



New historical records of *Anodonta cygnea* (Linnaeus, 1758) (Bivalvia: Unionidae) in the Iberian Peninsula and comments on its native status

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Unionoidea freshwater mussels are among the most endangered invertebrates in the world. In North America, half of them are included among critically endangered or extinct (Williams *et al.*, 1992), while in Europe the trend towards extinction is accelerating, at least for some of the taxa (Edmondstone *et al.*, 2022; Lopes-Lima *et al.*, 2017, 2021).

The number of Unionoidea taxa present in the Iberian Peninsula has been the subject of study and debate for many decades, with different conclusions. The most accepted work by Araujo *et al.* (2009) considered the presence of 11 species: *Pseudunio auricularius* (Spengler, 1793), *Margaritifera margaritifera* (Linnaeus, 1758), *Potomida littoralis* (Cuvier, 1798), *Unio mancus* Lamarck, 1819, *U. gibbus* Spengler, 1793, *U. delphinus* Spengler, 1793, *U. tumidiformis* Castro, 1885, *U. ravoisieri* Deshayes, 1847, *Anodonta anatina* (Linnaeus 1758) and *A. cygnea* (Linnaeus, 1758), besides the recently introduced *Sinanodonta woodiana* (Lea, 1834). While for the first nine species there is general agreement on their native status, much doubt is cast on *A. cygnea*.

Much of the confusion was generated by the general failure in discriminating between the two species of *Anodonta*. This has resulted in many publications reporting the presence of one of the two species, indistinctly, so there is not a clear picture of their actual distribution (Gasull, 1963, 1981; Altaba, 1990; Casadó Burillo & Anguera Terré, 1999; Abella Ciuraneta, 2005). The revision by Araujo *et al.* (2009) considered only valid as belonging to *A. cygnea* a few and scattered citations: a few of them in central Portugal, between Aveiro and Coimbra, and another one in north Catalonia (Reis, 2006; Araujo *et al.*, 2009, and Araujo unpublished results pers. comm. to K.O.N.). Since these populations are located in highly modified habitats, this claims rather to introductions in recent times. The same authors, however, highlighted two old citations from late 19th century (Mondego, Portugal) and first half of 20th century (Palmones River, Cádiz province) that could explain a completely different

hypothesis, since they are located in places very far apart from all the others, and in highly preserved habitats at that time.

Recently, a new citation was given for the lower Ebro River (Quiñonero-Salgado *et al.*, 2019), which is also a heavily invaded watercourse, so it could certainly represent a recent introduction from France or Central Europe.

The authors of the present work have been working with different samples of different origin, which allow adding new citations for *A. cygnea* in the Iberian Peninsula. This adds new information that should be kept in mind when discussing on its likely native status.

One of the authors (K.O.N.) searched among the Malacology Collection of the Senckenberg Research Institute Frankfurt, where there are a total of 238 complete specimens, 6 single valves and 8 shell fragments of *Anodonta* available (SMF 3170, 3171, 3172, 21483, 21484, 168209, 168210, 168212, 168293, 345160 and 13 lots without catalogue number) that Fritz Haas had collected in different parts of the Albufera de Valencia in June/July 1917 (Haas 1918: 7). Among them, there are two specimens of *Anodonta cygnea* (SMF 368225, Figure 1). They belong to a series with the indication of origin “Carrer de Saler, nahe der Mündung. Zäher Humussandschlamm, 0,5 - 0,75 m Tiefe” (Carretera del Saler, near the mouth; mud mixed with humus and sand, 0.5 - 0.75 m depth). The condition of the shells suggests a common origin with the other twelve *Anodonta anatina* of this series, since coloration and state of preservation are comparable. In the collection there are furthermore two valves of the species (SMF 345161, Coll. C. Bosch), which, also mixed with 3 shells of *A. anatina*, had been given by Haas to Carl Bosch with the indication of origin “Albufera de Valencia. Topotypen, jüngere Stücke” (Albufera de Valencia. Topotypes, younger specimens).

Besides this, other of the present authors (S.Q.S.) found additional shells at the Ebro River in 2021 (Figure 2). Some other likely specimens of *A. cygnea* have recently been found in different places in the Iberian geography, but their detailed determination is still pending.

Regarding the Albufera shells of Haas, although the distinction between the two species, *A. anatina* and *A. cygnea*, was achieved

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Figure 1. Specimen of *Anodonta cygnea* from Albufera de Valencia, from the Haas collection at Senckenberg Research Institute, Frankfurt, Germany (SMF 368225) (picture by B. Heinrich, Senckenberg Research Institute).

earlier, the recognition prevailed only later (see Nagel *et al.*, 1996 and Riccardi *et al.*, 2019 for reviews). All shells illustrated by Haas in his publication on the Unionids of the Albufera de Valencia can be counted to *A. anatina*. Even the shell described as juvenile is an *A. anatina* (plate 4 figure c). Haas encountered only this one form (Haas 1918: 27). Therefore, *A. cygnea* seems to have been very rare indeed at that time. Whether these were remnants of an ultimately unsuccessful introduction or an extinct native population can only be guessed at. Anyway, the presence of old and new citations in places covering almost the four corners of the peninsula, allow to suggest that this could still represent a native species, that has been re-introduced in some places only in recent decades, presumably from Western or Central European populations.

