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The Unionidae (Bivalvia) of Latium (Italy), past and present in a historical survey

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ABSTRACT The recent Checklist of the Fauna of Italy reports for Latium only five species of bivalve molluscs belonging to the Unionidae family. In this work we take into considerations the current species and all the taxa reported in the historical bibliography, no longer present or no longer recognized as valid at the taxonomic level.

KEY WORDS *Anodonta*; *Unio*; Unionidae; Latium; Museum collections.

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INTRODUCTION

Freshwater bivalve species provide important information of the ecosystem in the natural environments (Eriksson et al., 1989; Naimo, 1995; Strayer et al., 1999; Vaughn & Hakenkamp, 2001; Gutiérrez et al., 2003; Bogan, 2008; Sousa et al., 2009; Vaughn, 2010; Lopes-Lima et al., 2017; Collas et al., 2018). Particularly, freshwater unionids are one of the most threatened groups of organisms worldwide due to multiple anthropogenic impacts (Allan & Flecker, 1993; Lopes-Lima et al., 2018; Ferreira-Rodriguez et al., 2019; Malmqvist & Rundle, 2002; Lydeard et al., 2004; Dudgeon et al., 2006). For example, 20% of North American species is already listed as Extinct or Possibly Extinct (Master et al., 2000). Freshwater unionids are declining more rapidly than most other taxa because of life-history characteristics that make them more sensitive to human and natural disturbances and that reduce their ability to recover (e.g. a complex life cycle, an obligate parasitic larval stage on a suitable fish host, and limited mobility) (Strayer et al., 2004; Riccardi et al., 2022). In Europe, the situation is exacerbated by the lack of adequate legislation for the protection of most species that is limited to just three of the 20 currently recognised European species none of which is present in Italy (Lopes-Lima et al., 2017; Mammola et al., 2020; Riccardi et al., 2022). Bodon et al. (2021) provide extremely interesting and worrying data regarding the presence in Latium of freshwater molluscs belonging to the Unionidae family. In this region five species are listed, one of which is allochthonous: *Unio mancus turtonii* Payraudeau, 1826; *Anodonta anatina* (Linnaeus, 1758); *Anodonta cygnea* (Linnaeus, 1758); *Anodonta exulcerata* Porro, 1838; and *Sinanodonta woodiana* (Lea, 1834).

Morphologically, the molluscs of the Unionidae family have a marked variability of the shell due to an adaptive phenotypic response to habitat (Zieritz & Aldridge, 2009; Hornback et al., 2010; Zieritz et al, 2010; Reis et al., 2013; Guarneri et al., 2014). This high variability has led the authors of the past to describe numerous taxa almost exclusively on external morphological characteristics: more or less accentuated rear rostrum, more or less pronounced umbo, more or less compressed, more or less elongated shell and, in some cases, also color,

external and internal, of the valves. For these reasons, it is often difficult to be able to classify a single individual especially if one does not know its provenance (Castagnolo et al., 1997). The richest family of freshwater mussels is the Unionidae with 753 species (153 genera), 79% of the species richness of the order (Graf & Cummings, 2021), but they have declined dramatically in recent decades and are currently considered one of the most threatened taxonomic groups worldwide (Dudgeon et al., 2006; Lopes-Lima et al., 2014; Ferreira-Rodríguez et al., 2019; Ludovisi et al., 2022). Despite their ecological importance, conservation of these animals has been hindered by unresolved taxonomy and a lack of data on the distribution and status of populations, especially in southern Europe (Froufe et al., 2017). Based on a typological approach to within and between population phenotypic diversity, hundreds of nominal species have been described, especially as a result of the excesses of the 19th century French "Nouvelle École" (Bouchet, 2002; Prie et al., 2012). In fact in the past, characters subject to high variability have been used as diagnostics, such as the general shape of the shell, its outline and even the color of the periostracum and nacre (Castagnolo et al., 2002). Moreover, usually a limited number of specimens and sometimes even single individuals were studied to create new specific taxa (Castagnolo & Nagel, 1994).

All these species, subspecies, forms and varieties have created many problems and this is particularly evident when reading the many perplexities of Paulucci in the determination and consequent labeling of the specimens in her collection (Castagnolo et al., 2002). In those days, in fact, there was a typological concept of species as applied, particularly, by the French "Nouvelle École" led by Bourguignat, Locard, Servain and Drouët, active between the middle and the end of the 19th century (Castagnolo et al., 2002). Bourguignat (1883) supported this theory with numerous statements: "*Je sais bien qu'en publiant ces lignes je susciterai un profond émerveillement chez les adeptes de la vieille école, qui sont loin de se douter de la richesse de la faune. Mais, je dois la vérité, et bien que cela puisse paraître dur, il est de mon devoir de leur dire que la science malacologique, telle qu'il faut l'entendre, ne fait que commencer. Ces gens n'adoptent peut-être pas les formes "Nouvelle École" voire déforment le sens des descriptions, dans l'espoir d'arrêter le mouvement, ils ne réussiront qu'à prendre du retard et à devenir incapables de publier la moindre faune* [I know that by publishing these lines I will arouse deep wonder among old-school followers, who are far from suspecting the richness of the fauna. However, I owe the truth, and though it may sound harsh, it is my duty to tell them that malacological science, as it should be understood, has only just begun. These people may not adopt "Nouvelle École" forms, or even twist the meaning of descriptions, hoping to stop the movement; they will only succeed in falling behind and becoming unable to publish any wildlife]".

However, on the contrary, by quickly merging too many taxa, important information on the geonemia and biology of these molluscs is lost.

For all these reasons, in this work on the unionids of Latium, I list the current and recognized valid species but I also report all the taxa that no longer exist or are considered synonyms. The aim is to recover, through a malacological study, the historical memory of the original environment of this region and its faunal richness.

MATERIAL AND METHODS

The general systematic framework follows the work of Bodon et al. (2021). The historical data contained in the reference bibliography cited in the text were also consulted and, where this has been possible, the catalogs of the collections deposited in the Italian Museums (Castagnolo et al., 2002). The Meli, Rigacci and Settepassi collections, kept in the Civic Museum of Zoology in Rome, were also studied. In the list of ancient taxa, where present, the description and name attributed by the author is just reported.

ACRONYMS. CMMGR = Mauro Grano malacological collection, Rome, Italy; MCZR = Museo Civico di Zoologia, Rome, Italy; MZUF = Natural History Museum University of Florence Zoological Section "La Specola", Florence, Italy.

The Rigacci Collection was made by Giovanni Rigacci (1816–1871), a well-known Roman collector during the nineteenth century (Fig. 1). Upon his death, the brothers Giuseppe and Enrico preserved the collection by publishing an edition of the cata-

log on the current molluscs (one of those fossils had already been published) (Rigacci, 1874). On Giuseppe's death, three years later, Enrico sold the collection and the library to the Italian government. The Rigacci collection from 1876 is preserved in the Civic Museum of Zoology in Rome. The Rigacci collection it consists of 150.000 specimens of marine, terrestrial and freshwater molluscs obtained through exchanges and purchases from all over the world.

This collection "... *conta ben 10.273 specie ed oltre all'essere fornita delle conchiglie le più rare e pregiate è ricca straordinariamente in mutazioni e duplicati di esemplari tanto marini che terrestri e fluviatili* [it has 10,273 species and in addition to being provided with the rarest and most valuable shells, it is extraordinarily rich in mutations and duplicates of both marine, terrestrial and fluvial specimens]" (Statuti, 1882).

The malacological collection of Romolo Meli (1852–1921), preserved in Museo Civico di Zoologia of Rome includes current species of gastropods and bivalves from all over the world, as well as fossils from geological sites in and around Rome. Romolo Meli (Fig. 2) was an eminent engineer, geologist, paleontologist, philologist, bibliographer, and malacologist (Epiceno & Appolloni, 2014). Member of the Italian Geographic Society, Meli was one of the founders of both the Roman Society for Zoological Studies and the Italian Geological Society, which he chaired in 1904. Several species of molluscs have been dedicated to Meli.

The Collection of Francesco Settepassi (1886–1982), include approximately 50,000 species with almost 3,000,000 specimens, besides 2,500 malacology books (Zanardi, 1994). In 1956, Settepassi donated his collection to the Municipality of Rome. Settepassi has held in his long career numerous positions (also Commendatore of the Italian Republic), but his most important feature was that of making people love malacology, gathering many enthusiasts in weekly meetings at the Zoological Museum of Rome.

Finally, the Paulucci Collection, preserved in the Zoological Museum "La Specola" in Florence, dates back to the second half of the last century. In fact, during this period, the Marquise Marianna Panciatichi Ximenes d'Aragona (Firenze, February

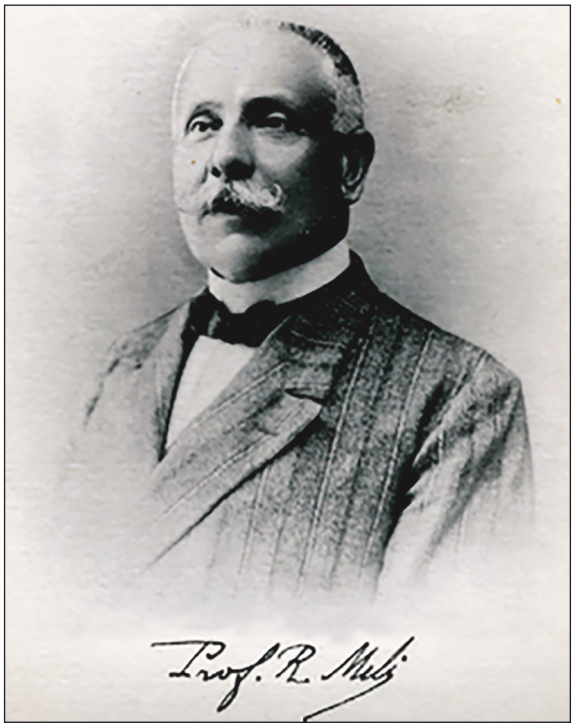

Figure 1. Giovanni Rigacci (Gentiluomo, 1875).
Figure 2. Romolo Meli (by https://www.socgeol.it/N2642/romoli-meli-roma-23-aprile-1852-1-gennaio-1921.html).

