On the identity of *Neritina baetica* Lamarck, 1822 and *Nerita meridionalis* Philippi, 1836 (Gastropoda: Neritidae) from the Iberian Peninsula

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Abstract
When Mermod (1953) depicted the types of *Theodoxus baeticus* of Lamarck’s collection his photo did not display a pseudo-apophysis (peg). This led recent authors believe, that *Th. baeticus* is a synonym of *Th. fluviatilis* and *Theodoxus meridionalis* is the valid species (Alba et al. 2016: 55). In this paper I studied the syntypes of *Th. baeticus* as well as the syntypes of *Th. meridionalis* and demonstrated that in *Th. baeticus* a pseudo-apophysis exists and the opercula of *Th. baeticus* and *Th. meridionalis* are similar. Thus *Th. baeticus* is a good species and *Th. meridionalis* is a younger synonym of it. Therefore I can conclude that three *Theodoxus* spp., i.e., *Th. fluviatilis*, *Th. baeticus* and *Th. valentinus* occur in the Iberian Peninsula.

Key words: *Theodoxus baeticus*, *Theodoxus meridionalis*, Iberian Peninsula, syntypes.

Introduction
Many species have formerly been described on the basis of shell morphology and especially on the patterns or the color of the shells. Many of these nominal taxa belong at least to *Theodoxus fluviatilis*. For instance in Central Europe *Th. fluviatilis* has patterns of drop shape, while it has in Spain zigzag lines, and in the Balkans we find a combination of both patterns (Glöer & Pešić 2015).

The morphology of the operculum may be the best morphological character which can be used to differentiate *Theodoxus* species. It is suggested to be more conserved intraspecifically yet more variable interspecifically for *Theodoxus* (Glöer and Pešić 2015, Alba et al. 2016, Anistratenko et al. 2017), with the apophysis (rib) and the pseudo-apophysis (peg), and in some species the rib-shield, rib-pouch, and the callus being the most important characters (fig. 1).

In the 19th century a high diversity of *Theodoxus* spp. have been mentioned in the literature. Morelet (1845) in his Malacofauna of Portugal described four new species, i.e., *N. violacea*, *N. inquinata*, *N. guadianensis*, and *N. elongatula* while Graells (1846) in his catalog of molluscs of Spain listed the following species: *N. baetica* Lamarck., *N. fluviatilis* Linnaeus, *N. intexta* Villa, *N. serratilinea* Ziegler, *N. violacea* Graells, and *N. valentina* Graells, describing only the outer structure of the opercula..
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Figure 1. Reproduction of Mermod’s figure of Lamarck’s syntypes of \textit{Theodoxus baeticus} (from Mermod 1953:155, fig. 169).

In the 20\textsuperscript{th} century Vidal Abarca & Suarez (1985) listed in his species list of the Iberian Peninsula and Baleares \textit{Theodoxus meridionalis} (Philippi, 1836), \textit{Th. bourguignati} (Recluz, 1852), \textit{Th. elongatulus} (Morelet, 1845), \textit{Th. fluviatilis} (Linnaeus, 1758), \textit{Th. hidalgoi} (Crosse, 1880), \textit{Th. hispalensis} (Martens, 1879), and \textit{Th. velascoi} (Graells, 1846). The authors believed that \textit{Th. baeticus} is only a var. of \textit{Th. fluviatilis} because considering Mermod’s (1953) description of two syntypes of \textit{Th. baeticus} from Lamarck’s collection housed at the National History Museum of Geneva (NHMG) in which the operculum of these specimens has no peg (1953: p. 155, fig. 169, see fig. 1), as it is in \textit{Th. fluviatilis}.

In the 21\textsuperscript{st} century other authors listed \textit{Theodoxus baeticus} as a threatened species (Moliner et al. 2001, Martinez-Ortí 2008, 2011, 2015) or listed it in their species lists for the Balearic Islands and mainland of Spain (Beckmann 2007, Bank 2011).

Bunje & Lindberg (2007) have been the first who showed that there is a relationship between \textit{Th. meridionalis} and \textit{Th. valentinus}, maybe an intraspecific relationship. Interestingly Bunje & Lindenberg (2007) also included specimens they attributed to \textit{Th. baeticus} in their phylogeny.

Zettler & Van Damme (2010) believe that \textit{Theodoxus meridionalis} is restricted to Sicily and Tunisia while Welter-Schultes (2012) listed \textit{Th. baeticus} from S-Spain in addition to \textit{Th. meridionalis} (Sicily and rare in Tunisia) and \textit{Th. elongatulus} (Morelet, 1845) which is restricted to Portugal.

