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A REVISION OF THE PLIOCENE NATICIDS OF NORTHERN AND CENTRAL ITALY. II. THE SUBFAMILY NATICINAE: ADDITIONS TO *COCHLIS*, *TANEA* AND *TECTONATICA*

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Abstract. The present paper is the second in a series devoted to the revision of the Pliocene naticids of Northern and Central Italy. It concludes the section covering the calcareous operculum-bearing Naticinae and expands to 18 the total number of species and subspecies of this subfamily recovered so far from the Pliocene deposits of Italy. Of the six taxa considered in this study, two (*epigloafuniculata* and *fredianii*) fully match the characters of the genus *Cochlis* Röding, 1798, one (*koeneni*) is assigned to the genus *Tanea* Marwick, 1931, the rest (*astensis*, *prietoi* and *tectula*) belong to the genus *Tectonatica* Sacco, 1890. All the six taxa considered in this paper are described and commented in the systematic account. One, *Cochlis fredianii*, is proposed as new. In the chapter treating the generic assignment of the studied taxa, the range of *Tanea*, hitherto used to allocate several Indo-Pacific species, is extended to the Mediterranean Basin as well, and the relations between *Tectonatica* and *Cryptonatica* Dall, 1892 are discussed. This study further demonstrates that the morphological characters of the teleoconch are of low significance in species recognition. In fact, should the characters be ranked, the operculum comes first and is the primary element, sufficient to distinguish each species. The protoconch and the color pattern are the second and third relevant attributes that can be used diagnostically for several taxa, but not always. The other shell features appear to be useful tools in separating species only occasionally. Some species lack distinctive shell characters and do require operculate specimens in order to be confidently identified.

Riassunto. Il presente lavoro è il secondo di una serie dedicata alla revisione dei naticidi pliocenici dell'Italia settentrionale e centrale. Esso completa la sezione concernente i Naticinae che sono dotati di opercolo calcareo ed amplia a 18 il numero totale di specie e sottospecie appartenenti a questa sottofamiglia, rinvenute finora nei depositi pliocenici italiani. Dei sei taxa considerati in questa ricerca, due (*epigloafuniculata* e *fredianii*) hanno caratteri che coincidono perfettamente con quelli del genere *Cochlis* Röding, 1798, uno (*koeneni*) viene attribuito al genere *Tanea* Marwick, 1931, mentre i rimanenti (*astensis*, *prietoi* e *tectula*) appartengono al genere *Tectonatica* Sacco, 1890. Tutti i sei taxa considerati in questo lavoro vengono descritti e commentati nella enumerazione sistematica; uno di questi, *Cochlis fredianii*, viene proposto come nuovo. Nel capitolo che discute l'attribuzione generica dei taxa studiati, la distribuzione di *Tanea*, finora comprendente solo specie indo-pacifiche, viene ampliata a comprendere anche il Bacino Mediterraneo dove è rappresentato dalla specie attuale *Tanea dillwyni* (Payraudeau, 1826) e dalla sua sottospecie fossile *koeneni*. Inoltre, vengono discussi i rapporti tra *Tectonatica* e *Cryptonatica* Dall, 1892. Questo studio fornisce una ulteriore dimostrazione del fatto che i caratteri morfologici della teleoconca hanno scarsa rilevanza ai fini del riconoscimento delle specie. Se si organizzano i caratteri in ordine di importanza, l'opercolo risulta essere l'elemento più significativo, sufficiente per distinguere ciascuna specie. La protoconca e la colorazione sono rispettivamente il secondo e terzo carattere importante e risultano diagnostici in molti casi, anche se non sempre. Gli altri aspetti della conchiglia possono servire solo occasionalmente per distinguere una determinata specie. Alcuni taxa, i cui caratteri conchigliari non sono diagnostici, possono essere identificati affidabilmente solo sulla base del loro opercolo.