3, 1835 - Reggello (FI), December 7, 1919), wife of Marquis Alessandro Anafesto Paulucci, passionate about Natural Sciences, began (from 1876) to also collect terrestrial and freshwater molluscs. material from other collections - Pecchioli, Uzielli, Pini, Caramagna and Menici - was subsequently added in this collection (Castagnolo et al., 2002; for more information see also Cianfanelli et al., 2021).

RESULTS AND DISCUSSION

Historical notes

As regards the Pliocene, Unionidae are known to be present in the pelitic sediments of the Unit of Rio Fratta (Corchiano, Civita Castellana) and of *Margheritifera (Pseudunio) auricularia* (Spengler, 1793) (= *Pseudunio auricularius*) in the fluvial sands of the Unit of Graffignano always in the province of Viterbo (Mancini et al., 2003–2004). The presence of *Pseudunio auricularius* fossil in Latium it had been reported in the last century in Rome in the "*fluvio lacustri*" formations of the middle terrace, present in the confluence area Tevere - Aniene with presence documented by the 8 isotopic stage (OIS 8) up to the Sub-Boreal (Clerici, 1888; Malatesta, 1964; Segre, 1986; Biddittu & Girod, 2004). Specimens of *P. auricularius* have been identified in two Pleistocene deposits in the province of Frosinone, in Isoletta (Arce) and in Pofi (Biddittu & Girod, 2004). Other fossil remains of *Unio* sp. were found in the hinterland of Civitavecchia, along the Mignone River (Fig. 3).

In Graffignano have been found shell fragments of *Unio* sp. from medieval times in food wells of the Castello Baglioni - Santacroce (Romagnoli et al., 2019). In addition, remains of *U. elongatulus* C. Pfeiffer, 1825 is present in the travertine barrier of Rieti Basin (Carrara et al., 1995). Sporadic remains of *Unio* sp. were found in Rome, in the medieval and post-medieval contexts of the Colosseum and the Forum della Pace (unpublished data, personal communication by Luca Brancazi, 2022). A separate discussion deserves the single *Unio* Philipsson, 1788 valve recovered in the second hearth of Templus Pacis (11th century) in Rome. The shell could constitute the stomach residue of a malacovoro fish, but the edible use of the mollusk, once widespread in Italian waters, cannot be excluded (Brancazi, 2019).

Since prehistoric times there is news of the use of bivalve molluscs of the Unionidae family (for his size up to 20 cm long, strength and shape of the shells) as containers, spoons, blades, scrapers, spatulas, awls, buttons (Strobel, 1872; Girod, 2005). The nacreous inner layer of the valves of some species was appreciated for the production of ornamental objects such as plates, pendants and necklace elements. It was precisely the sturdiness of the material and its pleasant mother-of-pearl appearance that made it an important raw material, used at least until the mid-19th century for inlay work and furniture decoration, sword handles, handgun and rifle butts, footwear and musical instruments (Girod, 2005). *Margaritifera margaritifera* (Linnaeus, 1758) was known since Roman times for producing beautiful river pearls (Boettger, 1962; Økland, 1976; Borrello & Girod, 2006). Pliny the Elder (23–79 A.D.) in its Naturalis Historia dedicates a whole chapter to Margarittae which also calls uniones and also mentions a *Porticus Margaritaria* along the Via Sacra (Biddittu & Girod, 2003). In the same place there is also news of one *Margaritaria Taberna*, through the discovery of an indicatory marble insignia partially recomposed from three fragments and datable to the first half of the 1st century. A.D., which was discovered in 1904 in front of the "Tempio del divo Romolo", among the burnt rubble that served to regularize the soil after the fire that happened during the rule of Emperor Nero (Di Giacomo, 2016). De Filippi (1852) remembers the *Margaritarii*, pearl merchants in ancient Rome, gathered in a guild, even if they were interested more than anything else in oriental pearls and on the quays of the river port of Rome they chose, evaluated and bought wholesale lots of pearls to be treated and for retail sale along the Via Sacra in the Foro Romano (Di Giacomo, 2016).

The molluscs of the Unionidae family are not counted among the continental molluscs usually consumed as food in Rome (Grano, 2021), but Statuti (1886) about *Anodonta scapulosa* cite this evidence: "… *purché sia ben condizionato ossia cotto e condito a dovere, non solo è innocuamente commestibile, ma secondo che vennemi riferito, presenta un sapore abbastanza gustoso* [… provided it is well treated, i.e. cooked and seasoned properly, it is not only harmlessly edible, but ac-

Figure 3. *Unio* sp., surroundings of Civitavecchia (Rome, Italy). Courtesy of Luca Brancazi.

cording to what I was told, it has a quite tasty flavor]". The food use of these molluscs is, in fact, historically known, although the freshwater species are less valuable than the marine ones and can host parasites that are harmful to human health (Romagnoli et al., 2019). Even in very recent times there is evidence on the food use of Unionidae: still in the 90s of the last century in the mountains and countryside of Tolfa area (RM), "Cozze del Mignò" were cooked - basically, the *Unio* of the Mignone River that the fishermen brought from the Civitavecchia fish market together with the marine molluscs (Girod, 2015). In the Collection of Museo Malakos is present a specimen of *Sinanodonta woodiana* (catalog number 14655) coming from a mussel's farm in Latium that sold its food products at the fish market of Fiumicino (RM) (Gianluigi Bini, personal communication, 2022).

From the biological point of view, the larval stages of these bivalves are hosts of some fish species and their loss is a risk also for the existence of the Unionidae (Castagnolo & Nagel, 1994). For example, it is interesting to note how the approximate period of the disappearance of *Pseudunio auricularius* in Italy coincides with the demographic crisis and the rapid decline that sturgeons, *Acipenser naccari* and *A. sturio* have had in Italy and more generally in Europe (Plehm & Scotti, 1909; Scortecci, 1967; Altaba, 1990, 1997; Arajuno & Ramos, 2001; Wächtler et al., 2001; Mills, 2003; Biddittu & Girod, 2004). The contemporary decline of *P. auricularius* and of the sturgeons in our local waters suggests that there was also a very close link between these species in Italy (Biddittu & Girod, 2004). In the Tiber River in Rome the sturgeon had to suffer the effects of aggressive fishing and its capture was always an important event, both for the size and for the quality of the meat (Cataudella, 2000) even if its presence was guaranteed by the numerous fish ponds present in the Tiber River and by the coastal ponds of Ostia, Palo Laziale and Maccarese (Pucci Donati, 2017). As evidence of the importance that this fish had in Rome, a bas-relief remains preserved in the Sala dei Conservatori of the Capitoline Museums (Fig. 4) which represents a 1.15 m long sturgeon and identified the minimum size subject to the tax that fishmongers of Portico d'Ottavia had to give to the Conservatori of Rome, already mentioned in the statutes of the city of 1363, 1580 and 1611 (Capogrossi Guarna, 1877). In the urban stretch of the Tiber River until 1924, sporadic catches of "porcellette", young sturgeons

Figure 4. Bas-relief in Capitoline Museums of Rome (Italy).

Figure 5. *Unio* sp., Stimigliano (Rieti, Italy), Meli-MCZR.

Figure 6. *Unio romanus*: "*Vicinanze di Roma*" (Italy), Rigacci-MCZR.

ready to go back to the sea, were still reported (Cataudella, 2000). The great climatic changes and the heavy anthropic impact that the area in question has suffered, especially in the urban area, has ensured that many of the toponyms reported on the labels of the historical collections are no longer present (Figs. 5, 6). Above all, the network of canals and ditches that flowed into the Roman countryside have now disappeared, upsetting the ancient landscape. In the same city of Rome, where there were some of

the toponyms reported in the labels of the historical collections, great changes took place. In fact, at the end of the 19th century, coinciding with the events of the Risorgimento, Rome was one of the least developed and populated cities of the Italian peninsula. Still in 1870, Rome appeared as a small strongly rural city, dotted with monumental ruins of antiquity and with vast green areas and urban gardens. In the years following its designation as the capital of the Kingdom, however, the city experienced a rapid and tumultuous development. For the transfer of the capital from Florence to Rome, a special law was issued on February 3, 1871, which gave the State ample powers of expropriation, and this allowed the demolition of buildings, the destruction of many of the urban gardens and consequently the filling of the many canals, marane, as they were called in Rome, that flowed into the city and were also exploited for the irrigation of the vegetable gardens. Also in these years the problem of the floods of the Tiber River (Fig. 7), which had afflicted the city for centuries, was definitively resolved. Based on a project by the engineer Raffaele Canevari, it was decided to stem the river with travertine walls, with the Lungotevere at their top. The construction of the embankments lasted almost half a century and ended only in 1926, but it changed the face of Rome and freed it from floods. The price to pay, however, was the loss of the natural banks of the river and of many traditional economic activities linked to the Tiber River, in addition to the disappearance of the two river ports of Ripa Grande (Fig. 8) and Ripetta (Fig. 9). Furthermore, a great impact on the Latium area was due to the remediation works that substantially changed the countryside around Rome and Latina. In 1865, 9% of the entire surface of the Kingdom of Italy was infested by malaria. In less than 60 years, over three hundred thousand hectares of land were cleared. In particular, in Latium and following the proclamation of Rome as the capital, the Italian State plans and carries out, with a law made in 1878 but starting from 1884, the draining of the marshes and ponds of the Tiberine Delta, from Ostia to Maccarese (Fig. 10), performed by peasants from northern Italy. The reclamation of the Roman coast and its destination for agricultural use were completed, in the 1920s, through the Bonifica Integrale. The complete reclamation of the Agro Pontino began in 1924, with the

Figure 7. Tiber River in Rome (Italy).

Figure 8. Port of Ripa Grande, 1800. Author's private collection.

Figure 9. Port of Ripetta, 1800. Author's private collection.

