

## REVISION OF LATE MESSINIAN LYMNOCARDIINAE (BIVALVIA) FROM PIEDMONT (NW ITALY)

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**Key words:** Lymnocardiinae, Bivalvia, Systematics, NW Italy, Late Messinian, Mediterranean, Paratethys.

**Abstract.** The paper discusses a revised interpretation of the Late Messinian malacofaunas of Piedmont, namely the bivalves of the subfamily Lymnocardiinae (family Cardiidae), which are kept at the Museo Regionale di Scienze Naturali of Turin and the Museo Civico Archeologico e di Scienze Naturali “Federico Eusebio” of Alba (Cuneo). The historical Bellardi and Sacco collection in Turin contains various specimens of Lymnocardiinae that F. Sacco collected from various sites in the provinces of Cuneo and Alessandria (Piedmont) at the end of the 19<sup>th</sup> century. The Alba museum holds several species that O. Cavallo and G. Repetto found in the Alba area in the 1980-1990s. The authors of the paper deemed it necessary to reinvestigate the above-mentioned material, in spite of its non-optimal conservation status, because it testifies the high specific diversity of the Late Messinian “lago-mare” molluscan assemblages of Piedmont, whose original deposits are often no longer accessible. Both Pontian Paratethyan taxa and Late Messinian Mediterranean endemics were recognised. Fifteen species referable to five genera were identified. Five species have been left in open nomenclature, due to poor preservation and scarcity of material, and a new species of Lymnocardiinae, referable to the genus *Pseudocatillus* Andrussov, was described: *Pseudocatillus nevesskayae* n. sp.

**Riassunto.** Viene intrapresa una revisione delle malacofaune tardo-messiniane piemontesi, con particolare riguardo ai bivalvi della sottofamiglia Lymnocardiinae (famiglia Cardiidae), conservati presso il Museo Regionale di Scienze Naturali di Torino e il Museo Civico Archeologico e di Scienze Naturali “Federico Eusebio” di Alba (Cuneo). Nella storica collezione Bellardi e Sacco di Torino sono conservati diversi esemplari di Lymnocardiinae raccolti da F. Sacco alla fine dell’800 in varie località piemontesi delle province di Cuneo e Alessandria. Nel Museo di Alba si trovano diverse specie raccolte negli anni ’80-’90 da O. Cavallo e G. Repetto nell’area di Alba. Pur non essendo ottimale lo stato di conservazione dei reperti esaminati, è tuttavia significativo il riesame di tale materiale, in quanto esso costituisce una testimonianza di alta diversità specifica delle associazioni a molluschi di “lago-mare” tardo-messiniane piemontesi provenienti da giacimenti spesso non più reperibili.

Sono stati individuati sia elementi pontici di origine paratetidea sia elementi endemici mediterranei tardo-messiniani. Sono state riconosciute quindici specie riferibili a cinque generi. Cinque specie sono state lasciate in nomenclatura aperta, a causa del cattivo stato di conservazione e scarsità del materiale. Viene istituita una nuova specie di Lymnocardiinae del genere *Pseudocatillus* Andrussov: *Pseudocatillus nevesskayae* n. sp.

### Introduction

The paper discusses a revised interpretation of the latest Messinian “lago-mare” bivalves Lymnocardiinae (family Cardiidae) from Piedmont. The authors of the paper undertook the revision as part of their research on the latest Messinian “lago-mare” molluscan fauna of the Mediterranean domain and its relations with the eastern Paratethyan one (Cooperation CNR IGAG - RAS 2008-2010). Particular attention was paid to the Lymnocardiinae collected by: i) F. Sacco in the 19<sup>th</sup> century, making part of the historical Bellardi and Sacco malacological collection at the Museo Regionale di Scienze Naturali of Turin; and ii) O. Cavallo and G. Repetto at Ciabòt Cagna near Alba (Cuneo) (Cavallo & Repetto 1988), kept at the Museo Civico Archeologico e di Scienze Naturali “Federico Eusebio” of Alba. Sacco (1886a,b, 1889, 1899) recorded several species of Lymnocardiinae from various upper Messinian sites in the Cuneo and Alessandria provinces (Piedmont). Due to the peculiar faunal content and the location and stratigraphical position (at the Mio-Pliocene boundary) of the fossiliferous marly-sandy deposits described by Sacco (1886a,b, 1899) (Castagnito d’Alba, Guarene d’Alba, Narzole, T. Mondalavia and Benevagienna in the Cuneo

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province and Gavazzana and Castelletto d'Orba in the Alessandria province), they are very likely referable to the latest Messinian, post-evaporitic, fossiliferous marly horizon (i.e. Cassano Spinola Conglomerates, upper part), with brackish water molluscs ("*Congeria*, *Melanopsis*, *Limnocardium*"), recognised at regional extension in the Tertiary Piedmont Basin by Dela Pierre et al. (2011 and references therein). In spite of their imperfect preservation, the specimens stored in the Turin museum represent significant palaeontological records which are worthy of illustration (most of them have never been previously figured or described). The same applies to the Lymnocardiinae kept at the Alba museum, which have only in part been covered by the literature. Sturani (1976) recovered some "lago-mare" molluscan assemblages from clayey sediments ("*Congeria* beds") at T. Mondalavia, Benevagienna and Narzole too, but no detailed systematic study has been carried out. Sturani (1976) identified only the genera "*Theodoxus* sp., *Hydrobia* sp., *Melanopsis* sp., *Melanoides* sp., *Limnocardium* sp. and *Dreissena* sp."

At present, the material object of the paper represents unique preserved evidence of the "lago-mare" cardiid bivalves from the classical upper Messinian deposits of Piedmont (Esu 2007 and references therein). New field investigations carried out by the authors in some sites mentioned by Sacco, e.g. Narzole, Benevagienna and Castelletto d'Orba, failed to yield new material. The rarity of these palaeontological records, the common fragility of the lymnocardiid shells and the inaccessibility of their deposits did not make it possible to find additional specimens. Currently, also the outcrop of Ciabòt Cagna (Alba) is inaccessible due to vegetation cover.

In the last decade, numerous investigations were conducted on Messinian Mediterranean and Pontian Paratethyan Lymnocardiinae, given their close affinity and their usefulness for a thorough palaeoenvironmental interpretation of the "lago-mare" and Paratethyan oligo-mesohaline biofacies and for the palaeogeographical and chronological reconstruction of the connections between the two realms in the very Late Miocene (Orszag-Sperber et al. 2000; Popov & Neveeskaya 2000; Neveeskaya et al. 2001; Orszag-Sperber 2006; Popov et al. 2006; Esu 2007; Stoica et al. 2007; Guerra-Merchán et al. 2010). Moreover, due to their diffusion in the Mediterranean basin during the latest Messinian, the study of these molluscs is hoped to provide a better understanding of the regional distribution of Messinian brackish deposits in the same basin.

The paper updates the nomenclature of the revised taxa, taking into account the modern taxonomic revision of the subfamily Lymnocardiinae by Neveeskaya et al. (2001) and adopting the related description of genera. Comparisons with the Paratethyan molluscs

of the Russian A. Ebersin, L. Neveeskaya and S. Popov collections were carried out at the Palaeontological Institut RAS in Moscow. The palaeobiogeographical distribution of genera and species was taken from Neveeskaya et al. (2001 and references therein), Stoica et al. (2007) and previous works dealing with Mediterranean Messinian molluscs (Gillet 1965; Gillet & Geissert 1971; Esu 2007, among others). It is worth noting that the north-western region of Bulgaria had a crucial geographical position – between the Central and Eastern Paratethys – in the Late Miocene: some authors believe that it was part of the Central Paratethys in the Late Miocene (Ivanov et al. 2002); others assume that it belonged to the Eastern Paratethys, and that it formed the westernmost area of the south-eastern part of the Carpathian foreland basin system (cf. palaeogeographic maps in Meulenkamp & Sissingh 2003 and Leever et al. 2011).

#### The Lymnocardiinae collection of the Turin and Alba museums

The Messinian "lago-mare" lymnocardiids of the Bellardi and Sacco collection in the Turin museum include almost 40 shells, most of which are partly broken. They were collected by Sacco in various sites of Piedmont (above-mentioned). Sacco (1899) described twelve species of Lymnocardiinae attributing them to the genus *Limnocardium* (sic!) Stoliczka, 1870, subgenera *Limnocardium* s. str., *Pontalmyra* Sabba Stefanescu, 1896, and *Prosodacna* Tournouer, 1882. Only six species (mainly fragmentary specimens) were illustrated. Unfortunately, illustrations are not very clear and the shells are figured only in one position, so that shell shape, sculpture and hinge features are not well discernible.