Introduction

The present paper, following a previous one by Pedriali & Robba (2005), is the second in a series aiming to revise the Pliocene naticids of Northern and Central Italy. It examines five previously described taxa, two of which are placed in a different taxonomic level, one new species, and concludes the section devoted to the Naticinae, i.e. to those members of the Naticidae possessing a calcareous operculum.

This study is based on a collection of about 2500 specimens, recovered from 37 Pliocene exposures in Central and Northern Italy (Fig. 1). Additional material, relevant to the research, from Miocene of Italy and

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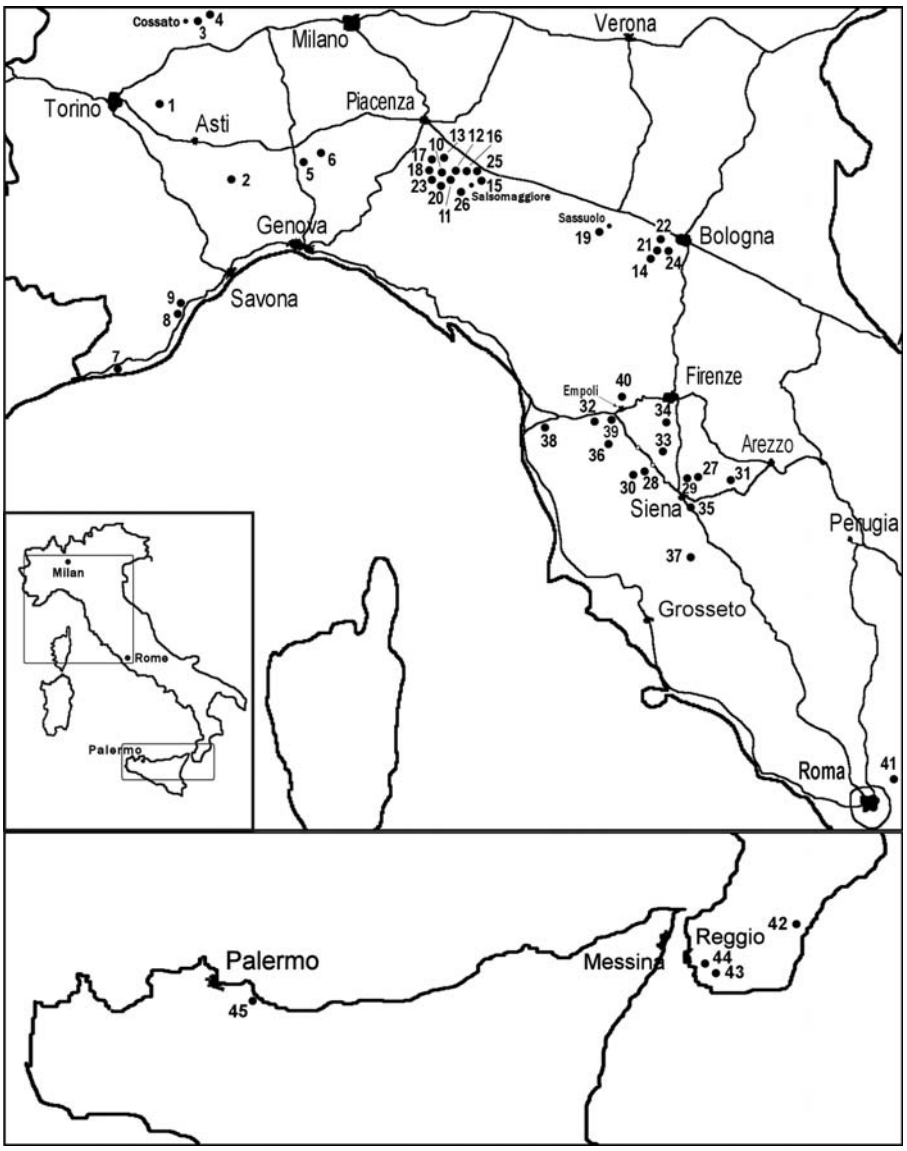


Fig. 1 - Sketch map of naticid localities; locality numbers are those in the appendix.