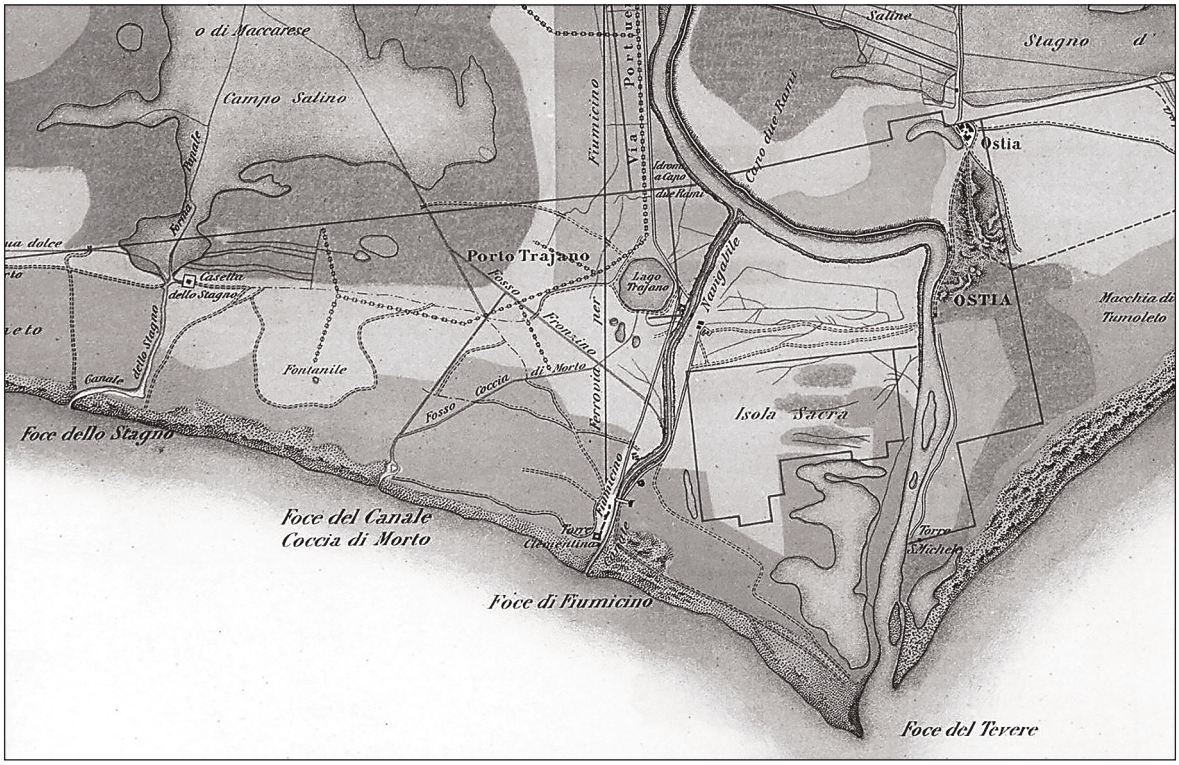

Figure 10. Mouth of theTiber River. Archivio Capitolino, Rome, Italy.

sale to the Italian State of an area of about 20,000 hectares, owned by the Caetani family, known as the Bacino di Piscinara (largely corresponding to the current municipal areas of Cisterna di Latina and Latina). This reclamation work lasted for 11 years with the use of over 50,000 workers from all over Italy. Even the innovative irrigation techniques of the crops have led to the drying up of the network of canals that were used, especially in the countryside of Litorale Romano, to irrigate the fields.

Besides these big problems, the negative impact of the introduction of non-native species should not be underestimated, since they compete with native species, as it is well known (Lopes-Lima et al., 2017, 2018; Böhm et al., 2021; Karaouzas et al., 2022). Non-native species introductions are a major concern for the conservation of natural ecosystems. The spread of non-native species depends not only on their adaptation to the new environment, but also on the biotic features of the non-native and resident native species and their environment that determine competition in natural habitats (Ferreira-Rodriguez et al., 2018), including inter-specific competition for trophic resources (Ludovisi et al., 2022). Especially the invasive mussel species have been reported to result in declines of native species (Collas et al., 2018; Ferreira-Rodriguez et al., 2018; Marszewska & Cichy, 2018; Huber & Geist, 2019; Ożgo et al., 2020). In addition, the epizoic colonization of unionid bivalves by exotic species has led to a decline and in many cases to a total eradication, of native species (Mackie, 1991; Haag et al., 1993; Schloesser et al., 1996). The increased frequency and duration of droughts further reduces the availability of permanent habitats that can guarantee the persistence of reproducing populations. Habitat destruction and dewatering benefit invasive species, which are more resistant to desiccation and able to recolonize rapidly after die-offs (Bielen et al., 2016; Riccardi et al., 2022). In addition, a number of reviews and long-term studies have suggested that invasive bivalves, dreissenid mussels in particular, may be superior competitors in food acquisition due to, e.g., more flexible diets, or higher ability and efficency to exploit trophic resources (Higgins & Vander Zanden, 2010; Sousa et al., 2014; Strayer & Malcom, 2018; Ludovisi et al., 2022).

Systematics

Phylum MOLLUSCA
Classis BIVALVIA Linnaeus, 1758
Subclassis AUTOBRANCHIA Grobben, 1894
Infraclassis HETEROCONCHIA J.E. Gray, 1854
Subterclassis PALEOHETERODONTA Newell, 1965
Ordo UNIONIDA Gray, 1854
Superfamilia UNIONOIDEA Rafinesque, 1820
Familia UNIONIDAE Rafinesque, 1820
Subfamilia UNIONINAE Rafinesque, 1820
Genus *Unio* Philipsson, 1788
Species *mancus* Lamarck, 1819

Unio mancus turtonii Payraudeau, 1826

Genetic analyzes of some Italian populations have shown that *Unio elongatulus* and *U. mancus* are two primarily allopatric autochthonous species (Marrone et al., 2019).

In Italy, *U. elongatus* C. Pfeiffer, 1825 is found in Piedmont, Lombardy, Trentino A. Adige, Veneto, Friuli Venezia Giulia, Liguria, Emilia Romagna, Tuscany, Marche, Abruzzi, Apulia (probably introduced in Liguria and Tuscany) (Bodon et al. (2021).

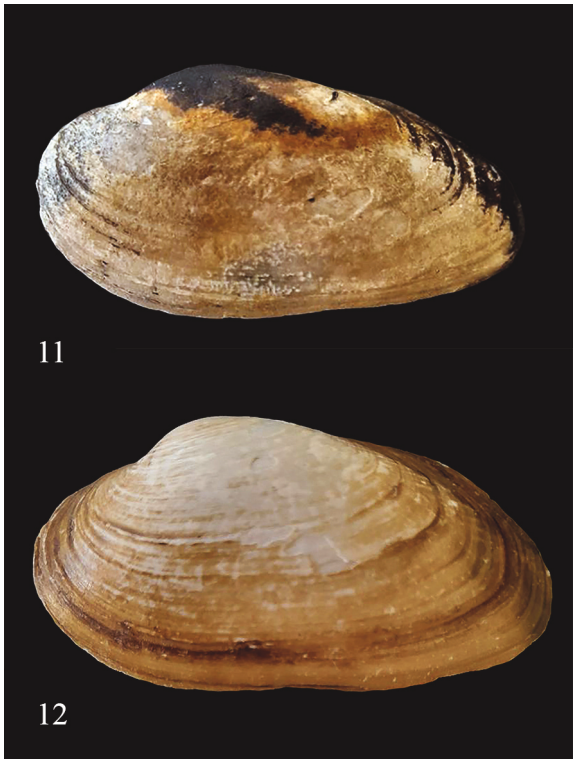

Figure 11. *Unio mancus turtonii*, Rome (Italy): Fiume Tevere, Isola Tiberina, Luglio 2022, 2483-CMMGR. Figure 12. *Unio mancus turtonii*, Viterbo (Italy): Fiume Mignone Blera, Settembre 2006, 1452-CMMGR.

Unio mancus (locus typicus from Lamarck, 1819: "*Bourgogne, dans la Drée*") has an areal that extends into Mediterranean Europe, North Africa and the Middle East. Three subspecies are recognized: *Unio mancus mancus* is spread in the French Atlantic drainage basins, in the Pyrenees, and in Mediterranean drainage basins from the Têt River in southwestern France to the Spanish Mediterranean; *Unio mancus requienii* Michaud, 1831 in the Seine, Saône-Rhône and Mediterranean drainage from the Rhône to the Herault River basin, introduced in Lake Montepulciano, Siena (Italy) (Froufe et al., 2017); *Unio mancus turtonii* in the French Mediterranean drainage east of the Rhône (Argens River), and in Itay: Liguria, Tuscany, Umbria, Latium, Abruzzi, Campania, Basilicata, Sicily, Sardinia and Corsica (Bodon et al., 2021).

Unio mancus is currently considered "Near Threatened" on the IUCN European Red List of Non Marine Molluscs (Cuttelod et al., 2011), but at the moment *U. mancus* satisfies the criteria to be listed as "Endangered" in the IUCN Red List (Prie et al., 2012). This species can live up to 19 years (Nardi, 1972; Nagel & Badino, 2001; Girod, 2005).

Statuti (1882) reports, at lot 141/1855: "U. Requieni *var.* Turtonii *Moq. Tand. Hist. Moll. Fr. pag. 575. Abita il canale Botte a Terracina* [...It lives in the Botte canal in Terracina]".

Fossil specimens were found in the alluvial sediments of Liri River, near Pontecorvo (Frosinone), where only one defective left valve is present, and in the alluvial sediments of Rio Poppeto, near Pignataro Interamna, where one complete left valve is present (Settepassi & Verdel, 1965) (Figs. 11, 12).

<u>The ancient taxa attributable to *Unio mancus*</u>

Unio campanus Drouët, 1883

Bourguignat, 1883: "*Le* campanus *vit dans les canaux de la plaine de San Germano, sous l'Abbaye du Mont-Cassin* [The *campanus* lives in the canals of the plain of San Germano, under the Abbey of Montecassino]".

Reported by Alzona (1971) as "Unio elongatulus campanus *(Blanc) Bourguignat - San Germano (Montecassino*)".