The Messinian brackish lymnocardiids kept at the Museo Civico "F. Eusebio" of Alba consist of whole shells extracted from sediment, some shells included in silt and many fragments. This material displays a fairly high systematic diversity. Five genera and at least seven species have been identified, partly in open nomenclature. All the material had been collected by O. Cavallo and G. Repetto at Ciabòt Cagna (Corneliano d'Alba, Cuneo).

The species and genera of the investigated specimens have been distinguished with more or less high accuracy. Nevertheless, the historical Bellardi and Sacco collection at the Turin museum and the modern collection at the Alba museum contain numerous specimens which can hardly be ascribed to known species, owing to poor preservation of the shells or involvement of new species and genera. However, available specimens are insufficient for a description of new taxa. The material

reviewed here also includes the fragments of *Lymnocardiinae* from both collections. The following is a tentative identification of species and genera.

**Location of the studied material:** MRSNT BS.123, Bellardi and Sacco collection, Museo Regionale di Scienze Naturali of Turin (original labels were reported); MFEA-G, Museo Civico Archeologico e di Scienze Naturali "F. Eusebio" of Alba; PIN, Paleontological Institut RAS of Moscow; MPUR7, Esu & Girotti collection, Museo di Paleontologia, Sapienza University of Rome.

### Systematic Palaeontology

Class **Bivalvia** Linnaeus, 1758

Subclass **Heterodonta** Neumayr, 1884

Order **Veneroida** H. & A. Adams, 1856

Family **Cardiidae** Lamarck, 1809

Subfamily **Lymnocardiinae** Stoliczka, 1870-71

Genus *Euxinocardium* Ebersin, 1947

**Occurrence.** Late Miocene-Late Pliocene. Pannonian of Central Paratethys: Slovenia, Croatia, Hungary, Bosnia, Serbia, Romania (Central Paratethys part); Late Miocene (Pontian)–Pliocene (Kimmerian, Dacian, Kujalnician) of Eastern Paratethys: Romania, eastern Bulgaria, southern Ukraine, southern Russia (Ciscaucasia, Taman Peninsula), Georgia (Stevanovic 1989a, b; Neveeskaya et al. 2001); Messinian, Greece (Popov & Neveeskaya 2000); latest Messinian, Italian peninsula and Sicily (Esu 2007), Spain (Castellbisbal, Papiol) (Almera 1894; Gillet 1965).

#### ***Euxinocardium subodessae*** (Sinzov, 1877)

Pl. 1, figs 8a, 9

1877 *Cardium subodessae* Sinzov, p. 63, pl. 5, figs 6, 7.

1947 *Limnocardium (Euxinocardium) subodessae* – Ebersin, p. 59, pl. 8, figs 2-4.

1965 *Euxinocardium* group *subodessae* – Gillet, p. 25, pl. 1, figs 19-27 (pars).

1969 *Euxinocardium* group *subodessae* – Gillet, p. 79, pl. 1, fig. 8, pl. 2, fig. 1, pl. 4, fig. 3.

1977 *Euxinocardium* ex group *subodessae* – Andreescu, p. 57.

1989a *Limnocardium (Euxinocardium) subodessae* – Papaianopol, p. 582, pl. 1, fig. 1.

1989b *Lymnocardium (Euxinocardium) subodessae* – Stevanovic, p. 481, pl. 7, figs 1-5.

1992 *Limnocardium* (s. l.) sp. – Cavallo & Repetto, p. 206, fig. 614.

1997 *Lymnocardium (?Euxinocardium) subodessae* – Neveeskaya et al., p. 26, figs 12-14.

2001 *Euxinocardium subodessae* – Neveeskaya et al., p. 186.

2007 *Euxinocardium subodessae* – Esu, p. 297, fig. 2. 3-4.

2010 *Euxinocardium subodessae* – Angelone et al., p. 94, fig. 4. 3.

**Material:** MFEA G-1617a (Pl. 1, fig. 8a), *Limnocardium* (s.l.) sp. in Cavallo & Repetto (1992, fig. 614), broken RV in silt; G-1619 (Pl.

1, fig. 9), articulated valves; Ciabòt Cagna, Corneliano d'Alba, Late Messinian.

**Description.** Shell small, ovate (H/L 0.72), moderately convex, with low, narrow, prosogyrate beak displaced forward (la/L 0.30-0.35); ribs smooth, well developed, the 8-9 anterior-most ribs are triangular in cross-section and higher than the 6 posterior ones which are small and narrow; interspaces flat; hinge not visible.

**Dimensions** (Tab. 1).

**Remarks.** Shell shape and features, type and number of ribs are typical of *Euxinocardium subodessae*, a common species widespread in Paratethys and Mediterranean domains. *Euxinocardium* Ebersin, 1947, was definitely stated at genus level by Neveeskaya et al. (2001).

**Occurrence.** Late Miocene (Pontian) of Central Paratethys: Serbia, Bosnia, Slavonia (Stevanovic (1989b), Eastern Paratethys: Romania, Bulgaria, southern Ukraine, southern Russia (Ciscaucasia), Georgia (Papaianopol 1989a; Neveeskaya et al. 1997); latest Messinian, Italian peninsula and Sicily (Esu 2007), Spain (Castellbisbal, Papiol) (Almera 1894; Gillet 1965).

Genus *Pontalmyra* Sabba Stefanescu, 1896

**Occurrence.** Late Miocene–Eopleistocene (Early Pleistocene). Pannonian of Central Paratethys: Croatia, Hungary, Bosnia, Serbia; Late Miocene (Pontian)–Pliocene (Kimmerian, Dacian, Kujalnician) and Eopleistocene (Chaudian) of Eastern Paratethys: Romania, western and eastern Bulgaria, Ukraine, southern Russia, Georgia, Azerbaijan, western Kazakhstan (Stevanovic 1989a; Neveeskaya et al. 2001); Messinian, Greece (Gillet & Geissert 1971; Popov & Neveeskaya 2000); latest Messinian, Italian peninsula (several localities) and Sicily (Di Geronimo et al. 1989; Esu 2007), Spain (Almera 1894; Gillet 1965; Guerra-Merchán et al. 2010).

#### ***Pontalmyra bollenensis*** (Mayer, 1871)

Pl. 1, fig. 8b; Pl. 2, figs 4-9

1871 *Cardium bollenense* Mayer, p. 15.

?1877 *Cardium spratti* Fuchs, p. 41, pl. 5, figs 25-32.

1879-82 *Cardium bollenense* – Fontannes, p. 89, pl. 5, figs 11, 12.

1886b *Adachna bollenensis* – Sacco, p. 389.

1889 *Adachna bollenensis* – Sacco, n. 1561.

1899 *Limnocardium (Pontalmyra?) bollenense* – Sacco, p. 59, pl. 12, fig. 28.

1899 *Limnocardium (Pontalmyra?) spratti* – Sacco, p. 59, pl. 12, figs 29, 30.

1965 *Didacna bollenensis* – Gillet, p. 29, pl. 2, figs 1-4.

1989? *Didacna* cf. *bollenense* – Esu & Taviani, p. 268, text-fig. 5.

1992 *Limnocardium* (s. l.) *spratti* – Cavallo & Repetto, p. 206, fig. 613.

**Material:** MRSNT BS.132.02.009/05, 02.009/01, 02.009 (Sacco 1899, pl. 12, fig. 30), 02.008 (Sacco 1899, pl. 12, fig. 29), *Pontalmyra? spratti* (Fuchs), Late Miocene, Messinian, Castelletto d'Orba; 02.007/01, 02.007 (Sacco 1899, pl. 12, fig. 28), *Pontalmyra? bollenensis* (Mayer), Late Miocene, Messinian, Gavazzana; several other fragmentary specimens (not labelled) collected by Sacco from Messinian deposits of Benevagienna (Rio Rivoletto) and Narzole; MFEA G-1617b, *Limnocardium* (s. l.) *spratti*, bivalve shell in silt (Pl. 1, fig. 8b), Ciabòt Cagna, Castagnito d'Alba, Late Messinian.

**Description.** Shell up to 30 mm long, rounded-triangular (H/L 0.71-0.86), moderately convex (C/H 0.33-0.43), moderately inequilateral (la/L 0.31-0.41), with prominent beak (h/H 0.14-0.24); 26-32 ribs separated by concave and narrow interspaces, the 19-25 ribs in anterior area are convex or flat, the 6-8 in posterior area are narrower; posterior ridge rounded; LV hinge with one rather prominent cardinal tooth and poorly developed single anterior and posterior lateral; RV with one cardinal deep socket and one anterior and posterior lateral tooth; lunule and nymph well distinct; inner surface radially sulcate.

