

On the presence of *Otala xanthodon* (Anton, 1838) (Gastropoda: Helicidae) in the Iberian Peninsula

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In this article, the first known established population of *Otala xanthodon* (Helicidae) is given for the Iberian Peninsula. Some few thousands of live specimens were found at the Sierra de Callosa de Segura mountain system (Baix Segura, Alicante province). The specimens were found preferably in sunny environments at an altitude above 400m, mainly on *Macrochloa* and *Asphodelus* plants or hidden in crevices. This is a species native to north Africa and is apparently already cited in the south of France. Its presence in an environment of high ecological value could endanger some endemic snails present in these mountains, particularly those of the genus *Iberus*.

Keywords: Gastropod, alien, Ibero-African fauna

Sobre la presència d'*Otala xanthodon* (Anton, 1838) (Gastropoda: Helicidae) a la península Ibèrica

A la present nota es recull la primera població establerta coneguda d'*Otala xanthodon* (Helicidae) a la península Ibèrica. Es van trobar milers d'exemplars vius en un punt de la serra de Callosa de Segura (el Baix Segura, província d'Alicant). Els espècimens trobats habiten preferentment en ambients assolellats per sobre del 400 m d'altitud, principalment sobre espart i *Asphodelus*, o amagats en esquerdes. Es tracta d'una espècie originària del nord d'Àfrica, però aparentment ja citada al sud de França. La seva presència en un lloc d'alt valor ambiental podria posar en risc poblacions de cargols endèmics, fonamentalment del gènere *Iberus*, present en aquesta serralada.

Paraules clau: gastròpode, invasor, fauna iberoafricana

During the last few years, a fair number of exotic terrestrial mollusks have been cited in the Iberian Peninsula. Among them, some species of the family Helicidae are well known, such as *Helix pomatia* Linnaeus, 1758, *Helix melanostoma* Draparnaud, 1801, and *Helix lucorum* (Linnaeus, 1758). All of them have likely been introduced as a food source since they are consumed in many countries. However, it is difficult to determine if they represent a risk for native flora and fauna, since only a few, scattered populations are as yet known. All of these species have already been cited in the Valencian Autonomous Community, but are also widespread in many other places in the Iberian Peninsula and Western Europe (Cadevall & Orozco, 2016).

Other land mollusks that have experienced an expansion of their distribution range in Western Europe in the last years are *Xerolenta obvia* (Menke,

1828), present in north Italy and recently cited in Teruel province in Spain, or *Xeropicta derbentina* (Krynicky, 1836), well extended in north Italy and southwestern France (Aubry et al., 2006; Martínez-Ortí, 2020). The arrival of these species seems to be the product of accidental transportation by anthropogenic activities such as tourism, trade, or agricultural practices. This stresses the need for better sampling in the search for exotic land snails in our geography, even for very conspicuous or large species.

A very peculiar case of invasion by a land snail is the presence of a single population of gastropods of the "*Dupotetia*" group in southern France (Bertrand, 2010). This is a genus (or at present, a subgenus of *Otala* Schumacher, 1810, according to Molluscabase) native of North Africa, comprising an indeterminate number of species. Recent revisions (Holoak &

Holyoak, 2017; Kneubühler et al., 2019; Holyoak et al., 2020) have substantially reduced this number and recognize only five to nine species in the genus *Otala*, although this is still a matter of debate. The presence of a species typical of semiarid to arid habitats so far to the north seems due to a direct human-mediated introduction, either intentional or accidental. In this paper we report the first established population of an exotic *Otala* species for the Iberian Peninsula.

Material and Methods

Field sampling was carried out at Sierra de Callosa de Segura during the period January-April 2021. Some shells were manually collected by the first author and photographed *in situ*.

For analysis of genitalia, the snails were drowned by immersion in water for 24 hours and then fixed in 70° alcohol, which was renewed two days later. Once removed from their shells, the animals were dissected and the genital tract was extracted, extended, and fixed on a silicone plate using entomological minutiae. The drawing of the distal genital tract was performed using a drawing tube coupled to a Nikon SMZ-1 stereomicroscope. The penis and vagina of another specimen were opened using micro-scissors and a micro-scalpel and photographed using the photographic equipment associated with a Nikon SMZ1500 stereomicroscope. Series of photographs were stacked using Helicon Focus v.7 software.