Unio elongatulus moltenii umbricus Adami, 1882

Type locality (Adami, 1882: 138, figg. 4, 6, 8): "*in Tiberi in Provincia Umbrica*".

Synonymous: *uziellii* Bourguignat 1883 (Bourguignat, 1883: 38, described for "*dans le canal des Marais-Pontins, entre Terracine et Velletri'*").

Alzona (1971) cite this taxon for Umbria, Tuscany and Latium.

Unio elongatulus polii Drouët, 1883

Type locality ((Drouët, 1883: 27): "*Le lac de la Villa Doria-Pamphili à Rome*".

Alzona (1971) cite this taxon for Roma: Villa Pamphili Doria (Fig. 13).

Unio elongatulus romanus Rigacci, 1874

Locus typicus "*Roma*" (Rigacci G. & Rigacci E., 1874: 18)

Alzona (1971) cite this taxon for Umbria and Latium in Tiber River.

Unio gargottae Philippi, 1836

In the Paulucci collection (MZUF), a specimen with 3 labels (Castagnolo et al., 2002) is listed as *Unio pictorum mancus* (Lamarck, 1819) (catalog number 1764): "Unio gargottae *Philippi. Fossés près de Rome* - Unio gargottae *Philippi var. minor. Fossi vicino a Roma* - Unio gargottae *Philippi var. minor, from Mr. Rigacci with the name of* U. romanus *Rigacci, var.* B. *Statuti (1882, lot 144/1836)*" (see also Paulucci (1879).

Unio Larderelianus Pecchioli, 1869

This taxon was dedicated by Pecchioli (1859) to Count Gastone Larderel, owner of the villa at Pozzolatico in Tuscany, in whose lake the specimens used for the description of the species were collected. Statuti (1882) reports, at lot 145/1868, *Unio Larderelianus* as "*varietà 1*" of *U. Lawleyanus*: "*1869* Unio Larderelianus *Pecchioli Bull. Malac. Ital. pag. 163. La varietà* U. Larderelianus *Pecchioli fu riconosciuta dallo stesso Pecchioli in taluni individui provenienti dalle Paludi Pontine che io stesso sottoposi a quell'esimio naturalista per la relativa determinazione* [1869 *Unio Larderelianus* Pecchioli Bull. Malac. Italian p. 163. The variety *U. Larderelianus* Pecchioli

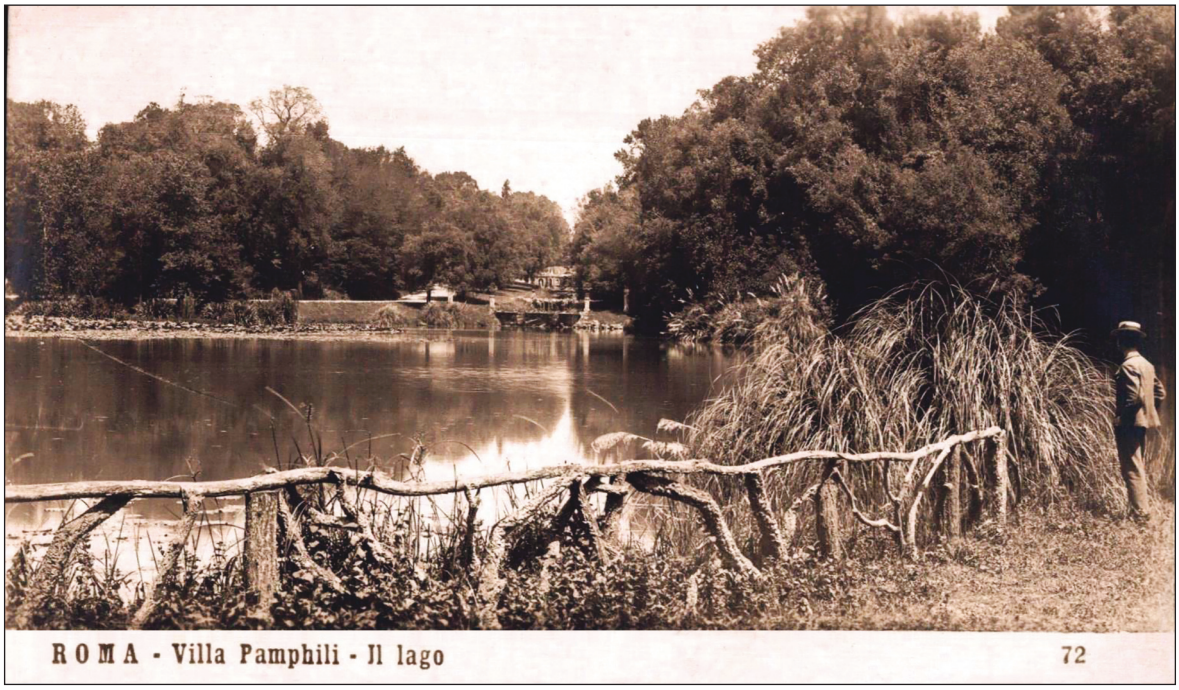

Figure 14. The lake of Villa Pamphili (Rome, Italy), 1930. Author's private collection.

was recognized by Pecchioli himself in some individuals from the Pontine Marshes which I myself submitted to that eminent naturalist for the relative determination]".

Unio latinus Bourguignat, 1883

According to Bourguignat (1883): "*Le* Latinus *a été recueilli par moi dans les Marais Pontins, sur le bord du canal qui longe la grande route de Terracine à Velletri* [The *Latinus* was collected by me in the Pontine Marshes, on the edge of the canal which runs along the main road from Terracina to Velletri]".

Unio Lawleyianus Gentiluomo, 1868

According to Bourguignat (1883): "*Le type de cette belle espèce est caractérisé par un test sinué à sa partie médiane, très haut de taille en avant, et offrant une région postérieure allant en s'atténuant notamment sur le contour supérieur, qui est recto-descendant, en un rostre inférieur assez exigu* [The type of this beautiful species is characterized by a sinuate test in its middle part, very high in size in front, and offering a posterior region going by attenuating in particular on the upper contour, which is descending rightward, in a lower rostrum quite cramped]".

Castagnolo et al. (2002) reports the following data from the Paulucci collection (MZUF):

1771. "*Roma. Lago Villa Pamphily-Doria, 1876*", 2 specimens;

1774. "*Fosso di Monte Pietro, presso Torre di Foce Verde, sul littorale oltrepassata Torre Astura, 1° Dicembre 1880*", 3 specimens;

1779. "*Fosse dei Pantani, adiacenti al fiume delle Volte. (Paludi Pontine), 11 Gennaio 1881*", 4 specimens;

1781. "*Canale Selcella in vicinanza del laghetto Manello (Paludi Pontine), 11 gennaio 1881*", 2 specimens;

1783. "*Canal Botte Paludi Pontine., 10 Dicembre 1880*", 1 specimen;

1785. "*Fosso dei Pantani. Paludi Pontine, Gennaio 1881*", 1 specimen.

1911. At this catalog number there is this citation: *Unio* ... (*difformis*?). (Fig. 14) from Rome (Villa Pamfili Doria, see also catalog number 1771) with a supernumerary tooth in the left valve. It was classified at first as *U. tumidus* and, afterwards, as *U. lawleyanus* (Castagnolo et al., 2002: "*teratological specimen!*").

Unio Molteni Adami, 1882

Type locality (Adami, 1882): "*Il corso superiore del Tevere in Umbria* [The upper course of the Tiber River in Umbria]".

Statuti (1882) reportS this taxon at lot 142/1877: "*1877* Unio Molteni *Adami in Sch. vedi Paulucci Molluschi inviati Esposizione di Berlino 1880, n. 75. Sulla fede della Chiarissima Signora Marchesa Paulucci cito la suddetta specie come propria del Lazio* [1877 Unio Molteni Adami in Sch. see Paulucci Molluscs sent to the Berlin Exhibition 1880, n. 75. On the faith of the most illustrious Signora Marchesa Paulucci, I cite the aforementioned species as typical of Latium] ".

Castagnolo et . (2022) report other data from the Tiber River near Foligno in Umbria (Paulucci collection, MZUF: 1845).

Unio pictorum Draparnaud, 1806

Statuti (1882) reports this taxon at lot 143: "*1758* Mya Pictorum *Linn. Syst. nat. Ediz. X, Vol. I, pag. 671 (non Mont.). 1788* Unio *Philipps Nov. Test. gen. pag. 17. 1821 Rostratus C. Pfr. Syst. Deutsch. Schneck. I, pag. 114. 1822* Mysca Pictorum *Turton. Conch. Brit. Vol. XLVI, pag. 245. Comune in molti corsi d'acqua della Provincia* [… Common in many watercourses of the Province]".

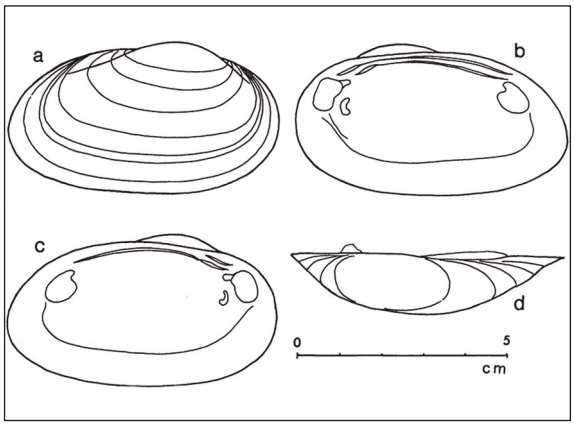

Figure 14. *Unio* ... (*difformis*): a specimen with a supernumerary tooth in the left valve by Castagnolo et al. (2002).

Remarks. In the Settepassi collection (MCZR) is present a fossil specimen from the locality Cava Bianca, Rome (Fig. 15).