**Dimensions** (Tab. 1).

**Remarks.** Based on their morphological characters, the studied specimens may be attributed to the genus *Pontalmyra* Sabba Stefanescu, 1896, revised by Neveeskaya et al. (2001: 191). The hinge of the figured LV (Pl. 2, Fig. 9, BS.132.02.009/05) clearly shows one prominent cardinal and obsolete lateral teeth, and the inner surface of the valve radially sulcate ventrally, which are characters proper to *Pontalmyra*. The figured specimen is included in coarse sediment together with *Dreissena* cf. *rostriformis* (Deshayes, 1838), *Theodoxus mutinensis* (D'Ancona, 1869) and *Saccoia* sp., representing a typical "lago-mare" assemblage (Esu 2007). *P. bollenensis* is a frequent species in the Mediterranean domain, it is very abundant in the Upper Messinian deposits of France and Spain (Fontannes 1879-1882; Gillet 1965). The similarity between "*Cardium*" *spratti* Fuchs, 1877 (pl. 5, figs 25-32) from Tertiary sandy strata of Livonates (Talandi, Greece) and *P. bollenensis* from Bollène (Rhône Basin, France) (locus typicus), noticed by Fuchs (1877: 41) too, may suggest conspecificity of the two taxa. More material of "*C. spratti*" is needed to assess their conspecificity.

**Occurrence.** Latest Messinian, southeastern France, Rhône valley (Fontannes 1879-1882), Spain (Castellbisbal, Papiol) (Almera 1894; Gillet 1965), North Italy (Romagna Apennines, Monticino Quarry) (Esu & Taviani 1989), Piedmont (Sacco 1899; Cavallo & Repetto 1992).

***Pontalmyra incerta chiaie* (Almera, 1894)**

Pl. 2, fig. 10a, b

1894 *Cardium chiaie* Almera, p. 230, pl. 12, f. 14.

1886a *Cardium carinatum* – Sacco, p. 79 (non Deshayes).

1886b *Adachna carinata* – Sacco, p. 389 (non Deshayes).

1889 *Adachna carinata* – Sacco, n. 1565 (non Deshayes).

1899 *Limnocardium* (*Pontalmyra*) *carinata* – Sacco, p. 58, pl. 12, fig. 25 (non Deshayes).

1965 *Didacna chiaie* – Gillet, p. 32, pl. 2, fig. 11 (non fig. 12), pl. 5, figs 1-16, pl. 7, figs 1-4.

1992 *Limnocardium* (s. l.) *carinatum* – Cavallo & Repetto, p. 206, fig. 612 (non Deshayes).

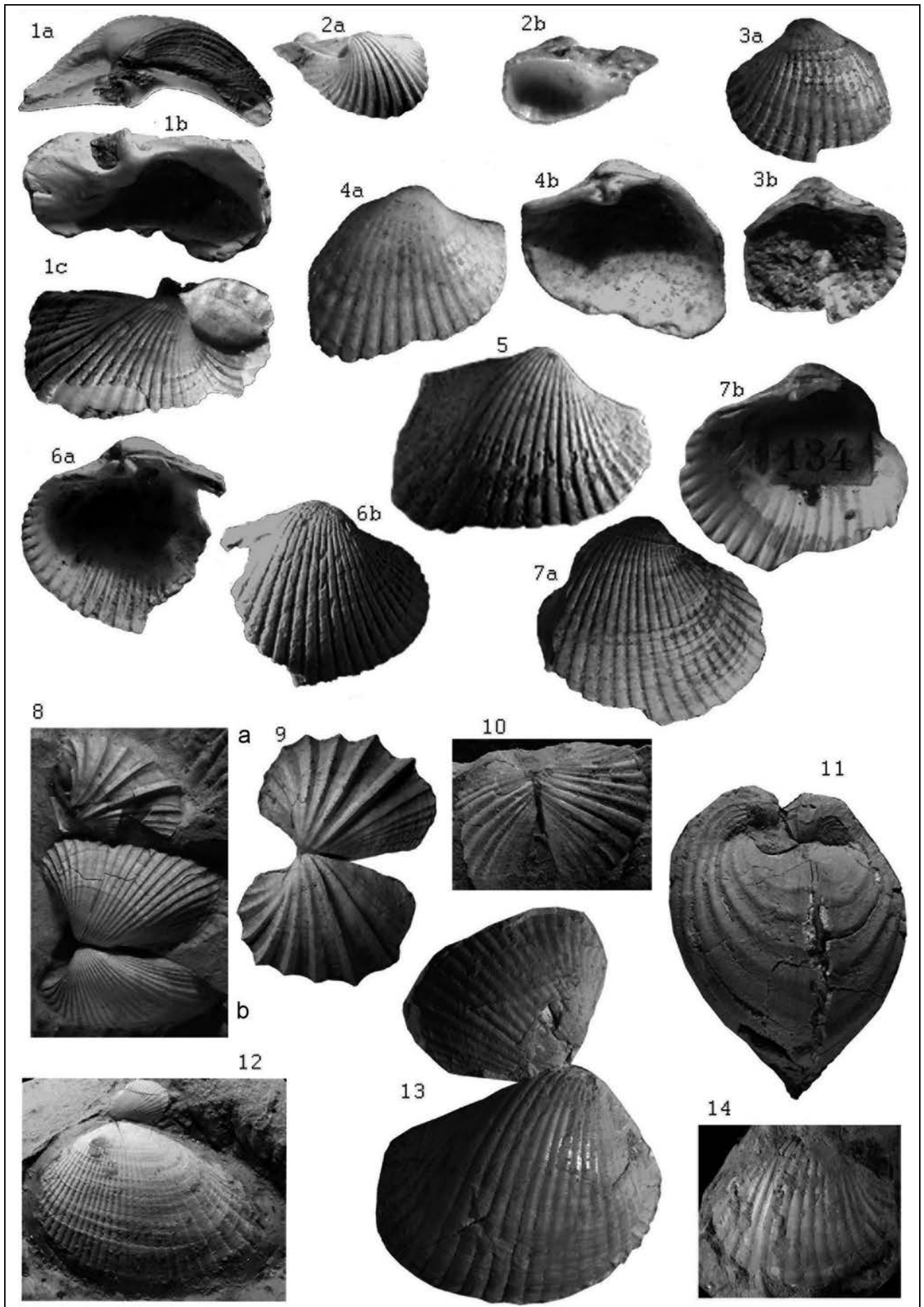
2000 *Pontalmyra incerta chiaie* – Popov & Neveeskaya, p. 201, figs 10-13.

**Material:** MRSNT BS.132.02.001, *Pontalmyra carinata* (Deshayes), Late Miocene, Messinian, Narzole (Sacco 1899, pl. 12, fig. 25), small carinate LV, umbonal part only; another fragmentary specimen from Gavazzana.

**Description.** Shell small, ovate-triangular, thin, weakly convex, moderately inequilateral; beak small, prosogyrate; posterior ridge sharply keeled; keel rib wider and more prominent than other ribs, provided by spinules; in anterior area there are 14 raised ribs rounded-triangular in cross-section, the 4-5 (or more)