Germany, Pliocene of Sicily and Spain, and Pleistocene of Emilia and Calabria, were also incorporated. Short information on the localities that yielded the naticids is appended. The preservation of the studied shells is ordinarily fair and the amplitude of the collection has allowed to obtain several specimens that have the operculum still filling the aperture. Consequently, the shell characters and the operculum of each species could be observed and analyzed in terms of range of variation and diagnostic value. Pertinent naticids in the Bellardi-Sacco huge collection (Museo di Geologia e Paleontologia dell'Università di Torino) and in private collections were also examined.

For general comments on Cenozoic Naticidae of Italy and details on other Pliocene Naticinae, reference can be made to Pedriali & Robba (2005, p. 110, 111). Of the six naticine taxa covered in this paper (one is proposed herein as new), five were described during the last quarter of the 19th century. The first species to be introduced was *Natica prietoi*, described by Hidalgo (1873) on the basis of Recent shells from the Balearic Islands. Subsequently, Sacco (1890) proposed *Natica epigloafuniculata*, *Natica astensis* and *Natica tectula*, the first regarded as a variety of *Natica millepunctata* Lamarck, 1822, the second as a variety of *Natica pulchella* Risso, 1826, the third as a distinct species on which he based *Tectonatica* (regarded as a subgenus of *Natica* Scopoli, 1777). One year later (1891), Sacco introduced *Natica koeneni* as a variety of *Natica epiglottina* Lamarck, 1822. Clearly, the genus *Natica* was intended in a quite broad sense, accommodating taxa with markedly different shell and opercular characters (cf. also Pedriali & Robba 2005, p. 133). Later on, *epigloafuniculata*, that we consider a genuine species (see discussion in the systematic account), was totally neglected, *koeneni* was quoted only from Miocene deposits of Northwestern Europe and assigned either to *Natica* or to *Polinices* Montfort, 1810, *prietoi* was never cited as fossil. From the review of the literature, it appears that only *astensis* and *tectula* were currently re-

corded from Miocene and Pliocene units, and ordinarily assigned to *Tectonatica* Sacco, 1890, the latter regarded as a full genus during the last decades.

The present paper further expands the number of Pliocene naticine taxa (twelve were treated by Pedriali & Robba 2005) to 18 in total. Of the six taxa considered herein, two (*epigloafuniculata* Sacco, 1890 and *fredianii* sp. n.) belong to the genus *Cochlis* Röding, 1798, another (*dillwyni koeneni* Sacco, 1891) is assigned to *Tanea* Marwick, 1931, a genus so far used only for Indo-Pacific species. The rest (*astensis* Sacco, 1890, *prietoi* Hidalgo, 1873 and *tectula* Sacco, 1890) belong to the genus *Tectonatica* Sacco, 1890. The two species of *Cochlis* can be included in the *raropunctata* group as defined by Pedriali & Robba (2005), in that have few-whorled protoconch and 2 ribs to the operculum.

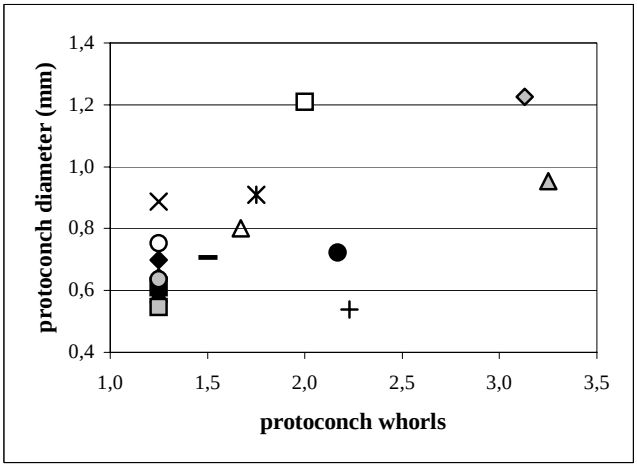


Fig. 3 - Relationship between protoconch diameter and protoconch whorls (species of *Natica*, *Cochlis* and *Tanea*); symbols as in Fig. 2.