Unio Requienii Michaud, 1831

Castagnolo et al. (2002) report the following data from the Paulucci collection (MZUF):

1822. "*Villa Doria Pamphili*" - 2 specimens;

1823. "*Roma*", 4 specimens;

1825. "*Fiume Sacco presso Ceprano, 1877*", 3 specimens;

1833. "*Roma. Villa Doria Pamphili*", 6 specimens;

1919. "*Marrana dell'Acquataccio p.o. Roma, 11 Gennaio 1881*", 1 specimen;

Statuti (1882) reports this taxon at lot 140: "*Il tipo di questa specie si trova in diversi corsi di acqua della Provincia soprattutto nei canali principali della Palude Pontina* [The type of this species is found in various watercourses of the Province especially in the main canals of the Pontine Marsh]".

Unio romanus Rigacci, 1874

Type locality (Rigacci, 1874): "*Il Tevere e i suoi affluenti, dintorni di Roma* [The Tiber River and its tributaries, surroundings of Rome]".

According to Bourguignat (1883): "*Cet Acéphale, qui vit dans les fossés des environs de Rome, et que mon ami de Francfort signale du Tibre (toujours sous deux noms différents), se trouve également dans le Volturno à Capoue. Il m'a encore été adressé des environs de Spolète sous l'appellation fautive de* Moltenii [This Acephalus, which lives in the ditches in the surroundings of Rome, and which my friend from Frankfort reports from the Tiber (always under two different names), is also found in the Volturno at Capua. It was again addressed to me from the surroundings of Spoleto under the faulty name of *Moltenii*]".

Castagnolo et al. (2002) report the following data from the Paulucci collection (MZUF):

1847. "*Roma, nei fossi vicino Roma* [In the ditches near Rome]", 1869, 2 specimens;

1996. *Unio Requienii* Mich. var. = *U. romanus* "*typus Rigacci in Sched. - Fossés des environs de Rome* [In the ditches near Rome]".

Figure 15. Fossil specimen of *Unio pictorum*: Cava Bianca near Rome (Italy), Settepassi-MCZR.

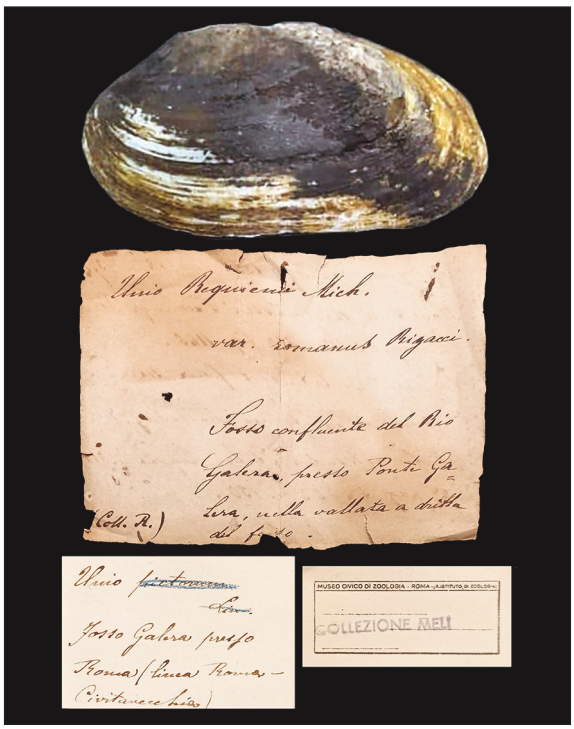

Figure 16. *Unio Requienii* var. *romanus*: confluent ditches of Rio Galeria, Ponte Galeria, Rome (Italy), Meli-MCZR.

Statuti (1882) described at lot 140/1874 *Unio Romanus* as "varietà 1" of *U. Requieni*: "*1874* Unio Romanus *Rigacci Paulucci Matériaux ecc. n. 518, pag. 20. Le varietà 1 e 2 sono forme localizzate dei fossi che esistono nei contorni di Roma* [... Varieties 1 and 2 are localized forms of the ditches that exist along the borders of Rome] ".

In fact, Paulucci (1878) says in this regard: "*J'ai également reçude M. Rigacci une autre forme, sous le nom d'*U. Romanus*, Rigacci, et je partage complétement l'avis du Dr. Kobelt qui en fait une variété du* Requieni*. D'apres l'indication de l'auteur, cette forme vit dans les fossés de Rome* [I also received from M. Rigacci another form, under the name of *U. Romanus,* Rigacci, and I completely share the opinion of Dr. Kobelt who makes it a variety of *Requieni*. According to the indication of the author, this form lives in the ditches of Rome]" (Figs. 16–18).

The author indicates the rivers and ditches of the Viterbo area as typical localities of this species (Lepri, 1909).

REMARKS. Due to the great taxonomic confusion that characterized the end of the 19th century, *Unio romanus* is present as a valid species but also as a subspecies and as a variety of *U. Requienii*.

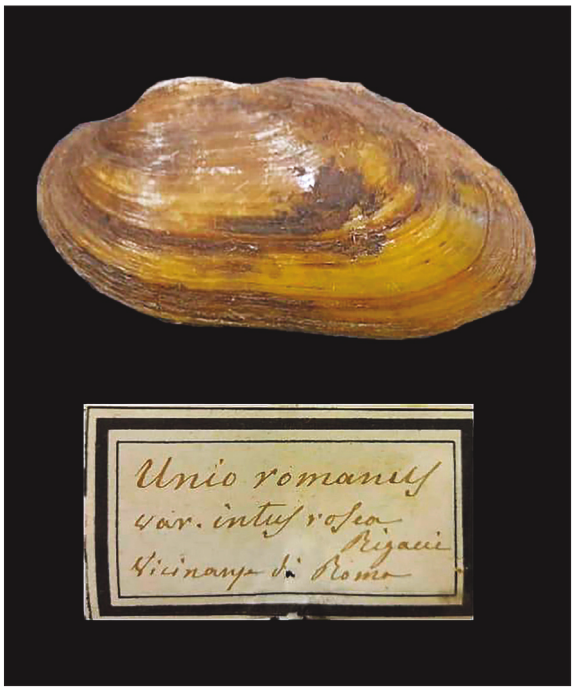

Figure 17. *Unio romanus* var. *intusrosea*: "*Vicinanza di Roma* [Surroundings of Rome]", Rigacci-MCZR.

Unio rosea Rigacci, 1874

Type locality (Rigacci, 1874): "*Dintorni di Roma* [surrounding Rome]".

Statuti (1882) reports this taxon at lot 140/1874 as "varietà 2" of *U. Requieni*: "*1874* Unio rosea *Rigacci Catalogo Moll. n. 1375. Le varietà 1 e 2 sono forme localizzate dei fossi che esistono nei contorni di Roma* [...Varieties 1 and 2 are localized forms of the ditches that exist along the borders of Rome]" (Fig. 17).

Unio rostrata Lamarck, 1819

Statuti (1882) reports this taxon at lot 143/1831 as "*varietà 1*" of U. pictorum: "*1831* Unio rostrata *Mich. Compl. Drap. pag. 108, n. 4. La varietà* rostrata *si trova a Terracina* [1831 *Unio rostrata* Mich. Compl. Drap. p. 108, no. 4. The *rostrata* variety is found in Terracina]".

Unio sinuatus Lamarck, 1819

Statuti (1882) at lot 139 writes: "*Il Ch. Sig. Prof. Ing. Romolo Meli in una sua erudita memoria sulla natura geologica dei terreni incontrati nelle fondazioni tubulari del nuovo ponte in ferro costruito sul Tevere a Ripetta in Roma indicò l'esistenza dell'*Unio sinuatus *Lamk. nei depositi superiori dell'alveo attuale del Tevere, dichiarando altresì che questa specie avea vissuto sul posto in epoche non molto lontane, ma recenti d'assai. Posteriormente alla pubblicazione della suddetta memoria nell'ultimo tronco del fosso delle Castellaccie che ha la sua foce nel Tevere superiore, nella località appunto di questo nome, da taluni operai addetti ai lavori di navigazione del fiume venne raccolta una valva di un individuo adulto lunga mm 123 larga mm 62 in uno stato di quasi perfetta conservazione sia per la lucentezza dello strato perlaceo interno sia per l'epidermide nerastra tuttora esternamente aderente al guscio. Questa valva vennemi favorita dall'esimio Prof. di Scienze Naturali Sig. G. Tuccimei, il quale tenuto conto della relativa sua freschezza, mi dichiarava che a suo avviso, non avrebbe potuto considerarsi come un esemplare rappresentante una specie rigorosamente fossile. Il prelodato Sig. Prof. Meli a cui resi ostensibile la suddetta valva nel riconoscerne l'assoluta superiorità in fatto di conservazione su tutte le molte altre fin qui estratte*

Figure 18. *Unio romanus*: "*Campagna Romana* [Roman countryside]", Rigacci-MCZR.

dal Tevere da esso già esaminate, volle altresì farmi rilevare che coll'aver' egli dichiarato nella sua precitata memoria che la detta specie avea vissuto sul posto in epoche recenti d'assai, non avea inteso di precludersi la via ad ammettere che la medesima potesse vivere tuttora nel Tevere e nei suoi principali influenti; opinione nella quale anzi, dopo l'ispezione della valva in parola, riteneva doversi più che mai confermare (Meli, 1880). *Esclusa pertanto l'ipotesi che la detta valva si possa considerare come fossile, nel dubbio tuttavia se debba ineccezionabilmente riferirsi ad una specie attualmente vivente nel nostro fiume o tutto al più sub - fossile, ho creduto comprendere tale specie con riserva nel presente catalogo, nel pieno convincimento però che ulteriori più accurate ricerche nel Tevere e suoi influenti non tarderanno ad eliminare qualsiasi incertezza in proposito, nel senso cioè di confermare l'esistenza nella nostra Provincia dell'* Unio sinuatus *Lamarck in istato vivente* [The Ill. Mr. Prof. Eng. Romolo Meli in one of his erudite work on the geological nature of the soils encountered in the tubular foundations of the new iron bridge built over the Tiber at Ripetta in Rome pointed out the existence of the *Unio sinuatus* Lamarck in the upper deposits of the current bed of the Tiber. He also declared that this species had been living in the area since recent times, and not since a long time. After the publication of the aforementioned work in the last section of the Castellaccie ditch which has its mouth in the upper Tiber, in the locality bearing this name, some workers involved in the navigation of the river collected a valve of an adult individual 123 mm long 62 mm wide in a state of almost perfect conservation both for the brightness of the internal pearly layer and for the blackish epidermis still externally adherent to the shell. This valve came to me in favor of the distinguished Professor of Natural Sciences Mr. G. Tuccimei, who, taking into account its relative freshness, declared to me that in his opinion, it could not have been considered as a specimen representing a strictly fossil species. The praised Mr. Prof. Meli - to whom I made the aforementioned valve visible in recognizing its absolute superiority in terms of conservation over all the many others extracted up to now from the Tiber already examined by him - also wanted to point out to me that by having declared in his aforementioned work that the said species had lived on the spot in very recent times, he had not intended to preclude