PLATE 1

- Fig. 1 - cf. *Pontalmyra* (? subgen. nov.) sp. MRSNT BS.132.01/01, Gavazzana, Late Messinian, RV, umbonal fragment, x4.5, a, hinge detail, b, lower part of hinge plate, c, beak and upper part of hinge plate.
- Fig. 2 - cf. *Pachydacna* sp. 1. MRSNT BS.132.01.002, Castelletto d'Orba, Late Messinian, LV, umbonal fragment, x4.5, a, beak, b, hinge detail.
- Figs 3-4 - *Pontalmyra* cf. *P. magdalenensis* (Fontannes). Castelletto d'Orba, Late Messinian, 3, MRSNT BS.132.01/03-1, LV, a, exterior, b, interior; 4, BS.132.01/03-2, RV, fragment, a, exterior, b, interior. All x4.
- Figs 5-6 - cf. *Pseudocatillus* sp. Castelletto d'Orba, Late Messinian, 5, MRSNT BS.132.02.005/01-1, RV, exterior; 6, BS.132.02.005/01-2, RV, a, interior, b, exterior.
- Fig. 7 - *Pseudocatillus* cf. *P. submedius* Neveeskaya. MRSNT BS.132.02.005, Castelletto d'Orba, Late Messinian, RV, a, exterior, b, interior.
- Fig. 8 - *Euxinocardium subodessae* (Sinzov). MFEA, G-1617, RV in silt (upper part, 8a); *Pontalmyra bollenensis* (Mayer), articulated valves in silt (lower part, 8b), Ciabòt Cagna, Corneliano d'Alba, Late Messinian, x3.
- Fig. 9 - *Euxinocardium subodessae* (Sinzov). MFEA, G-1619, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, articulated valves in silt, x4.
- Fig. 10 - cf. *Pachydacna* sp. 1. MFEA, G-1619, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, articulated valves in silt, x4.
- Fig. 11 - cf. *Pachydacna* sp. 2. MFEA, G-1614, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, articulated valves, anterior view, x2.5.
- Fig. 12 - *Pseudocatillus* cf. *P. pseudocatillus* (Barbot de Marny). MFEA, G-1620, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, LV in silt, x3.
- Figs 13-14 - cf. *Prosodacnomya* sp. 13, MFEA, G-1615, articulated valves, x2; 14, G-1618, RV in silt, x3, Ciabòt Cagna, Corneliano d'Alba, Late Messinian.



anterior-most are covered with small spinules, the 7 posterior ones are lower; interspaces flat and narrower than the ribs; hinge very thin, partly broken, only one lateral anterior tooth is visible; lunule well distinct, elongate.

**Dimensions** (Tab. 1).

**Remarks.** The described umbonal fragment shows some affinity with the topotype material of *Pontalmyra incerta* (Deshayes, 1838, pl. 2, figs 11-13) from the Pontian of Crimea (Kerch peninsula), to which Popov & Nevesskaya (2000) approached the Mediterranean “*Cardium*” *chiaie* Almera, 1894, identifying it as a subspecies of *P. incerta*. The Upper Messinian Mediterranean morphotype named *Pontalmyra carinata* (Deshayes, 1838) by some authors (Sacco 1886a,b; Esu 2007 and references therein) must be also related to it.

**Occurrence.** Early Messinian, north Greece, Strimon Basin (Popov & Nevesskaya 2000); latest Messinian, Spain (Castellbisbal, Papiol) (Almera 1894; Gillet 1965), Italian peninsula (Sacco 1899; Cavallo & Repetto 1992; Esu 2007).

**Pontalmyra** cf. ***P. magdalenensis*** (Fontannes, 1879-82)

Pl. 1, figs 3, 4

**Material:** MRSNT BS.132.01/03-1, 03-2, *Limnocardium* sp. Stol., Late Miocene, Messinian, Castelletto d’Orba, LV with broken posterior part (Pl. 1, fig. 3), umbonal fragment of RV (Pl. 1, fig. 4).

**Description.** Shell small, rounded-rectangular, convex, with wide, prominent, displaced forward or almost central prosogyrate beak (la/L 0.36-0.44); posterior ridge slightly developed; flat wide ribs rectangular in cross-section, with prominent growth lines in anterior part; 17-20 anterior ribs and 6 very fine on posterior area; interspaces flat, narrower than the ribs; one prominent cardinal tooth in each valve, laterals absent in LV, not preserved in RV; lunule narrow, long, well distinct.

**Dimensions** (Tab. 1).

**Remarks.** These specimens are very close to the species *Pontalmyra magdalenensis* (Fontannes) from the uppermost Messinian deposits of the Rhône Basin, described by the author as *Cardium semisulcatum magdalenensis* (Fontannes 1879-82, pl. 6, figs 1-2). Based on the shell characters and hinge features the studied specimens may be attributed to the genus *Pontalmyra* and clearly distinguished from the species “*Cardium*” *semisulcatum* Rousseau, 1842, which is assigned to the genus *Prosodacna* Tournouer, 1882 (Nevesskaya et al. 1997: 113, pl. 48, figs 15-18).

**Pontalmyra** cf. ***P. partschi*** (Mayer, 1878)

Pl. 2, fig. 13

**Material:** MRSNT BS.132.02.006, *Pontalmyra partschi* (Mayer), Late Miocene, Messinian, Narzole.

**Description.** One broken posterior part of LV; small rounded shell with spiny carina on the dorsal side and raised ribs. Measurements are not detectable.

**Remarks.** The shell characters suggest a very close resemblance to *Pontalmyra partschi* (Mayer), which was also noticed by Sacco (1899: 59) for the material from Narzole. Nevertheless the incompleteness of the fossil remain does not allow to identify it with certainty. *P. partschi* is a widespread Mediterranean latest Messinian species, known from the “lago-mare” deposits of France (Fontannes 1879-1882), Corse (Gillet 1963), Spain (Gillet 1965; Guerra-Merchán et al. 2010), Italian peninsula and Sicily (Capellini 1880; Di Geronimo et al. 1989; Abbazzi et al. 2008).

cf. **Pontalmyra** (? subgen. nov.) sp.

Pl. 1, fig. 1

**Material:** MRSNT BS.132.01./01, *Limnocardium* sp., Late Miocene, Messinian, Gavazzana, umbonal fragment of RV (Pl. 1, fig. 1), anterior fragment of LV.

**Description.** Shell rounded-rectangular (as indicated by growth lines), convex; beak strongly prominent, prosogyrate, displaced forward; posterior ridge distinctly expressed in umbonal area; flat rectangular in cross-section wide ribs with distinct growth lines in anterior part; 19 anterior and 6 posterior narrower ribs; interspaces narrow; RV hinge with one prominent posterior and one very small anterior cardinal tooth; laterals not preserved; lunule very well marked forming a wide rounded plate.

**Dimensions** (Tab. 1).

**Remarks.** The illustrated specimen differs from the known lymnocardiins by the peculiar structure and position of the lunule. As regards the shell sculpture and hinge characters, it is mostly similar to the genus *Pontalmyra*. The lunule feature may be a valid morphological element to describe a new taxon at genus or subgenus level, but the scantily available fragmentary material is not sufficient to define it better. This form has been defined in open nomenclature as cf. *Pontalmyra* (? subgen. nov.) sp.

Genus *Pseudocatillus* Andrussov, 1903

**Occurrence.** Late Miocene–Eopleistocene (Early Pleistocene). Pannonian and Pontian of Central Paratethys: Croatia, Hungary, Bosnia, Serbia, Slovenia (Stevanovic 1989a,b); Late Miocene (Pontian)–Pliocene (Kimmerian, Dacian, Kujalnician) and Eopleistocene (Chaudian) of Eastern Paratethys: Romania, western and eastern Bulgaria, Ukraine, southern Russia, Georgia, Azerbaijan, western Kazakhstan (Nevesskaya et al. 2001); Messinian, Greece (Gillet & Geissert 1971; Popov & Nevesskaya 2000); latest Messinian, Italian pe-

ninsula (several localities) and Sicily (Di Geronimo et al. 1989; Esu 2007), Spain (Almera 1894; Gillet 1965).

***Pseudocatillus neveskayae* n. sp.**

Pl. 2, figs 16-19

1899 *Lymnocardium* (*Pontalmyra*) *solitaria* – Sacco, p. 58 (non Krauss).

1899 *Pontalmyra castellanensis* – Sacco, p. 59 (non Capellini).

2007 *Pseudocatillus pseudocatillus* – Esu, p. 297, fig. 2. 10a, b (non Barbot de Marny).

2008 *Pseudocatillus pseudocatillus* – Abbazzi et al., p. 624, fig. 8B, C (non Barbot de Marny).

**Derivatio nominis:** The name is proposed in memory of the Russian palaeontologist Lidia Neveskaya.

**Holotype:** MPUR7-3425 (one RV, well preserved), Borro Strolla, Tuscany, Late Messinian.

**Stratum typicum and locus typicus:** Upper Messinian clayey horizon (UM2), Borro Strolla (Poggibonsi, SE Valdelsa Basin, Tuscany) (Abbazzi et al. 2008).

**Material:** MPUR7-3425, RV, Borro Strolla, Tuscany, Late Messinian; MRSNT BS.132.02.002, *Pontalmyra solitaria* (Krauss), Late Miocene, Messinian, Castelletto d'Orba; 132.02.002-1, one almost complete LV (Pl. 2, fig. 18a, b); 132.02.002-2, RV broken in posterior and lower part (Pl. 2, fig. 19a, b); 132.02.004, *Pontalmyra castellanensis* (Capellini), Late Miocene, Messinian, Castelletto d'Orba, two broken RV with well developed hinge (Pl. 2, fig. 17).