Morphology and character analysis

A review of the various naticid characters, along with information on the significance accorded to them by different authors, was provided by Pedriali & Robba (2005) and there is no need for further additions. In the following we examine those same characters, occurring in the taxa covered by this study in order to evaluate their actual relevance. The terms indicating the parts of the naticid shells as well as the standard measurements are those adopted by Pedriali & Robba (2005) and shown in their text-fig. 2. Quantitative data provided by the just cited authors are sometimes incorporated for comparison.

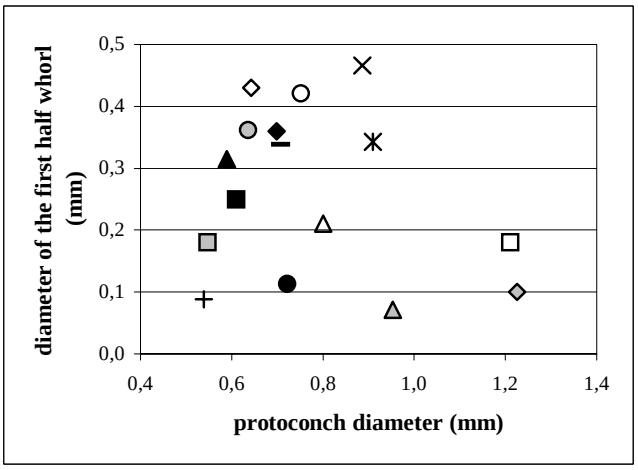


Fig. 2 - Relationship between diameter of the first half whorl of the protoconch and protoconch diameter (species of *Natica*, *Cochlis* and *Tanea*); solid triangle: *depressofuniculata*; gray-shaded triangle: *dillwyni*; open triangle: *epigloafuniculata*; solid square: *fredianii*; gray-shaded square: *fulgurata*; open square: *koeneni*; solid diamond: *obliquicallosa*; gray-shaded diamond: *plicatula*; open diamond: *propinqua*; solid circle: *pseudoepiglottina*; gray-shaded circle: *raropunctata*; open circle: *strictiumbilicata*; multiplication sign: *sulcogradata*; asterisk: *undata*; dash: *virguloides*; cross: *vittata*.

Protoconch

Pedriali & Robba (2005) dealt with the morphology of the larval shell of naticids and investigated its diagnostic value. They concluded that a least 20-25% difference in diameter (protoconch and/or first half whorl) as well as a half whorl difference in number of whorls are sufficient to distinguish species.

As regards the present material, we have found convenient to examine *Cochlis* and *Tanea* species separately from those of *Tectonatica* in order to preserve clarity of the graphs. The plots of Fig. 2 through 5 show the average values of the characteristic features of the protoconch pertaining to *epigloafuniculata*, *fredianii*, *koeneni*, and to the taxa already treated by Pedriali & Robba (2005) along with *Tanea dillwyni* (Payraudeau, 1826), these latter considered for comparison. The plots of Fig. 6 through 9 refer to the three *Tectonatica* species covered in this paper and to another three worthy to be compared to the former ones; of these latter, *filosa* Philippi, 1845 (Pl. 3, fig. 24, 25) belongs to the genus *Cryptonatica* Dall, 1892 (see discussion in generic classification).