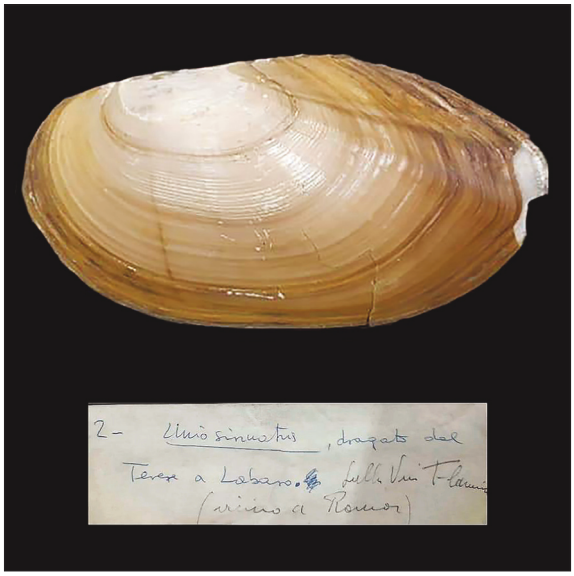

Figure 19. *Unio sinuatus*, Rome (Italy): Tiber River near Labaro in Via Flaminia, Settepassi-MCZR.

himself from admitting that the same species could still live in the Tiber River and in its main influences; an opinion he felt he had to confirm himself more than ever after the inspection of the valve in question (Meli, 1880). Therefore excluding the hypothesis to consider the said valve as a fossil, however doubting whether it should unexceptionably refer to a species currently living in our river or as a sub-fossil, I included this species with reservation in the present catalogue, fully believing, however, that further more accurate research into the Tiber and its tributaries will soon eliminate any uncertainty in this regard, confirming the existence in our Province of the *Unio sinuatus* Lamarck in a living state]" (Fig. 19).

Unio tumidus Stabile, 1845

Martens (1870) reports the presence of *Unio tumidus* through a previous observation of Bonanni (1681): "*Recreatio mentis et oculorum in observatione animalium testaceorum, Romae, 1684. 4° - pars II, n° 41, Albulae aquae Romam ferunt*. A few years later, Statuti also mentions the same report: "*A semplice notizia trovo opportuno di aggiungere che il Bonanni Ricreatione dell'occhio e della mente citò un* Unio tumidus *vivente nelle Acque Albule presso Tivoli, il quale ove dovesse riunirsi all'* Unio tumidus *Philipps Mya Orata Donov. nulla avrebbe di comune coll'* Unio Lawleyanus *Gentiluomo. Ho detto però ove dovesse riunirsi, giacchè ad onta di accurate indagini fatte eseguire ripetutamente per mio conto sia nei laghetti che nel canale portatore delle dette acque, le quali come è noto sono eminentemente sovraccariche di zolfo ed acido carbonico, non mi è riuscito finora scoprire in essa la presenza di alcuna specie di* Unio [As simple news, I find it appropriate to add that the Bonanni *Ricreatione dell'occhio e della mente* cited a *Unio tumidus* living in the Acque Albule near Tivoli, which would have nothing in common with the *Unio Lawleyanus* Gentiluomo, if it were to become synonimous with the *Unio tumidus* Philipps *Mya Orata* Donov. However, I have said if it were to reunite since, in spite of accurate investigations repeatedly carried out on my behalf both in the lakes and in the canal carrying said waters, which as it is known are eminently overloaded with sulfur and carbonic acid, I have not been able to find out so far in it the presence of any species of Unio]" (Statuti, 1882). For this species, Paulucci (1878) says: "*Unio tumidus*, Retzius. *C'est d'après des types de Suède, envoyés par le Dr. Westerlund, que j'ai déterminé des exemplaires qui ont été recuillis dans le lac de la Villa Panfili, près Rome* [*Unio tumidus*, Retzius. I determined the specimens which were collected in the lake of Villa Panfili, in Rome from types from Sweden, sent by Dr. Westerlund]".

REMARKS. Although these statements of a biological nature are absolutely correct, it is worth mentioning that in the Collection of Museo Malacologico Malakos of Città di Castello (Perugia) at catalog number 36801 is present a lot of ten specimens of *Unio mancus* (from M. Orlandini collection, Mestre, Italy) collected in 1985 in Tivoli Lake. It is very difficult to establish with certainty which places exactly these collections correspond to since the Acque Albule basin, which is defined as Tiburtino Lake or Tivoli Lake, occupies an area of about 45 sq km and includes numerous small lakes and canals (Ceruleo, 2005).

Unio Umbricus Adami, 1882

Bourguignat (1883) writes: "*Cette forme que je sépare du* Moltenii*, parce qu'à mon sens, elle en est bien distincte, est une espèce plus commune que la précédente, qui est fort rare. Elle se rencontre,*

d'après Adami, dans tout le cours du Tibre, en Ombrie, d'où cet auteur a eu la bonté de m'envoyer de forts beaux échantillons. J'ai recueilli Umbricus *dans le canal des Marais Pontins, entre Terracine et Velletri. L'*Umbricus*, qui est fort bien représenté sur la planche qui accompagne le mémoire du cap. Adami, est une forme allongée, d'apparence un peu subquadrangulaire, à bord inférieur rectiligne, parfois légèrement concave; les sommets sont relativement plus antérieurs que ceux du* Moltenii*; le bord supérieur droit jusqu'à l'angle postéro-dorsal, descend ensuite sur le rostre en un contour peu arqué, presque rectiligne; tandis que chez le* Moltenii*, il est régulièrement arqué jusqu'au rostre; la sinuosité ventrale, si accusée chez le* Moltenii*, n'existe pas chez* Umbricus*; à sa place, se montre une surface peu convexe, presque méplane, avec un sentiment de légère concavité, chez quelques échantillons; il résulte de ce caractère une répartition plus régulière de la convexité, qui, chez le* Moltenii*, par suite de la sinuosité, se trouve très accusée sur une portion de la région antérieure et sur l'arête dorsale. Au point de vue de la charnière, il existe des différences notables: la cardinale est plus longue, un peu moins épaisse, à sommet plus largement tronqué; la latérale est, de son côté, bien plus longue que celle du* Moltenii*: ainsi, elle dépasse de près de 10 mm l'extrémité du ligament, tandis que chez le* Moltenii*, elle se prolonge à peine au delà de 4; d'où il résulte que la lunule terminale ligamentaire est fort courte chez le* Moltenii *et très allongée chez l'*Umbricus. *Quant à la coloration: le* Moltenii *est d'une teinte uniforme jaune plus ou moins olivâtre; l'*Umbricus*, d'un marron presque noir passant au rouge vers les sommets, etc.* [This form which I separate from the *Moltenii*, because in my opinion it is quite distinct from it, is a more common species than the preceding one, which is very rare. It is found, according to Adami, throughout the whole Tiber River, in Umbria, whence this author had the kindness to send me very fine specimens. I picked up *Umbricus* in the canal of the Pontine Marshes, between Terracina and Velletri. The *Umbricus*, which is very well represented on the plate in the work of Captain Adami, is an elongated shape, somewhat subquadrangular in appearance, with a straight lower edge, sometimes slightly concave; the summits are relatively more anterior than those of the *Moltenii*; the upper edge straight to the postero-dorsal angle, then descends on the rostrum in a slightly arched contour, almost straight; while in the *Moltenii* it is regularly arched to the rostrum; the ventral sinuosity, so marked in *Moltenii*, does not exist in *Umbricus*; in its place is shown a slightly convex surface, almost flat, with a feeling of slight concavity, in some specimens; from this character results a more regular distribution of the convexity, which, in the *Moltenii*, in consequence of the sinuosity, is found very marked on a portion of the anterior region and on the dorsal ridge. From the point of view of the hinge, there are notable differences: the cardinal is longer, a little less thick, with a more widely truncated top; the lateral is, on its side, much longer than that of the *Moltenii*: thus, it exceeds by almost 10 mm the extremity of the ligament, while in the *Moltenii* it hardly extends beyond 4; whence it follows that the terminal lunule of the ligament is very short in the *Moltenii* and very elongated in the *Umbricus*. As for the coloring: the *Moltenii* is of a uniform more or less olive-yellow hue; the *Umbricus*, an almost black brown fading to red towards the tops, etc.]".

Unio Uzielli Bourguignat, 1883

Bourguignat (1883) writes: "*Long. max. 67; haut. perp. et max. 38; épaiss. 26; dist. des sommets à l'angle 31, et de cet angle au rostre 24 (cette mesure dénote une partie rostrale très courte); rég. ant. 27, post. 41 millim. Cette forme remarquable, que je dédie au professeur Vittorio Uzielli de Livourne, a été trouvée dans le lac de la villa Doria Pamphili à Rome* [Long. max. 67; high. perp. and max. 38; thick. 26; dist. vertices at angle 31, and from this angle to rostrum 24 (this measurements denotes a very short rostral part); reg. ant. 27, post. 41 mm. This remarkable form, which I dedicate to Professor Vittorio Uzielli of Livorno, was found in the lake of the villa Doria Pamphili in Rome]".