**Diagnosis:** Shell small, ovate-trapezoidal, inequilateral; beak small, prosogyrate; posterior ridge distinct; ribs up to 30, very fine, convex-triangular in cross-section on anterior part, asymmetric-rectangular on central field, convex on posterior one; interspaces flat and narrow. RV hinge with two small cardinals and long laterals; LV with one small, protruding cardinal and long laterals; lunule elongate and concave.

**Description.** Shell small (L= 6-7.5 mm, H= 4-4.7 mm), trapezoidal-rectangular-rounded (H/L 0.63-0.76), moderately convex (C/H 0.30-0.34), inequilateral; beak very small, acute, prosogyrate, slightly prominent (h/H 0.15), displaced forward (la/L 0.30-0.40); posterior ridge evident, sharper in umbonal part, with spinules; sculpture represented by about 30 weak, fine ribs: 22-27 convex-triangular and asymmetric flat on anterior field, separated by flat and narrow interspaces, 6-8 slightly convex on posterior field separated by wider flat interspaces; some of the posterior-most ribs show tendency to have small spinules; hinge with one small, protruding cardinal tooth in the LV and two small, well distinct, cardinals in the RV, the posterior one heavier; anterior and posterior laterals are long, present in both valves, and better developed in the RV; anterior and posterior adductor scars rounded and weak; lunule well distinct, narrow, elongate and concave.

**Dimensions** (Tab. 1).

**Remarks.** Based on the shell shape, the sculpture and the hinge features, the studied specimens may be attributed to the genus *Pseudocatillus*, which is characterized by “weakly to moderately convex and weakly to conspicuously inequilateral shell, beak moderately pro-

jecting, posterior ridge shallow or developed only near beak, ribs flat or weakly convex, often asymmetrical in posterior part of anterior area, rarely some ribs are angulated in cross-section, hinge weakened, cardinal teeth small, one-two in RV and one in LV, lateral teeth usually only in RV, rarely also rudimentary lateral teeth in LV” (Neveskaya et al. 2001: 192). The described new species is similar to *Pseudocatillus pseudocatillus* (Barbot de Marny, 1869) from the Eastern Paratethys (cf. Neveskaya et al. 1997, pl. 24, figs 1-6) in shell morphology and number of ribs, but it differs by the more complete hinge with two distinct cardinals in the RV, anterior and posterior laterals in both valves, and by the more prominent posterior ribs, with frequent rudimental spinules mostly developed on the last rib. “*Cardium*” *castellanensis* Capellini, 1874, from the Messinian of Tuscany differs by the less numerous, more prominent and spaced ribs (Capellini 1874, pl. 8, fig. 11). “*Cardium*” *solitarium* Krauss, 1852 from the Early Miocene of the Kirchberg Formation (South Germany), to which Sacco (1899) referred his material, is assigned to the genus *Cerastoderma* Poli, 1795 (cf. Kowalke & Reichenbacher 2005). The material stored in the Turin museum is very likely to belong to the new species.

**Occurrence.** Latest Messinian, Italy, Piedmont (Sacco 1899) and Tuscany (Esu 2007; Abbazzi et al. 2008).

***Pseudocatillus* cf. *P. pseudocatillus***

(Barbot de Marny, 1869)

Pl. 1, fig. 12

**Material:** MFEA G-1620, Ciabòt Cagna, Castagnito d'Alba, Late Messinian, LV and RV (fragment) in silt.

**Description.** Shell small, thin, ovate-elongate, weakly convex, inequilateral, with low beak displaced forward; numerous ribs, fine and slightly rounded in cross-section on the anterior area, wider, flat and sharply asymmetric on the posterior one; interspaces narrow and shallow.

**Dimensions** (Tab. 1).

**Remarks.** Shape and shell ornamentation fit well the characters of the genus *Pseudocatillus*.

The specimen is very close to *P. pseudocatillus* from the Pontian of Eastern Paratethys (Neveskaya et al. 1997, pl. 24, figs 1-6). Nevertheless the incompleteness of the shell does not allow to identify it with certainty.

***Pseudocatillus* cf. *P. simplex*** (Fuchs, 1870)

Pl. 2, fig. 14 a, b

**Material:** MRSNT BS.132.02.003, *Pontalmyra simplex* (Fuchs), Late Miocene, Messinian, Castelletto d'Orba (Sacco 1899, pl. 12, fig. 26), single small LV broken in anterior and posterior part.

**Description.** Shell very small, rounded-rectangular, moderately convex (C/H 0.35), with wide prominent prosogyrate beak, slightly displaced forward (la/L 0.40); posterior ridge poorly defined; ribs prominent with rudiments of spinules, the 22 anterior ribs are rounded-triangular in cross-section, the 11 posterior slightly convex and narrower; LV hinge with two cardinal teeth slightly developed, laterals almost reduced; lunule long, well distinct.

**Dimensions** (Tab. 1).

**Remarks.** Shell morphology, hinge feature and type of ribs are similar to those displayed by the type material of *Pseudocatillus simplex* (Fuchs, 1870) from the Pannonian of Hungary (Pl. 2, fig. 15a,b, PIN 3945/203), which was noticed by Sacco (1899) too, but the imperfect preservation of only one broken shell does not allow to identify it with certainty and to confirm the attribution made by Sacco. Thus, it has been preferably referred to as *Pseudocatillus* cf. *P. simplex*. This species, attributed to the genus *Cardium* by Fuchs (1870) and to *Limnocardium* (*Pontalmyra*) by Sacco (1899), was assigned to the genus *Pseudocatillus* by Gillet & Marinescu (1971), and definitely by Neveeskaya et al. (2001).

***Pseudocatillus* cf. *P. submedius* Neveeskaya, 2000**

Pl. 1, fig. 7a,b

**Material:** MRSNT BS.132.02.005, *Pontalmyra novarossica* (Barbot de Marny), Late Miocene, Messinian, Castelletto d'Orba (Sacco 1899, pl. 12, fig. 27), small RV broken in posterior part.

**Description.** Shell small, rounded, weakly convex (C/H 0.30), with small, narrow, slightly prominent, sub-central prosogyrate beak; posterior ridge gently expressed; sculpture represented by numerous flat wide ribs with distinct growth lines; the 22 anterior ribs are slightly prominent; interspaces narrower than the ribs; hinge thin, partially broken, with single visible anterior cardinal and one anterior lateral tooth; lunule deep, well distinct.

**Dimensions** (Tab. 1).

**Remarks.** This specimen differs from *Pontalmyra novarossica* (Barbot de Marny, 1869) and from other members of the genus *Pontalmyra* by the fragile weakly convex rounded-ovate shell with flat ribs, and hinge with prominent anterior cardinal tooth in the RV. It is very close to the holotype of *Pseudocatillus submedius* Neveeskaya (Popov & Neveeskaya 2000, fig. 14, non fig. 15) from the Early Messinian of North Greece (Strimon Basin), but due to its imperfect preservation, it has been preferably referred to as *Pseudocatillus* cf. *P. submedius*. Moreover, it differs from the following cf. *Pseudocatillus* sp. by the short, rounded, almost equilateral shell with more prominent flat ribs.

cf. ***Pseudocatillus* sp.**

Pl. 1, figs 5, 6a,b

**Material:** MRSNT BS.132.02.005/01-1, 01-2, *Pontalmyra novarossica* (Barbot de Marny), Late Miocene, Messinian, Castelletto d'Orba, two small RV, one valve broken in posterior part (Pl. 1, fig. 6), the other one consists of umbonal fragment without hinge (Pl. 1, fig. 5).

**Description.** Shell small, ovate-rectangular, moderately inequilateral, moderately convex; beak wide, slightly prominent (h/H 0.22), prosogyrate; posterior ridge slightly expressed; flat wide ribs, 21-23 on anterior part, tuberculate, and 7 not well distinct on posterior part; interspaces narrow and deep; RV hinge with two cardinals, the anterior smaller than the posterior one; two anterior lateral teeth, posterior one (probably two) not well preserved; lunule well distinct.