Results

The field survey in the mountainous area of Sierra de Callosa de Segura (in the south of Alicante province) by the first author yielded the surprising finding of a population formed by a huge number of specimens of a peculiar Helicidae taxon, clearly belonging to the *Dupotetia* group of species (Fig. 1-3). The presence of a second tooth in the aperture, the co-existence of two color morphs, and detailed analysis of its genitalia, allow its assignment to the species *Otala xanthodon* (Anton, 1838), native of the Maghreb (Fig. 3-6).

More than 5,000 specimens, including both alive and empty shells, were observed in the mountains of Sierra de Callosa de Segura, mainly at an altitude of about 400-450 m, on an exposed slope, although some were found around the 500m level (Fig. 1C, 2). Most of the snails were on plants, mainly *Macrochloa tenacissima* (L.) Kunth (1829), *Asphodelus fistulosus* Linnaeus, 1753, and *Asphodelus cerasiferus* J. Gay

(1857), or hidden in rock crevices. Along with this exotic snail, some other native gastropods were found including *Iberus alonensis* (Férussac, 1821) (Fig. 3). Densities varied from 2-4 shells per plant in the areas with a lower density of snails, to up to 20-30 snails per plant in the highest infested areas. Shells of the exotic species included two different morphotypes; one completely white and another with four brown spiral lines (Fig. 4). The snails were active after rain, feeding on *Asphodelus* leaves, and were seen mating and laying eggs in early March (AMF personal observation, see also Fig. 3). No juveniles were found until mid-April, while a remarkable number of juveniles appeared after rain starting only in the last half of the month. The coordinates of the findings are [30SXH8421] and [30SXH8422], comprising an area of about 70 000 m² where most of the shells were found (Fig. 1C). No shells of this species were found in the other mountain systems nearby.

Shells of this population are depressed-conical in

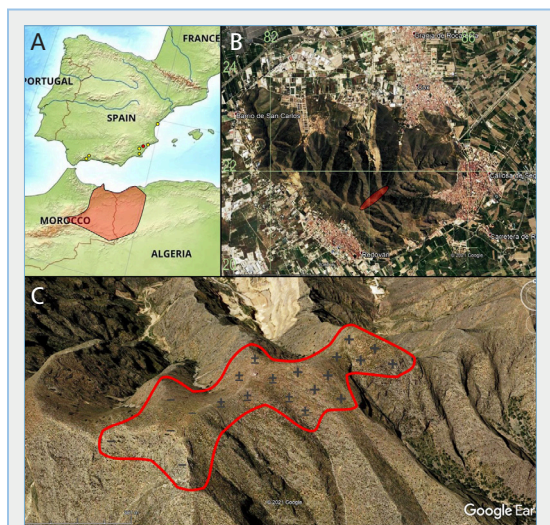


FIGURE 1. Geographical distribution of *Otala xanthodon*. **A:** Geographical range in the Maghreb (surrounding the sites recorded by Holyoak & Holyoak, 2017), and the distribution of cited Spanish localities (yellow dots) and Callosa de Segura (red dot). **B:** Current presence in the Sierra de Callosa de Segura (red patch). **C:** Detailed area with confirmed presence of the species during the survey period. Signs (+ and -) reflect relative abundance.

Distribució geogràfica d'*Otala xanthodon*. **A:** Rang geogràfic al Maghreb (al voltant dels punts descrits per Holyoak & Holyoak, 2017), i distribució de les localitats citades a Espanya (punts grocs) i de Callosa de Segura (punt vermell). **B:** Presència actual a la Serra de Callosa de Segura (taca vermella). **C:** Àrea detallada amb presència confirmada de l'espècie durant el període de prospeccions. Els signes (+ i -) reflecteixen abundància relativa.

shape, of 21 to 28 mm wide, with shallow sutures. Smooth sculpture, sometimes showing few growth lines. Umbilicus absent. Aperture is oval shaped, showing two teeth, one in the outer part of the labrum, and an upper one in the palatal area which is short and curved inwards. Shells can be white or show brown bands on a white background. The aperture usually has brown traces in the inner part.