Even if a genetic analysis is done in some recent populations, no clear picture of their status as native or introduced could likely be achieved, unless much more information and specimens are gathered and included in the analysis. In this sense, searching through old collections could add relevant information to solve this puzzle.

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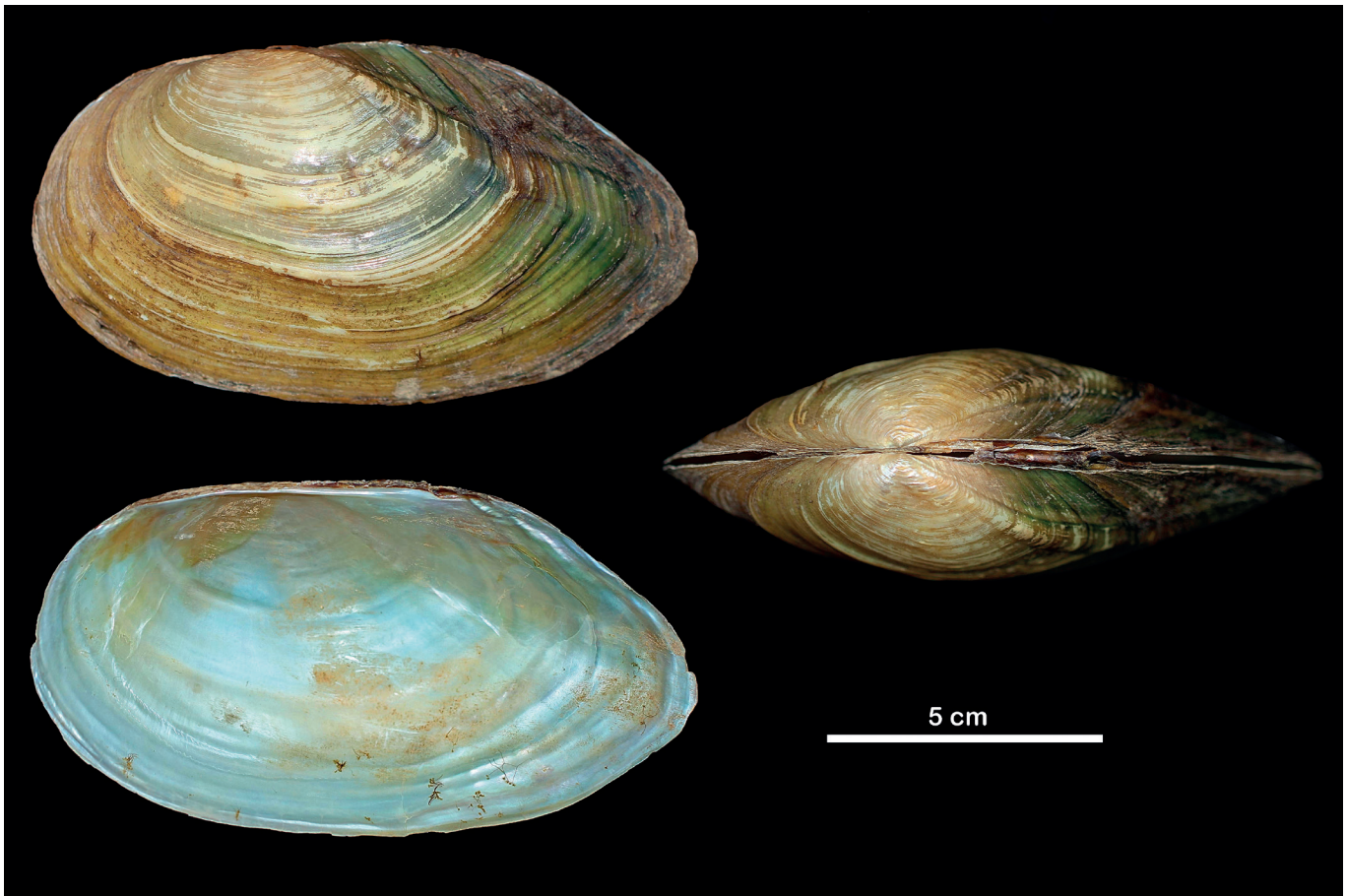


Figure 2. Specimen of *Anodonta cygnea* from Flix, Ebro River (Tarragona province), collected in 2021 (picture by SQS).

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