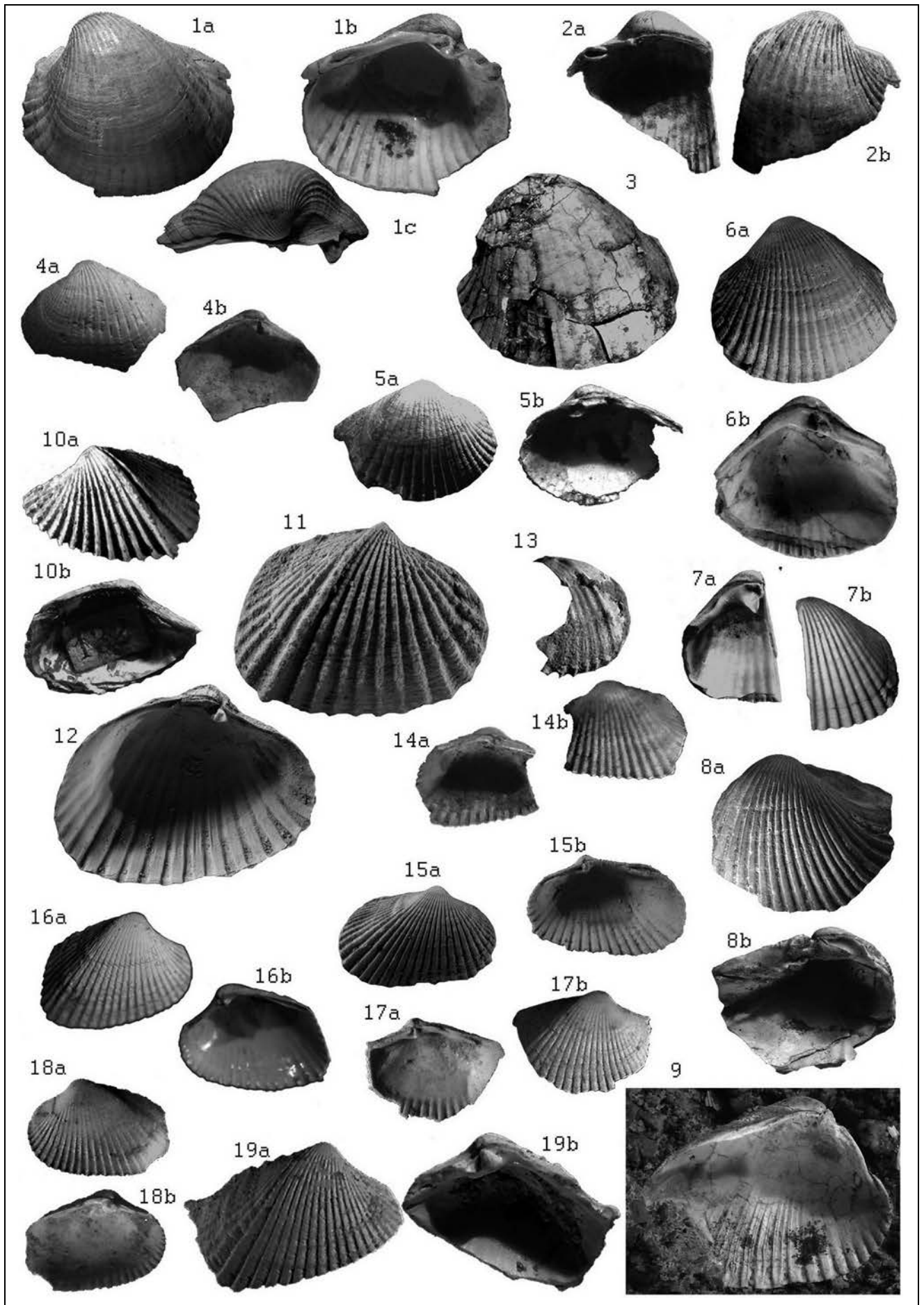
**Dimensions** (Tab. 1).

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PLATE 2

- Fig. 1 - *Prosodacnomya sabbiae* Andreescu. 1, MRSNT BS.132.03.001, Gavazzana, Late Messinian, LV, x2, a, exterior, b, interior, c, umbonal part; 2, BS. 132.01.001/01, Castagnito d'Alba, Late Messinian, RV, x2.5, a, interior, b, exterior; 3, BS.132.01.001, Narzole, Late Messinian, LV, x2.
- Figs 4-9 - *Pontalmyra bollenensis* (Mayer). 4, MRSNT BS.132.02.009/01, Castelletto d'Orba, Late Messinian, LV, x2.5, a, exterior, b, interior; 5, BS 132.02.009, same locality, RV, x2, a, exterior, b, interior; 6, BS.132.02.007, same locality, LV, x2, a, exterior, b, interior; 7, BS.132.02.007/1, Gavazzana, broken LV, x2, a, interior, b, exterior; 8, BS.132.02.008, Castelletto d'Orba, RV, x2, a, exterior, b, interior; 9, BS.132.02.009/05, same locality, LV, interior, x2.
- Fig. 10 - *Pontalmyra incerta chiaie* (Almera). MRSNT BS.132.02.001, Gavazzana, Late Messinian, LV, umbonal fragment, x3.5, a, exterior, b, interior.
- Figs 11-12 - *Pontalmyra incerta* (Deshayes). Ukraine, Kerch, Karantin Bay, Upper Pontian, 11, PIN 3945/201, RV, exterior, x2; 12, PIN 3945/202, LV, interior, x1.5.
- Fig. 13 - *Pontalmyra* cf. *P. partschi* (Mayer). MRSNT BS.132.02.006, Narzole, Late Messinian, LV, x3.
- Fig. 14 - *Pseudocatillus* cf. *P. simplex* (Fuchs). MRSNT BS.132.02.003, Castelletto d'Orba, Late Messinian, LV, x5, a, interior, b, exterior.
- Fig. 15 - *Pseudocatillus simplex* (Fuchs). PIN 3945/203, Banat, Hungary, Pannonian, topotype, RV, x3, a, exterior, b, interior.
- Figs 16-19 - *Pseudocatillus neveeskayae* sp. nov. 16, holotype MPUR 3425, Borro Strolla, Tuscany, Late Messinian, RV (Esu 2007, fig. 2. 10a,b), a, exterior, b, interior; 17, MRSNT BS.132.02.004, Castelletto d'Orba, Late Messinian, RV, x4.5, a, interior, b, exterior; 18, BS.132.02.002-1, same locality, LV, x4, a, exterior, b, interior; 19, BS.132.02.002(2), same locality, RV, x4, a, exterior, b, interior.





**Remarks.** Clearly these specimens differ from *P. novarossica* (Neveškaya et al. 1997: 47, pl. 8, figs 4-5) by the more complete hinge and wider flat tuberculate ribs. Due to these morphological characters, they may be attributed to cf. *Pseudocatillus* rather than to *Pontalmyra*.

#### Genus *Prosodacnomya* Ebersin, 1959

**Occurrence.** Late Miocene-Late Pliocene. Upper Pannonian of Central Paratethys: Croatia, Hungary, Bosnia, Serbia; lower Pontian (Odessa Beds) of southern Ukraine; Pontian, Dacian and Early Romanian of Romania (Papaianopol 1995; Neveškaya et al. 2001); latest Messinian, Italy (Esu 2007), Spain (Guerra-Merchán et al. 2010).

#### *Prosodacnomya sabbae* Andreescu, 1977

Pl. 2, figs 1-3

1886b *Adacna semisulcata* – Sacco, p. 389 (non Rousseau).

1889 *Adacna semisulcata* – Sacco, n. 1560 (non Rousseau).

1899 *Prosodacna semisulcata* – Sacco, p. 60, pl. 12, fig. 31 (non Rousseau).

1975 *Prosodacnomya sturi sabbae* Andreescu, p. 242, nom. nudum.

1977 *Prosodacnomya sturi sabbae* Andreescu, p. 25, pl. 3, figs 10-19, pl. 4, figs 12-15, pl. 5, figs 1-18, pl. 6, figs 1-22.

1995 *Prosodacnomya sabbae* – Papaianopol, p. 149, pl. 28, figs 1-3.

2007 *Prosodacnomya sturi sabbae* – Esu, p. 297, fig. 3. 2-3.

2010 *Prosodacnomya* cf. *P. sturi sabbae* – Angelone et al., p. 94, fig. 4.6.

**Material:** MRSNT BS.132.03.001, *Prosodacna semisulcata* (Rousseau in Demidoff), Late Miocene, Messinian, Gavazzana (Sacco 1899, pl. 12, fig. 31), incomplete LV (Pl. 2, fig. 1); 01.001/01, *Limnocardium banaticum* (Fuchs), Late Miocene, Messinian, Castagnito d'Alba, umbonal fragment of RV (Pl. 2, fig. 2); 01.001, *Limnocardium banaticum* (Fuchs), Late Miocene, Messinian, Narzole, incomplete LV (Pl. 2, fig. 3).

