11–12) for its identification, made by Mr. Adam Broadley from the same institution, but of Melbourne. Also to the first for the information on the presence of *X. obvia* currently in Australia. Finally, to our friend and collaborator in the MVHN, Mr. Luis Colomer Rubio, that collected and gave us the studied specimens.

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