Anodonta anatina (Linnaeus, 1758)

Shell very variable, usually greenish yellow, brown or black, very solid, often twice as heavy as *A. cygnea*, frontal part of the inside lower margin thickened, ligament shorter and broader than in *A. cygnea*, dorsal and ventral margins less parallel, ventral margin often curved, dorsal margin can be straighter. Embryonal shell smoother than in *A.*

cygnea, with coarse undulated lines, often not reaching the margin. Animal like *A. cygnea*, yellowish, greenish or light reddish, mantle large and brownish yellow, gills greyish and like gaze, foot large and darker than the rest of the body, opening for water supply much wider than in *A. cygnea*, and with short papillae (Fig. 20).

It lives in calm rivers, river bays, lakes, creeks, in muddy or sandy substrate, usually 2–3 m deep, not below 20 m, tolerates slightly faster water currents than *A. cygnea*. Up to 1800 m altitude, usually below 1200 m, higher than the other freshwater mussels. Eutrophic conditions are better tolerated than by *U. pictorum*, but less than by *A. cygnea*. Local forms are increasingly threatened by uniform forms introduced with gamefish. Generally threatened by continuous destructions of habitats, water pollutions and agricultural fertilization. This species can live up to 4 years (Nardi, 1972; Nagel & Badino, 2001; Girod, 2005).

Anadonta anatina has a European distribution, from the Iberian peninsula to Scandinavia and Siberian region including Continental and Peninsular Italy (Bodon et al., 2021). Species recently confirmed in Italy on molecular data (Riccardi et al., 2019).

Statuti (1882) reports this taxon at lot 146: "*Anche questa specie benchè non tanto comune quanto la prima, si trova nei corsi di acqua Pontini verso Piscinara* [Even this species, although not as common as the first, is found in the Pontine watercourses towards Piscinara].

Figure 20. *Anodonta anatina*, Rome (Italy): Tiber River, Nazzano, May 2007 (2995-CMMGR).

The ancient taxa attributable to *Anodonta anatina*

Anodonta exulcerata lacustrina Clessin, 1877

In the Collection of Museo Malacologico Malakos of Città di Castello (Perugia) is present a specimen of this taxon marked with the catalog number 22058, collected in 1995 (ex coll. G. D'Anna, Napoli) in Minturno (Latina) at the mouth of the Garigliano River.

Anodonta piscinalis Nilsson, 1822

Castagnolo et al. (2002) report the following data from Paulucci collection (MZUF: 2200):

"*Fosso di Monte Pietro presso Torre di Foce Verde sul littorale S. della Provincia di Roma*"; isolated valve.

"*Fosso di Monte Pietro presso Torre di Foce Verde sul litorale S. della Prov. di Roma. Una valva ricevuta dall'Ing. Meli - 1 Gennaio 1881, posta subito in collezione. (1 valva sin.)* [... A valve received from Eng. Meli on 1 January 1881, immediately placed in my collection (1 left valve)]".

Seven specimens of this taxon are preserved under the catalog number 4252 in the Collection of Museo Malacologico Malakos of Città di Castello (Perugia) which were collected in 1974 in the cannals surrounding San Felice Circeo (Latina).

Alzona (1971) cites this taxon for northern and central Italy.

Anodonta piscinalis romana Drouët, 1883

Alzona (1971) reports this taxon as subspecies of *A. piscinalis* from Latium (see also below).

Anodonta sabatina Meli, 1898

Type locality (Meli, 1898): "*Lago di Bracciano* [Bracciano Lake]".

Alzona (1971) reports this taxon as "*Species dubiae vel incertae sedis*' from Bracciano Lake.

In the Meli Collection (MCZR–M–39338) is present a specimen from the Bracciano Lake, Trevignano Romano (Rome), 1898 (Fig. 21).

Anodonta cygnea (Linnaeus, 1758)

Shell yellowish or greenish brown, thin, not

very solid, ligament long and narrow, without teeth, lower side of frontal interior margin not thickened. Embryonal shell finely striated along the growth lines, the lines reach the margin. It differs from *A. anatina* in its larger shell with dorsal and ventral margins being straighter and more parallel, the growth lines of the embryonal shell are finer and less undulated, and reach the margin. Animal like *A. anatina*, yellowish, greenish or light reddish, mantle large and brownish yellow, gills greyish, foot large and darker than the rest of the body, opening for water supply short with long papillae. It live in lakes, old canals, artificial lakes, needs slow waters, only rarely in running waters, usually in lowlands. It prefers muddy substrate bare of vegetation. Artificial lakes are usually reached when infected fishes are brought in, young mussels are rarely dispersed by water birds. It tolerates eutrophic conditions, but not in the last toxic stadium. This species can live up to 12 years (Nardi, 1972; Nagel & Badino, 2001; Girod, 2005) (Fig. 22).

Figure 21. *Anodonta sabatina*: Bracciano Lake, Trevignano Romano (Rome, Italy), 1898 (Meli-MCZR).

Northern and central Italy (Alzona, 1971).

Castagnolo et al. (2002) report the following data from Paulucci collection (MZUF: 2119):

"Anodonta cygnea *(varietà* tumida*). Dal Canale Selcella (Paludi Pontine)* [From the Selcella Canal (Pontine Marshes)]. Two specimens".

Canale Selcella (Paludi Pontine). N. 2 esemplari ricevuti l'1 gennaio 1881 dall'Ing. Romolo Meli. Posti subito in collezione [Selcella Canal (Pontine Marshes). Two specimens received on 1 January 1881 from Eng. Romolo Meli. Immediately placed in my collection]".

Statuti (1882: 146) reports "*Magnifici esemplari di questa specie lunghi mm. 161 larghi mm. 175 alti mm. 51 si possono avere dragando nel fondo melmoso dell'antica foce ora condannata del fiume Portatore presso Badino* [Magnificent specimens of this species 161 mm long, 175 mm wide, 51 mm high can be obtained by dredging the muddy bottom of the now condemned ancient mouth of the Portatore River near Badino]".

The ancient taxa attributable to *Anodonta cygnea*

Anodonta anxurensis Drouët, 1883

Type locality (Drouët 1883: 95):"*Le Portatore, à Badino, près de Terracine; le lac Trasimène*".

Alzona (1971) listed this taxon as doubtful in "*Lago Trasimeno e presso Badino (Terracina)*".

Anodonta Romana Drouët, 1883

Type locality (Drouët 1883: 106): "*le Portatore, à Badino près de Terracine; les marais Pontins, canal Mortola; le lac de Martignano*".

Statuti (1886) writes on this taxon*:* "*Allorché sottoposi al distinto Malacologo Francese Sig. H. Drouët un certo numero di esemplari dell'* Anodonta *NOVA SPECIES da me dragati in quel di Terracina (quale specie presentai già all'Accademia sotto il nome di* Anodonta Anxurensis *nella sessione del Giugno 1882), il prelodato Naturalista ebbe luogo a rimarcare fra quelli parecchi individui che, a suo avviso, presentavano tale una modalità di caratteri fissi, e ben determinati da non lasciar dubbio che potessero essere ragionevolmente considerati come un'altra specie anch'essa*

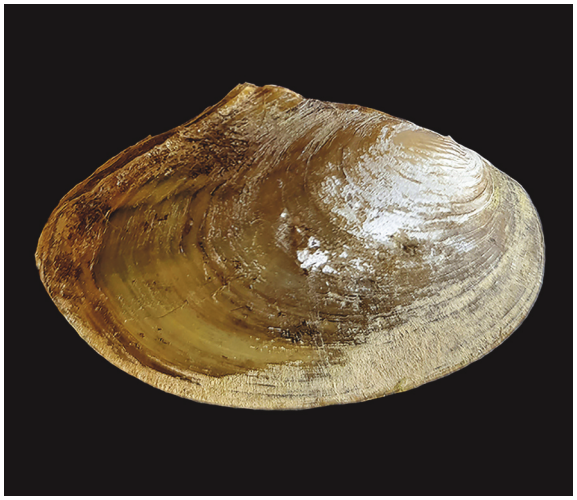

Figure 22. *Anodonta cygnea*, Rieti (Italy): Turano Lake, February 2022 (2347-CMMGR).

nuova, che al medesimo piacque intitolare Anodonta Romana*. L'* Anodonta Romana *fu da me pel primo trovata, come ho già detto insieme all'* A. Anxurensis *molti anni indietro nell' estremo tronco del fiume Portatore a Badino presso Terracina, nel Mortola (uno dei canali della Bonificazione Pontina) e recentemente anche nel Lago di Martignano* [When I submitted to the distinguished French malacologist Mr. H. Drouët a certain number of specimens of *Anodonta* NOVA SPECIES dredged by me in that of Terracina (the same species I already presented to the Academy under the name of *Anodonta Anxurensis* in the session of June 1882), the well-lauded Naturalist took the time to point out several speciemens among those who, in his opinion, presented such a modality of fixed and well-defined characters as to leave no doubt that they could reasonably be considered as another new species that he liked to name *A. Romana*. The *A. Romana* was first found by me, together with *A. Anxurensis* as I have already said many years ago in the extreme trunk of the Portatore River at Badino near Terracina, in the Mortola (one of the canals of the Pontine reclamation) and recently also in the Martignano Lake]" (Fig. 23).

Anodonta scapulosa Drouët, 1883

Type locality (Drouët, 1883: 104): "*le lac de Martignano*".