The measures of both protoconch diameter and diameter of the first half whorl are classified according to Pedriali & Robba (2005). The protoconch is small in the *Cochlis* species (*epigloafuniculata* and *fredianii*), medium-sized in *Tanea dillwyini koeneni* (Fig. 2). The three taxa exhibit small or rather small diameter of the first half whorl (Fig. 2). The paucispiral larval shell of these taxa (Fig. 3) points toward a non-planktotrophic larval development. Considering the relations between diameter of the first half whorl (DHW) and number of protoconch whorls (Fig. 4) as well as those between the

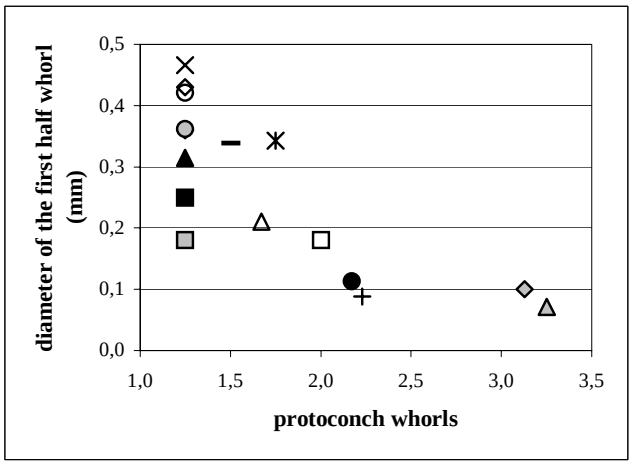


Fig. 4 - Relationship between diameter of the first half whorl of the protoconch and protoconch whorls (species of *Natica*, *Cochlis* and *Tanea*); symbols as in Fig. 2.

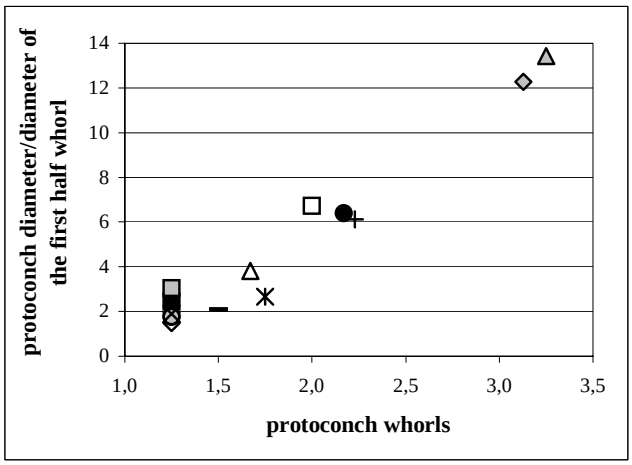


Fig. 5 - Relationship between protoconch diameter/diameter of the first half whorl ratio and protoconch whorls (species of *Natica*, *Cochlis* and *Tanea*); symbols as in Fig. 2.

PD/DHW ratio and number of protoconch whorls (Fig. 5), it appears that *epigloafuniculata*, *fredianii* and *koeneni* provide further evidence to previous records of Pedriali & Robba (2005). In fact, the latter authors noted (p. 117) that ordinarily the size of the tip changes inversely with relation to the number of protoconch whorls and that there is a direct correlation between the PD/DHW ratio and the protoconch whorls. Actually, the 1.25 whorled protoconch of *fredianii* has a larger tip (0.25 mm), whereas the 1.5-2 whorled larval shells of *epigloafuniculata* and *koeneni* have smaller ones. Conversely, the PD/DHW ratio is higher in *koeneni*, lower in *epigloafuniculata* and more so in *fredianii*.

The species of *Tectonatica* considered herein have small (*prietoi*) or medium-sized protoconchs with small diameter of the initial half whorl (Fig. 6). The latter exhibits a quite narrow extent of variation, with average values (0.10 to 0.12 mm) falling in the lower half of the range pertaining to small tips (cf. Pedriali & Robba 2005). All taxa possess multispiral larval shells (Fig. 7) reflecting a planktotrophic larval development. The relations between diameter of the first half whorl and number of protoconch whorls (Fig. 8) and those between the PD/DHW ratio and number of protoconch whorls (Fig. 9) fit in with the general trends noted for *Cochlis* and *Tanea* species.

Pedriali & Robba (2005) remarked that the protoconch shows little variation within a species, since the range is of no more than 0.25 as regards the number of whorls and of less than 20% if the diameters (protoconch and first half whorl) are considered. The measurements effected for five of the taxa examined in the present paper fully conform to these records; nothing can be said as regards *koeneni*, since only 1 protoconch could be measured.