Discussion

The presence of two teeth in the aperture is a characteristic only described within the genus *Otala* for some populations of *O. xanthodon* (Holyoak & Holyoak, 2017). The simultaneous presence of the two colour morphs, one completely white and another with four (rarely three) brown spiral bands in the last whorl (Valledor de Lozoya, 2006; Holyoak & Holyoak, 2017)

is also characteristic of this species, as in the sample from Callosa de Segura (Fig. 3-4).

Analysis of the genitalia further confirms this classification. The distal genitalia show the generic diagnostic features (Fig. 5), e.g.: long penial flagellum, penis formed by two cylindrical parts, free oviduct much longer than the vagina, two robust multibranching mucous glands. Detailed observations of the internal structures of penis and vagina (Fig. 6) confirm the presence of a large tongue-like atrial stimulator entering into the distal vagina, a penial outer sheath and two penial papillae (or verges in Schileyko's terminology), the proximal papilla being small and inconspicuous, and the distal one much larger and cylindrical. Schileyko (2006) indicated also a well-developed sphincter in the atrio-penial junction, which was dismissed by Holyoak & Holyoak (2017) and Kneubühler et al.



FIGURE 2. Habitat of *Otala xanthodon* at the Sierra de Callosa de Segura. Two views of the slopes where the highest density of the species was recorded, around 400-450 masl. The area has semiarid character, and is dominated by *Macrochloa tenacissima* and *Asphodelus cerasiferus*.

Hàbitat d'*Otala xanthodon* a la Serra de Callosa de Segura. Es mostren dues vistes de la zona amb pendent, on es va trobar la màxima densitat d'exemplars, al voltant dels 400-450 msnm. L'àrea té caràcter semiàrid, i està dominada per les plantes *Macrochloa tenacissima* i *Asphodelus cerasiferus*.

(2019). A penial flap like the one figured by Kneubühler et al. (2019: Fig. 5-10) for *Alabastrina* spp. can be seen (Fig. 5A) although they (o.c.: table 3) consider that the penial flap is a diagnostic trait for the genus *Alabastrina* Kobelt, 1904. Nevertheless, Kneubühler et al. (2019: Fig. 19C) illustrate an unlabelled small flap in the atrio-penial junction.

In addition, shells of the Callosa de Segura population clearly resemble those found in the French population near Perpignan (Roussillon), pending of taxonomic identification (Bertrand, 2010). According to Holyoak & Holyoak (2017), the presence of two teeth in the aperture and their range size, also allow to classifying the latter as *O. xanthodon*, but further anatomical



or genetic studies on this population should confirm this assignation.

The Sierra de Callosa de Segura is a small mountain system formed by Medium to Upper Triassic dolomitic calcareous rocks. It has a semiarid climate, similar to other places in the region (Almeria and Murcia provinces, and south of Alicante), characterized by low pluviometry (less than 250 mm per year) and average annual temperature of 20°. It has pronounced slopes

and little vegetal cover, mainly formed by xerophytic bushes, which facilitates the formation of temporal streams and quick erosion of soil. The presence of a few endemic plants and a number of the so-called Ibero-African vegetal species, and the fragility of these semiarid habitats, have determined its cataloguing with different protection figures such as SCI (or LIC in Spanish terminology; 92/43/UE Directory) in the Red Natura 2000, and "Paraje Natural Municipal" (2005).



FIGURE 4. A-F: Variability of the shells of *Otala xanthonodon*, including banded (**A; C-F**) and white (**B**) morphs. **G-I.** Detail of aperture, showing the presence of two teeth, a characteristic of the species. Scale bar A-F = 20 mm. G-I = 10 mm.

A-F: Variabilitat de les conques d'*Otala xanthonodon*, incloent-hi els morfs bandejat (**A; C-F**) i blanc (**B**). **G-I.** Detall de l'obertura, que mostra la presència de dues dents, una característica de l'espècie. Barra d'escala A-F = 20 mm. G-I = 10 mm.