Statuti (1886) writes on this taxon*:* "*In una nota pubblicata nella mia comunicazione del Gennaio 1883 accennai a questa specie che fu scoperta a mia cura nel vicino lago di Martignano. Questa* Anodonta v*ive in numerose famiglie nelle acque del suindicato lago ed il suo animale, purché sia ben condizionato ossia cotto e condito a dovere, non solo è innocuamente commestibile, ma secondo che vennemi riferito, presenta un sapore abbastanza gustoso. Una circostanza che merita di essere ricordata in ordine a questa specie di* Anodonta *si è che tra gl'individui a mia richiesta pescati, parecchi presentavano delle concrezioni o bernoccoli madreperlacei aderenti alle valve, ed uno si rinvenne fornito di una bella perla, libera, quasi perfettamente sferica della grossezza all' incirca di un pisello. E' cosa notissima che alcune specie particolari di Najadi sono perlifere; ma poiché per quanto io mi sappia tra le* Anodonta *Italiane capaci di produrre delle vere perle, non si conoscono finora con sicurezza che le* Anodonta *del R. Parco di Raconigi presso Torino, e quelle del lago d'Alice parimenti in Piemonte, non sarà senza interesse l'aver constatato che anche l'*Anodonta scapulosa *indigena della nostra Provincia possiede questa bella ed importante proprietà. Il solo Bonanni fin da un secolo fa ci lasciò scritto d'aver trovato alcune perle in una specie di* Unio *che racconta di aver pescato nelle acque del nostro Teverone* [In a note published in my communication of January 1883, I mentioned this species which was discovered by me in the nearby lake of Martignano. This *Anodonta* lives in numerous families in the waters of the aforementioned lake and its animal, provided it is well treated or cooked and seasoned properly, is not only harmlessly edible, but according to what I was told, it has a quite tasty flavour. A circumstance that deserves to be remembered in relation to this species of *Anodonta* is that among the individuals fished at my request, several had mother-of-pearl concretions or bumps adhering to the valves, and one was found provided with a beautiful pearl, , not attached, almost perfectly spherical about the size of a pea. It is well known that some particular species of Najadi are able to produce pearls; but since, as far as I know, among the Italian *Anodonta* capable of producing real pearls, we only know with certainty so far the *Anodonta* of the Royal Park of Raconigi near Turin, and those of Lake Alice likewise in Piedmont, it will be interesting to ascertain that also the

Anodonta scapulosa indigenous to our Province possesses this beautiful and important property. A century ago, Bonanni alone wrote to us that he had found some pearls in a species of *Unio* which he said he fished in the waters of our Teverone]".

Remarks. Teverone is the ancient name of the Aniene River. This species also reported by Alzona (1971) for Martignano Lake, albeit in the paragraph on doubtful species.

Anodonta exulcerata Porro, 1838

Originally described in Porro (1838), locus typicus: "*Nei piccoli laghi di Oggiono, Alserio, e più ancora di Pusiano in Brianza*".

Shell generally thin, equivalve and inequilateral, large (max. length 103 mm) elliptical to suboval, moderately inflated. Angle between dorsal margin and posterior margin 124° to 147°. Anterior margin broadly rounded, posterior margin narrowly rounded to bluntly pointed; ventral margin convex, occasionally flat straight in the middle nearer to the posterior edge; dorsal margin straight to slightly convex in passing from the posterior margin, occasionally extending into a low dorsal wing; posterior ridge rounded, occasionally weakly biangulated distally; posterior slope moderately steep, flat to slightly convex; umbo broad, moderately inflated, elevated slightly above hinge line; umbo sculpture with thin wavy rugae; umbo cavity wide, shallow. Pseudocardinal and lateral teeth absent. Adductor muscle scars rather shallow. Nacre is white to bluish white, usually iridescent. Periostracum tawny to olive or brown; small individuals yellowish brown to dark olive, large individuals brownish black with dark green rays of varying width and intensity (Riccardi et al., 2019).

Anodonta exulcerata is found from the Italian Peninsula to Croatia west of the Dinaric Alps (Froufe et al., 2017), which confirms the distribution reported by Clessin (1876). The discovery of a third *Anodonta* species in the region, *A. exulcerata*, in fact the most common *Anodonta* species in Italy, was unexpected. The reason why this species has not been discovered before is possibly related to its conchological similarity to the other two co-existent congeneric species, *A. anatina* and *A. cygnea* (Froufe et al., 2017). Morphological identification is notoriously difficult in almost all Unionida because of the high morphological variability within species and morphological convergences between species, but the problem is particularly common in Anodontinae, which lacks diagnostic teeth (Zieritz et al., 2010; Lopes-Lima et al., 2017). It is listed in Continental and Peninsular Italian regions by Bodon et al. (2021). *Anodonta exulcerata* occur in waters with little or no current and substrates typically composed of mud or muddy sand, often with detritus. Due to misidentification with other *Anodonta* species, information on biology is scarce. Gravid individuals brooding glochidia at different stages of development have been observed from early September to late December in Lake Maggiore and Lake Varese. Glochidial host fish species are unknown (Riccardi et al., 2019).

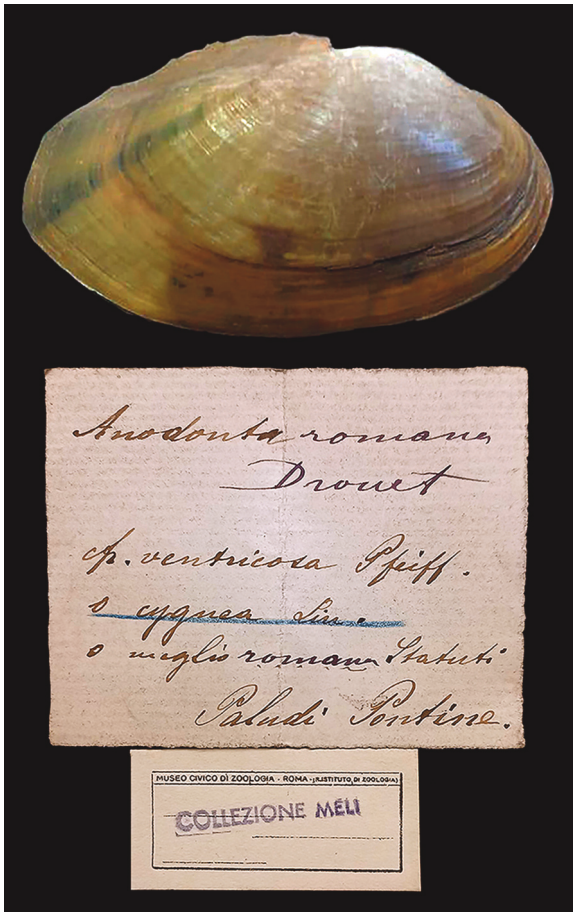

Figure 23. *Anodonta romana*, Latina (Italy): Pontine Marshes (Meli-MCZR).

Sinanodonta woodiana (Lea, 1834)

Shell brown or blackish, sometimes with greenish hue, colour very variable but usually more in-

tensively coloured at the periphery, elliptical to almost spherical, lower margin strongly convex (Lea, 1834) (Figs. 24, 25).

The Chinese pond mussel, native to the Yangtze River basin (Lopes-Lima et al., 2020), has spread rapidly to central Asia and Europe, mostly due to the transport of farmed cyprinid fish species (Bolotov et al., 2016). The *S. woodiana* species complex includes several divergent, species-level phylogenetic lineages with a native distribution from Northern Vietnam to the Russian Far East and Japan (Bolotov et al., 2016; Bespalaya et al., 2018; Do et al., 2018; Kondakov et al., 2018; Lopes-Lima et al., 2020). However, two of these lineages are spread beyond their native ranges and should be considered successful invaders (Bolotov et al., 2016). Because of its reproduction success when compared to native mussel species (Huber & Geist, 2019), it spreads rapidly (mainly during the parasitic stage) and can reach high densities in many rivers and standing water bodies (Douda et al., 2012; Benkő-Kiss et al., 2013; Beran, 2020). Thermal conditions, water flow and substrate characteristics mostly determine the distribution and density of *S. woodiana* (Kraszewski & Zdanowski, 2007). According to Demayo et al. (2012), this species prefers habitats with higher temperatures (the optimal thermal conditions vary within 10 and 35 ºC). Furthermore, recent studies by Urbańska et al. (2019) and Benedict & Geist (2021) showed that *S. woodiana* can expand even in colder regions and establish new populations. The first ever discovery in Europe in 1979 came from fish farms in Romania (Popa et al., 2007). It was first reported in Italy in 1996 (Manganelli et al., 1998), and in about 15 years it formed colonies in many Italian regions: Emilia-Romagna and Latium (Manganelli et al., 1998; Fabbri & Landi, 1999; Bodon et al., 2005; Lodde et al., 2005a; 2005b; Albano, 2006), Tuscany and Veneto (Niero, 2003; Lori & Cianfanelli, 2006), Marche, Piedmont, Umbria and Lumbardy (Solustri & Nardi, 2006), Campania (De Vico et al., 2007), Sicily (Colomba et al., 2013), Basilicata and Calabria (Renda & Niero, 2014). A study has shown that *S. woodiana* has a negative impact on several native unionids in Europe, especially on *A. anatina* (Froufe et al., 2017). For example, *S. woodiana* has almost completely replaced *A. anatina* in some canals in North Italy (Fabbri & Landi, 1999) and Venetian area (Niero, 2003). As in other countries of Europe, the mode of arrival of the species is unintentional; the main vector of *S. woodiana* introduction is accidental transport in association with fish, and a possible pathway of spreading in Italy seems to be fish stocking (Gherardi et al., 2008; Cappelletti et al., 2009).

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Figure 24. *Sinanodonta woodiana*, Rome (Italy): Tiber River, January 2022, 2294-CMMGR.

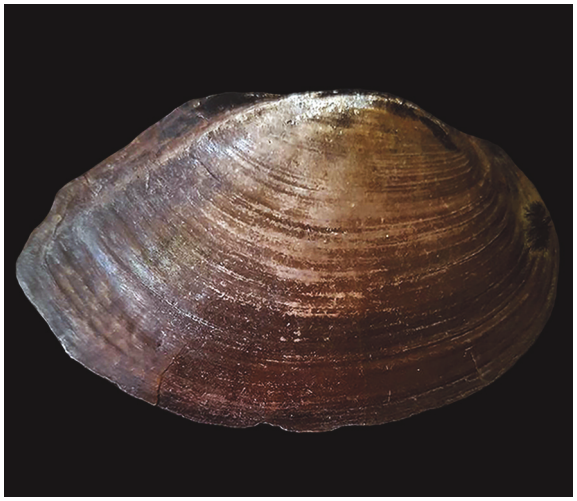

Figure 25. *Sinanodonta woodiana*, Rome (Italy): Tiber River, Isola Tiberina, February 2022, 2299-CMMGR.

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Sitography

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