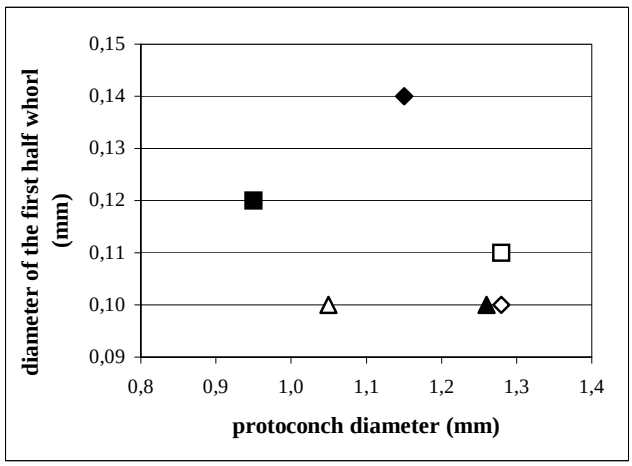


Fig. 6 - Relationship between diameter of the first half whorl of the protoconch and protoconch diameter (species of *Tectonatica* and *Cryptonatica*); solid triangle: *adansoni*; open square: *astensis*; open triangle: *filosa*; solid square: *prietoi*; solid diamond: *rizzae*; open diamond: *tectula*.

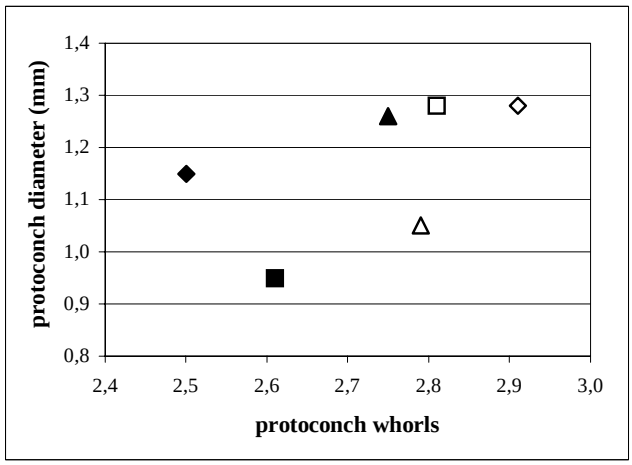


Fig. 7 - Relationship between protoconch diameter and protoconch whorls (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 6.

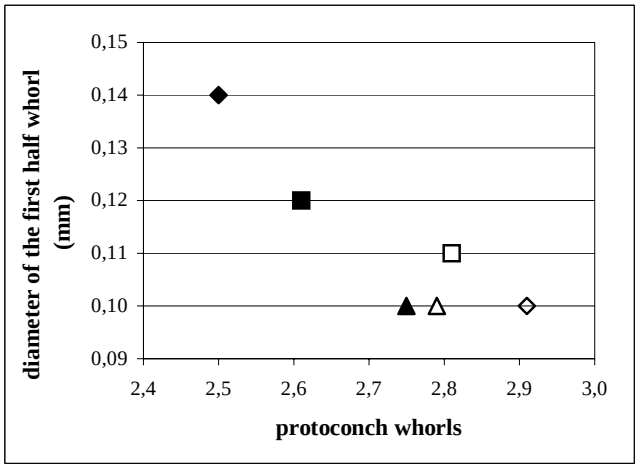


Fig. 8 - Relationship between diameter of the first half whorl of the protoconch and protoconch whorls (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 6.