Little is known about its malacofauna with only a few taxa already cited (Ayuntamiento de Callosa de Segura, 2008). A big concern for both flora and fauna is the recent release of some goats (*Capra hircus*, Linnaeus, 1758) which have become established in the area.

The arrival of a north African species of gastropod, which seems established given the large number of live individuals spotted and its reproductive behavior (confirmation of both egg laying and presence of juveniles), could hamper the populations of some other snails, such as those of the genus *Iberus* Montfort, 1810, an Iberian endemism common in this mountain system (see figure 3F). Little is known about how it was introduced but it seems to be clearly associated with human activities, possibly in an intentional way, given the isolation and the altitude of the habitat where

the main population was found and the distance to any native or previously introduced populations. Preliminary surveys in other nearby mountain systems have yielded negative results for the species so far, but special care should be taken in reporting a possible geographical expansion.

A well-known and very dense population (up to 800 specimens/m²) of a taxon classified as *Dupotetia arabica* (Terver, 1839) is present in the Chafarinas Islands (or Iles Zaffarines), off the North African coast (Valledor de Lozoya, 2006; Rojo-Guerra et al., 2010), which territorially belong to Spain, and where a military garrison is permanently present. It is easy to speculate that this could be a likely origin of the new population described in this paper should both populations prove to belong to the same species. Indeed, it seems to be occasionally gathered by soldiers as a food source (Valledor de Lozoya, 2006), so gastronomic intent could even lie behind the introduction into the Peninsula, as was suspected for example for a South

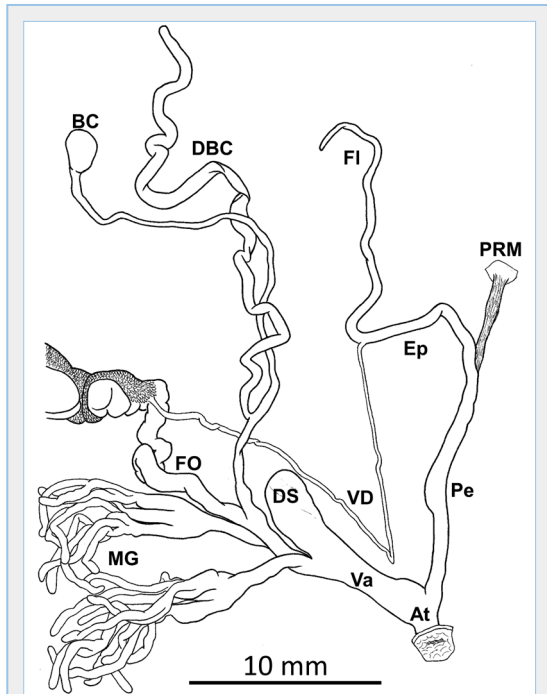


FIGURE 5. Distal genitalia of *Otala xanthodon* (the proximal part to the spermoviduct is omitted). Abbreviations. **At:** atrium; **BC:** bursa copulatrix; **BCD:** diverticulum of the bursa copulatrix; **DS:** dart sac; **Ep:** epiphallus; **FI:** flagellum; **FO:** free oviduct; **MG:** mucus glands; **Pe:** penis; **PRM:** penis retractor muscle; **Va:** vagina; **VD:** vas deferens.

Genitàlia distal d'*Otala xanthodon* (la part pròxima de l'espermiducte s'ha omès). Abreviatures. **At:** atri; **BC:** bursa copulatrix; **DBC:** diverticuli de la bursa copulatrix; **DS:** sac del dard; **Ep:** epifal·lus; **FI:** flagell; **FO:** oviducte; **MG:** glàndula mucosa; **Pe:** penis; **PRM:** múscul retractor del penis; **Va:** vagina; **VD:** vas deferens.