Martinez-Ortí et al. (2015) stated that \textit{Th. baeticus} is a synonym of \textit{Th. fluviatilis} and in the Iberian Peninsula, the Balearic islands, and in Portugal \textit{Th. meridionalis} occurs. Later Martinez-Ortí stated that \textit{Th. fluviatilis}, \textit{Th. valentinus} and \textit{Th. meridionalis} are the only valid species of \textit{Theodoxus} present in the Iberian Peninsula (Martínez-Ortí et al. 2015).

This paper is intended to show that \textit{Theodoxus baeticus} is a good species distinct from \textit{Th. fluviatilis} and \textit{Th. meridionalis} is a synonym of \textit{Th. baeticus}.

\section*{Material and Methods}

To be sure which species occur in the Iberian Peninsula I borrowed the syntypes of \textit{Theodoxus baeticus} and \textit{Th. meridionalis}. With the help of Dance (1966), who listed where the collections of former malacologists are housed, the syntypes could be found in the Natural History Museum of Geneva (NHMG, \textit{Th. baeticus} of Lamarck’s collection) and Natural History Museum Berlin (NHMB, \textit{Th. meridionalis} of Philippi’s collection).

The shells of \textit{Th. meridionalis} are dried up and to get the operculum it was processed in a solution of KOH for some minutes to remove the operculum. The photos of \textit{Th. meridionalis} have been made with a Leica digital camera system.

\section*{Results}

At the operculum some adductors are attached which closes the shell to be save against exsiccation and predators. The prominent feature of the operculum is the apophysis, sometimes named “rib”, and in some species the pseudo-apophysis, also named “peg” or “knob”. The two latter names are appropriate for
Theodoxus spp., but not for species from the Mediterranean, because Th. baeticus and Th. meridionalis have a diagonal pseudo-apophysis which links the basis of the operculum with the apophysis (figs. 5-6). Some Theodoxus spp. have a rib shield, which forms together with the apophysis the rib pouch (figs. 3-4).

Figures 2-6. The operculum of Theodoxus fluviatilis (2-4), Th. baeticus (5), and Th. meridionalis (6). Abbreviations: ca = callus, eo = embryonic operculum, la = left adductor, ap = apophysis, pa = pseudo-apophysis, ra = right adductor, rp = rib pouch, rs = rib shield.

When Mermod (1953: p.155, Fig. 169) published the types of Lamarck’s collection in Geneva he depicted in addition to the black shell a photo of the operculum of Theodoxus baeticus (Lamarck, 1822) (fig. 1). The quality of this photo was very poor and led some authors believe that Th. baeticus is a synomy of Theodoxus fluviatilis Linnaeus, 1758 (Vidal Abarca & Surez 1985) because a pseudo-apophysis was not visible.

Mermod depicted only one operculum of the two syntypes (fig. 7), possibly because the second one was broken (fig. 9). But on this operculum the pseudo-apophysis is visible, in the depicted operculum it was broken. New high quality photos of the operculum of the syntypes of Th. baeticus showed that this species has a diagonal pseudo-apophysis, like Th. meridionalis (figs. 8-9), while in Th. fluviatilis a peg is missing (fig. 2).

Figures 7-9. Opercula of Theodoxus baeticus. 7: Photo of Mermod’s depicted operculum (reproduction, rotated for better comparison), 8-9: actual photos the opercula of the two syntypes (MHNG-MOLL-51319).

For the sake of completeness I borrowed the syntypes of Nerita meridionalis Philippi, 1836, which are housed in the Museum für Naturkunde Berlin. The type series consists of 40 specimens, predominant empty shells in addition to a few specimens with operculum. All specimens show slimmer or broader violet zig-zag lines on light or dark ground (figs. 10-15).
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The diagonal peg of the operculum shows that it is conspecific with *Th. baeticus*. The rib shield is small and thus the rib pouch is short.

Already Bunje & Lindberg (2007) found that *Theodoxus* samples from Spain, Sicily, Tunisia, and Greece build one cluster (clade D in their paper). Recent molecular data confirm that there are only three *Theodoxus* spp. which occur in the Iberian Peninsula: *Th. fluviatilis*, *Th. meridionalis*, and *Th. valentinus* (Martinez-Ortí et al. 2015, Alba et al. 2016: 55).

The comparisons of the type material showed that *Theodoxus baeticus* is a good species and *Th. meridionalis* is a younger synonym of it.

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