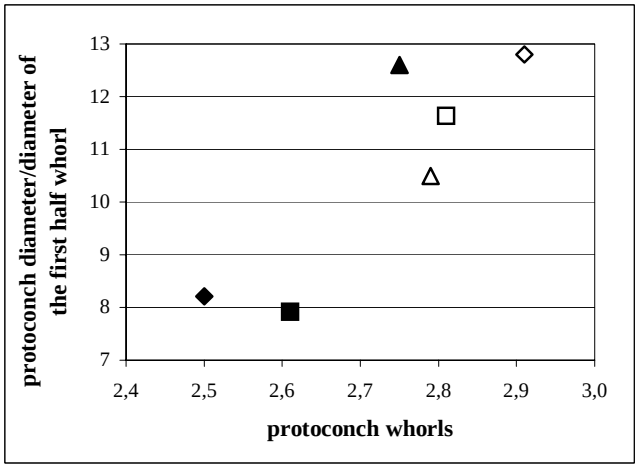


Fig. 9 - Relationship between protoconch diameter/diameter of the first half whorl ratio and protoconch whorls (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 6.

The matrices in Tab. 1 to 3 consider the same taxa of Fig. 2 through 9. As regards the difference in number of protoconch whorls within species pairs (Tab. 1), it can be seen that *epigloafuniculata* and *fredianii* differ significantly (half whorl difference or greater) only from some of the other *Cochlis* taxa, from *dillwyni*, and from all the species in the *Tectonatica/Cryptonatica* group. *Tanea dillwyni koeneni* can be readily distinguished from *Natica virguloides* Sacco, 1890 and from most of the *Cochlis* species except for *epigloafuniculata*, *pseudoepiglottina* (Sacco, 1890), *undata* (Sasso, 1827) and *vittata* (Gmelin, 1791); moreover, it differs clearly from *dillwyni* and from all taxa in the *Tectonatica/Cryptonatica* group. No significant difference does exist between the multispiral larval shells of the species in the latter group.

The percent difference in protoconch diameter (Tab. 2) resulted to be diagnostic for several species pairs. Concerning the forms covered in this paper, it serves to distinguish *epigloafuniculata* from *fredianii*, both from part of the other *Cochlis* species, from *koeneni* and from taxa in the *Tectonatica/Cryptonatica* group but for *epigloafuniculata* from *prietoi*. For this character, *koeneni* differs from species of *Natica* and *Cochlis* (except for *plicatula*), from *dillwyni* and from *prietoi*. Within the *Tectonatica/Cryptonatica* group, the percent difference in diameter can be used to separate:

- *astensis* from *prietoi*;
- *prietoi* from *tectula*.

The percent difference in diameter of the first half whorl (Tab. 3) proved to be highly significant in distinguishing:

- *epigloafuniculata* from all except for *fredianii*, *Cochlis fulgurata* (Meneghini in Pecchioli, 1864) and *koeneni*;
- *fredianii* from all the others (except *epigloafuniculata*);
- *koeneni* from all the others except for *epigloafuniculata* and *fulgurata*;
- *astensis* and *tectula* from *rizzae* (Pl. 3, fig. 26).

Teleoconch

Comments on the diagnostic value of the shell features of naticids were already provided by Pedriali & Robba (2005). It is deemed unnecessary to present here all the scatters relative to taxa of *Cochlis* and *Tanea* (*epigloafuniculata*, *fredianii* and *koeneni*) since they often overlap the graphs published by Pedriali & Robba (2005, text-figs. 7 A through 14 A) for the same pairs of characters. Instead, all the diagrams concerning the three *Tectonatica* species and *filosa* Philippi, 1845 (of *Cryptonatica*) considered for comparison are included herein.

Shell shape. As already stated by the present authors (2005), the shell shape can be defined statistically on the basis of the relations between 1) maximum diameter and shell height, 2) spire height and shell height and 3) by the values of the spire angle.