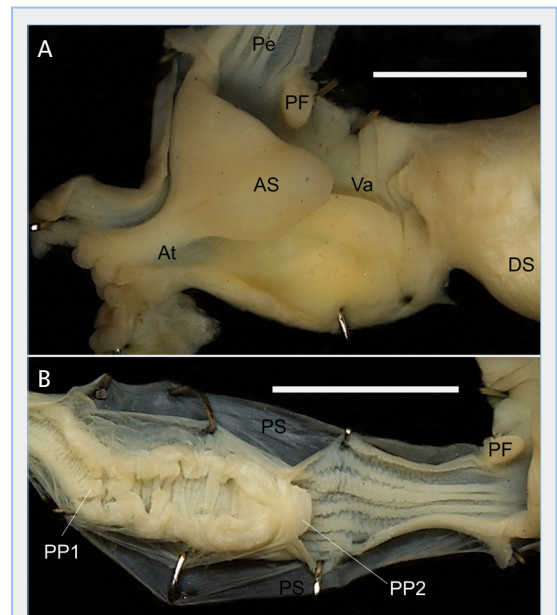


FIGURE 6. Internal structures of the distal genitalia of *Otala xanthodon*. **A:** Atrium and vagina; **B:** Penis. Abbreviations. **At:** atrium; **AS:** atrial stimulator; **DS:** dart sac; **Pe:** penis; **PF:** penial flap; **PP1:** proximal penial papilla; **PP2:** distal penial papilla; **PS:** penis sheath; **Va:** vagina. Scale bar A = 2 mm. B = 3 mm.

Estructures internes de la genitàlia distal d'*Otala xanthodon*. **A:** Atrium i vagina; **B:** Penis. Abreviatures. **At:** atri; **AS:** atrial stimulator; **DS:** sac del dard; **Pe:** penis; **PF:** beina del penis; **PP1:** papil·les proximals penials; **PP2:** papil·les distals penials; **PS:** beina del penis; **Va:** vagina. Barra d'escala A = 2 mm. B = 3 mm.

American Bulimulidae, *Naesiotus quitensis* (L. Pfeiffer, 1848), in Madrid (Ramos Sánchez et al., 2018). While gastronomic uses could seem of little magnitude in these two or other similar species, they cannot be completely ruled out until more information is obtained on their way of introduction. Indeed, evidence suggests large scale consumption of *Dupotetia* species in North Africa in the past (Taylor et al., 2011; Taylor & Bell, 2017), being the predominant species in many archaeological sites, so an origin from continental North Africa is likely, and this applies as well as for the French population.

It should be noticed that there were previous Iberian mentions of shells belonging to *Otala xanthonon* or any of their synonyms (see the revision by Holyoak & Holyoak, 2017), in the 19th and 20th centuries from several localities:

Cartagena (Murcia). Recorded as *Helix Dupotetiana* by Rossmässler (1853: 99). Probably, that record was recoded as “Murcia” by Pfeiffer (1859: 226) although Hidalgo (1875) recorded both sites as different places.

“España” (without further precision). Bourguignat (1864: 357) recorded *Helix Zapharina* and *Helix xanthonon* as belonging to the Spanish (Iberian) fauna.

Alicante. Shells of *Helix Dupotetiana* with that origin were offered in an exchange list by Kobelt (1869). Subsequently, the offer was recoded as “Spanien” by Kobelt (1870). Hidalgo (1875: 195) recorded it from “Alicante”.

“Sur de España”, according to a translation by Hidalgo (1875), would be the place mentioned by Kobelt (1871: 17) for *Helix Dupotetiana* var. *zaffarina*.

“Entre Murviedro et Valence (Valencia)”. “Echantillons identiques à ceux de l’Algérie” of *Helix Dupotetiana* were recorded by Servain (1880: 34).

“Rochers entre Ronda et Malaga (Málaga)”. Recorded as *Helix zapharina* Beck, 1838 by Servain (1880: 34).

Marbella (Málaga). Recorded as *Otala xanthonon* by Jaeckel (1967), that he himself considered an introduction. This seems the only introduction reported in the 20th century.

Hidalgo (1875) considered *Helix xanthonon* and *H. dupotetiana* as dubious in his final listing of Spanish terrestrial land molluscs. The species was discarded by Arrébola (1995) from Andalusia, and by Martínez-Ortí (1999) from the Valencian Community, given the lack of sightings for a long time, both following the suggestion of Ortiz de Zárate (1991) that they all were introductions.

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