**Description.** Shell ovoid-triangular, convex (C/H 0.32-0.47), inequilateral, with prominent slightly twisted prosogyrate beak; posterior ridge undeveloped, postero-lateral area depressed; maximum convexity point situated in the centre or central-anterior part of the shell; ribs nearly smooth on the central portion and slightly convex in marginal parts; there are 19-20 anterior and 5-7 posterior ribs; the four-five anterior-most quite prominent, those towards the posterior edge are scarcely visible; hinge with two small cardinals in the LV and one in the RV, very prominent anterior lateral tooth and single small posterior lateral in the LV, the posterior lateral is not visible in the RV, probably due to imperfect preservation; nymph long, well distinguishable; lunule large. Inner surface with visible furrows

correlated with the external ribs, disappearing towards the hinge.

**Dimensions** (Tab. 1).

**Remarks.** The described specimens differ from the known Paratethyan *Prosodacna* species, including *Prosodacna semisulcata* (Rousseau, 1842) (Neveškaya et al. 1997, pl. 48, figs 15-18), by the more complete hinge with conical cardinals, more prominent ribs, and less twisted beak. They also differ from “*Cardium*” *banaticum* Fuchs, 1870, by the more globose shell, the wider umbo and lunule, and the presence of two cardinals in LV (cf. Fuchs 1870: 356, pl. 15, figs 9-11).

They are referable to the genus *Prosodacnomya* Ebersin which is characterized by ovate and conspicuously convex shell, projecting prosogyrate beak, smooth surface or nearly so, covered with flat to slightly convex ribs, posterior ridge undeveloped, hinge with anterior lateral teeth preferentially developed and one or two small cardinals, inner surface radially sulcate (Neveškaya et al. 2001). Very likely *Prosodacnomya sabbae* Andreescu, 1977, from the Dacic Basin (Andreescu 1977; Papaianopol 1995) seems to be the closest form.

**Occurrence.** Late Miocene-Early Pliocene. Pontian-lower Dacian of Dacic Basin (Andreescu 1977; Papaianopol 1995; Stoica et al. 2007); latest Messinian, north Italy, Piedmont (Sacco 1899; Angelone et al. 2010), Tuscany (Esu 2007).

#### cf. *Prosodacnomya* sp.

Pl. 1, figs 13, 14

**Material:** MFEA G-1615, Ciabòt Cagna, Cornelianò d'Alba, Late Messinian, RV and umbonal part of LV in silt (Pl. 1, fig. 13); G-1618, RV in silt (Pl. 1, fig. 14).

**Description.** Shell rounded-subtrapezoidal, slightly rostrate posteriorly, moderately convex, with wide, slightly prominent, almost central or displaced forward prosogyrate beak (la/L 0.28-0.44); posterior ridge not particularly developed. Sculpture represented by mostly flat, wide ribs separated by threadlike interspaces, slightly wider on the anterior field; the anterior region displays 19 ribs slightly prominent, with growth lines or threads near the anterior edge and in umbonal area; the 5 ribs at the anterior edge are triangular in cross-section, the 5-6 posterior ones are flatter. Inner surface and hinge were not observable.

**Dimensions** (Tab. 1).

**Remarks.** Shell shape and rib pattern approach these specimens to representatives of the genus *Prosodacnomya*. A more accurate definition is not possible because the hinge is not visible.

Genus *Pachydacna* Ebersin, 1959

**Occurrence.** Latest Miocene-Late Pliocene. Latest Pontian of Romania and Azerbaijan, Dacian of Romania, Kimmerian and Kujalnician of southern Ukraine, southern Russia and Georgia (Papaianopol 1989b; Nevevskaya et al. 2001); latest Messinian, Italy (Esu 2007), Malaga Basin, Spain (Guerra-Merchán et al. 2010).

cf. *Pachydacna* sp. 1

Pl. 1, figs 2, 10

**Material:** MRSNT BS.132.01.002, *Limnocardium secans* (Fuchs), Late Miocene, Messinian, Castelletto d'Orba, umbonal fragment of LV (Pl. 1, fig. 2); MFEA G-1616, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, small bivalve shell in silt (Pl. 1, fig. 10).

**Description.** Shell rounded-triangular, convex with wide prominent, almost central prosogyrate beak; posterior ridge undeveloped. Sculpture represented by 12-16 anterior ribs very prominent, triangular-rounded, separated by flat interspaces, and 5-6 posterior ribs less swollen and more rounded than the anterior ones; LV hinge with one cardinal and single massive lateral anterior tooth; posterior laterals not preserved; lunule wide, well marked.

**Dimensions** (Tab. 1).

**Remarks.** Shell shape, prominent prosogyrate beak and hinge features (only partly visible) are similar to those displayed by the representatives of the genus *Pachydacna* Ebersin. Nevertheless the Piedmont specimens differ by the more prominent and numerous ribs and well marked lunule. The bivalve from the museum of Alba (Pl. 1, fig. 10) is fairly well preserved, but its hinge is not visible. "*Cardium*" *secans* Fuchs, 1870, from the Pannonian of Hungary, differs by the sharp keeled ribs and wider interspaces (Fuchs 1870, pl. 15, figs 29-31). The two studied specimens have been tentatively referred to as cf. *Pachydacna* sp. 1.

cf. *Pachydacna* sp. 2

Pl. 1, fig. 11

**Material:** MFEA G-1614, Ciabòt Cagna, Corneliano d'Alba, Late Messinian, big bivalve shell with posterior part included in silt.

**Description.** Big shell with very convex rounded valves; high twisted beak; peculiar type of ribs, which are triangular in the umbonal region, rounded in the middle of the shell and flat and smooth in the lower part, 7 (+?) ribs are visible; interspaces wider in the umbonal part, threadlike in the ventral part.

**Dimensions** only partly measurable (Tab. 1).

**Remarks.** The posterior part of the shell is not visible, as it is partially included in silt. Due to its fra-

gility, the shell could not be extracted from the sediment. Similar high twisted umbonal area and prominent triangular-rounded ribs are present among representatives of the genus *Pachydacna* and the Prosodacnini (e.g. the Pontian *Prosochiasta* Ebersin, 1959 or the Pontian-Late Pliocene *Psilodon* Cobalcescu, 1883 (= *Pachypriopleura* Akhvlediani, 1970) (Nevevskaya et al. 2001). Typical *Prosodacna* Tournouer, 1882, which displays similar strongly prosogyrate, or coiled spirally, projecting beak, differs by the flat ribs beginning from the umbonal part of the shell (cf. Nevevskaya et al. 2001). Moreover, fragile shell is not peculiar to *Prosodacna* species, which are characterized by thickening of the anterior part. The listed genera are distinguishable by the hinge, without this structure the identification at genus level is uncertain, and, in addition, similar rib ontogenetic changes are not common among Lymnocardiinae. The specimen from Ciabòt Cagna is clearly different from *Pachydacna* sp. 1 described in this paper by the shell shape and type of ribs. It has been tentatively referred to as cf. *Pachydacna* sp. 2.

**Conclusions**

Among the cardiids of the Bellardi and Sacco collection and those stored in the Museo Civico "F. Eusebio" of Alba from the Messinian deposits of Piedmont, five genera and at least fifteen species of Lymnocardiinae have been identified (Tabs 1-2). The two collections are comparable in terms of diversity of genera and species, taking into account that the Alba material was from a unique deposit and many other shell fragments are present in the collections. Four genera and at least three species proved to be in common. Local palaeoenvironmental factors may have affected the faunal composition, taking into account that all the analysed taxa had been collected from the same latest Messinian fossiliferous horizon (Cassano Spinola Conglomerates, upper part) at regional extension (Dela Pierre et al. 2011), and belong to the brackish "lago-mare" faunal assemblages of Paratethyan affinity spread in the latest Messinian post-evaporitic sediments recording the final stage of the Messinian salinity crisis (from 5.53 to 5.33 Ma) in the Mediterranean basin (Esu 2007 and references therein). Most of the genera (*Euxinocardium*, *Pontalmyra*, *Pseudocatillus*, *Prosodacnomya*, *Pachydacna*) have proved to be common to the Mediterranean and Paratethyan realms, but only two or four species (*E. subodessae*, *P. sabbae*, and probably *P. cf. pseudocatillus* and *P. cf. simplex*) proved to be widespread also in the Paratethys. The others are typical latest Messinian endemics (*P. bollenensis*, *P. incerta chiaie*, *P. magdalenensis*, *P. partschi*, *P. nevevskayae*) known exclusively from different sites of the Mediterranean realm (*P. nevevskayae*

Taxon	Specimens	L	H	H/L	la	la/L	C	C/H	h	h/H	Ribs
<i>E. subdossae</i>	MFEA.G-1619	7.8	5.5	0.72	2.3	0.30	-	-	-	-	9+6
<i>E. subdossae</i>	MFEA.G-1617a RV	10.0	7.2	0.72	3.5	0.35	-	-	-	-	8+6
<i>P. bollenensis</i>	BS.132.02.009/05 LV	26.2	22.5	0.86	8.2	0.31	7.5	0.33	3.2	0.14	20+7
<i>P. bollenensis</i>	BS.132.02.009/01 LV	10.1	7.6	0.75	4.1	0.41	3.3	0.43	1.8	0.24	20+6
<i>P. bollenensis</i>	BS.132.02.009 RV fragm.*	12.6	9.5	0.75	4.4	0.35	4.1	0.43	-	-	23+8
<i>P. bollenensis</i>	MFEA.G-1617b RV	12.6	~9	0.71	4.2	0.33	-	-	-	-	20+7
<i>P. incerta chiae</i>	BS.132.02.001 LV fragm.*	~9	~6	0.7	~3.3	0.37	-	-	-	-	14+7
<i>P. cf. magdalenensis</i>	BS.132.01/03-1 LV	~7	5.6	0.80	2.5	0.36	2.0	0.36	-	-	17+6
<i>P. cf. magdalenensis</i>	BS.132.01/03-2 RV*	7.2	5.0	0.69	3.2	0.44	-	-	-	-	20+?
<i>P. cf. partschi</i>	BS.132.02.006	-	-	-	-	-	-	-	-	-	-
cf. <i>Pontalmyra</i> (?subgen. nov.) sp.	BS.132.01/01 RV*	7.3	4.9	0.67	2.5	0.35	-	-	-	-	19+6
<i>P. nevenskayae</i>	MPUR7-3425 RV	6.2	4.7	0.76	1.9	0.31	1.4	0.30	0.7	0.15	23+7
<i>P. nevenskayae</i>	BS.132.02.002-1 LV	6.0	4.0	0.67	1.8	0.30	1.2	0.30	-	-	24+6
<i>P. nevenskayae</i>	BS.132.02.002-2 RV*	7.5	4.7	0.63	3.0	0.40	1.6	0.34	-	-	22+7
<i>P. cf. pseudocatillus</i>	MFEA.G-1620 LV	13.0	9.0	0.76	3.5	0.26	-	-	-	-	28+?5
<i>P. cf. simplex</i>	BS.132.02.003 LV	~5	3.7	0.74	~2	0.40	1.3	0.35	-	-	22+11
<i>P. cf. submedius</i>	BS.132.02.005 RV	10.5	10.0	0.95	~5	0.47	3.0	0.30	-	-	22+?
cf. <i>Pseudocatillus</i> sp.	BS.132.02.005/01-1 RV	~10	7.8	0.78	~4	0.40	3.0	0.38	1.7	0.22	23+~7
	BS.132.02.005/01-2 RV	11.3	8.0	0.71	-	-	-	-	-	-	21+7
<i>P. sabbae</i>	BS.132.03.001 LV	18.5	16.0	0.86	6.0	0.32	~7	0.44	4.1	0.26	19+7
	BS.132.03.001 LV*	17.0	13.7	0.81	4.5	0.26	6.5	0.47	4.0	0.29	-
<i>P. sabbae</i>	BS.132.01.001/01 LV	19.4	17.2	0.89	7.2	0.37	5.5	0.32	-	-	20+5
cf. <i>Prosodacnomya</i> sp.	MFEA.G-1618 RV	11.0	~8	0.73	4.8	0.44	-	-	-	-	19+5
	MFEA.G-1615 RV	24.2	18.9	0.78	6.7	0.28	-	-	-	-	17+6
cf. <i>Pachydaena</i> sp.1	MFEA.G-1616	6.4	~5	0.8	2.6	0.41	-	-	-	-	12+?5
cf. <i>Pachydaena</i> sp.2	MFEA.G-1614	-	21.9	-	-	-	7.9	0.36	4.4	0.20	7+?

Tab. 1 - Measured shell dimensions. L, valve length; H, valve height; la, length of the anterior part of the shell from beak; C, valve convexity; h, beak height. Ribs, number of ribs of anterior + posterior area of the valve; LV, left valve; RV, right valve; asterisk indicates measurement of fragmentary shells based on growth lines. All dimensions in millimeter.

Lymnocyprinae in Turin museum		Lymnocyprinae in Alba museum	
Sacco (1899) or name in collection	Revised name	Cavallo & Repetto (1992) or name in collection	Revised name
<i>Pontalmyra? bollenensis</i> 02.007, 02.007/01; <i>Pontalmyra? spratti</i> 02.009, 02.009/01/05, 02.008	<i>Pontalmyra bollenensis</i> Pl. 2, figs 4-9	<i>Lymnocypridium</i> (s. l.) sp. G-1617a, G-1619	<i>Euxinocypridium subdossae</i> Pl. 1, figs 8a, 9
<i>Pontalmyra carinata</i> 02.001	<i>Pontalmyra incerta chiae</i> Pl. 2, fig. 10	<i>Lymnocypridium</i> (s. l.) <i>spratti</i> G-1617b	<i>Pontalmyra bollenensis</i> Pl. 1, fig. 8b
<i>Lymnocypridium</i> sp. 01../03	<i>Pontalmyra</i> cf. <i>P. magdalenensis</i> Pl. 1, figs 3, 4	<i>Lymnocypridium</i> (s. l.) <i>carinatum</i>	<i>Pontalmyra incerta chiae</i>
<i>Pontalmyra partschi</i> 02.006	<i>Pontalmyra</i> cf. <i>P. partschi</i> Pl. 2, fig. 13	without name G-1620	<i>Pseudocatillus</i> cf. <i>P. pseudocatillus</i> Pl. 1, fig. 12
<i>Lymnocypridium</i> sp. 01..01	cf. <i>Pontalmyra</i> (?subgen. nov.) sp. Pl. 1, fig. 1	without name G-1615, G-1618	cf. <i>Prosodacnomya</i> sp. Pl. 1, figs 13, 14
<i>Pontalmyra solitaria</i> 02.002; <i>Pontalmyra castellanensis</i> 02.004	<i>Pseudocatillus</i> <i>nevenskayae</i> Pl. 2, figs 17-19	without name G-1616	cf. <i>Pachydaena</i> sp. 1 Pl. 1, fig. 10
<i>Pontalmyra simplex</i> 02.003	<i>Pseudocatillus</i> cf. <i>P. simplex</i> Pl. 2, fig. 14	without name G-1614	cf. <i>Pachydaena</i> sp. 2 Pl. 1, fig. 11
<i>Pontalmyra novarossica</i> 02.005	<i>Pseudocatillus</i> cf. <i>P. submedius</i> Pl. 1, fig. 7		
<i>Pontalmyra novarossica</i> 02.005/01-1, 01-2	cf. <i>Pseudocatillus</i> sp. Pl. 1, figs 5, 6		
<i>Prosodacna semisulcata</i> 03.001; <i>Lymnocypridium banaticum</i> 01.001, 01.001/01	<i>Prosodacnomya sabbae</i> Pl. 2, figs 1-3		
<i>Lymnocypridium secans</i> 01.002	cf. <i>Pachydaena</i> sp. 1 Pl. 1, fig. 2		

Tab. 2 - Original denominations and revised names of Lymnocyprinae stored in the Turin and Alba museums.

seems to occur also in the Early Messinian of Greece), or forms which have been defined so far in open nomenclature. In this paper, most of the latter forms are regarded as possible Messinian endemics at species level. The taxa that have been left in open nomenclature at genus level, such as cf. *Pontalmyra* (?subgen. nov.), cf. *Pseudocatillus*, cf. *Prosodacnomya* and cf. *Pachydacna*, are possible Messinian endemics too. The Piedmont Messinian cockles often differ from the Paratethyan representatives of the same genera by a heavier hinge and a well distinct lunule. The identified morphological structures of the upper Messinian Lymnocardiinae are assumed to have close relations with the Paratethyan fauna on the one hand and with its further independent development in a specific “lago-mare” en-

vironment on the other hand. Additional sampling and investigations may lead to classify new Lymnocardiinae genera, clear their origin and assess the possible biogeographic fragmentation of the latest Messinian “lago-mare” system.

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