The plot of maximum diameter against the height of the shell for *epigloafuniculata*, *fredianii* and *koeneni* (not illustrated herein) shows that the points representing the shells belonging to these taxa form a single elongate scatter. The latter fully overlaps that obtained by Pedriali & Robba (2005, text-fig. 7 A) for the species in the *raropunctata* group. Thus, the forms considered in this study are neither significantly different from one another, nor they are from those in the *raropunctata* group. It is worthy to note that both *fredianii* and *koeneni* ordinarily attain a larger size compared to that of *epigloafuniculata*, which hardly exceeds 16 mm in height. As regards *Tectonatica/Cryptonatica* species, again the points are arranged into overlapping, elongate scatters indicating no significant difference (Fig. 10).

	virguloides	*depressofuniculata*	*epigloafuniculata*	*fredianii*	*fulgurata*	*obliquicallosa*	*plicatula*	*propinqua*	*pseudoepiglottina*	*raropunctata*	*strictiumbilicata*	*sulcogradata*	*undata*	*vittata*	*dillwyni*	*koeneni*	*adansoni*	*astensis*	*filosa*	*prietoi*	*rizzae*	*tectula*
Natica																						
virguloides		0,3	-0,2	0,3	0,3	0,3	**-1,6**	0,3	**-0,7**	0,3	0,3	0,3	-0,3	**-0,7**	**-1,8**	**-0,5**	**-1,3**	**-1,3**	**-1,2**	**-1,1**	**-1,0**	**-1,4**
Cochlis																						
depressofuniculata			-0,4	0,0	0,0	0,0	**-1,9**	0,0	**-0,9**	0,0	0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
epigloafuniculata				0,4	0,4	0,4	**-1,5**	0,4	**-0,5**	0,4	0,4	0,4	-0,1	**-0,6**	**-1,6**	-0,3	**-1,1**	**-1,1**	**-1,1**	**-0,9**	**-0,8**	**-1,2**
fredianii					0,0	0,0	**-1,9**	0,0	**-0,9**	0,0	0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
fulgurata						0,0	**-1,9**	0,0	**-0,9**	0,0	0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
obliquicallosa							**-1,9**	0,0	**-0,9**	0,0	0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
plicatula								**1,9**	**1,0**	**1,9**	**1,9**	**1,9**	**1,4**	**1,0**	-0,1	**1,1**	0,4	0,3	0,3	**0,5**	**0,6**	0,2
propinqua									**-0,9**	0,0	0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
pseudoepiglottina										**0,9**	**0,9**	**0,9**	0,4	0,0	**-1,1**	0,2	**-0,6**	**-0,6**	**-0,6**	-0,4	-0,3	**-0,7**
raropunctata											0,0	0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
strictiumbilicata												0,0	**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
sulcogradata													**-0,5**	**-1,0**	**-2,0**	**-0,8**	**-1,5**	**-1,6**	**-1,5**	**-1,4**	**-1,3**	**-1,7**
undata														**-0,5**	**-1,5**	-0,3	**-1,0**	**-1,1**	**-1,0**	**-0,9**	**-0,8**	**-1,2**
vittata															**-1,0**	0,2	**-0,5**	**-0,6**	**-0,6**	-0,4	-0,3	**-0,7**
Tanea																						
dillwyni																**1,3**	**0,5**	0,4	**0,5**	**0,6**	**0,8**	0,3
koeneni																	**-0,8**	**-0,8**	**-0,8**	**-0,6**	**-0,5**	**0,9**
Tectonatica/Cryptonatica																						
adansoni																		-0,1	0,0	0,1	0,3	-0,2
astensis																			0,0	0,2	0,3	-0,1
filosa																				0,2	0,3	-0,1
prietoi																					0,1	-0,3
rizzae																						-0,4
tectula																						

Tab. 1 - Matrix showing difference in number of protoconch whorls within species pairs; significant values are boldfaced. All the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper) are listed; *dillwyni*, *adansoni*, *filosa* and *rizzae* also eclosed for comparison.

	virguloides	*depressofuniculata*	*epigloafuniculata*	*fredianii*	*fulgurata*	*obliquicallosa*	*plicatula*	*propinqua*	*pseudoepiglottina*	*raropunctata*	*strictiumbilicata*	*sulcogradata*	*undata*	*vittata*	*dillwyni*	*koeneni*	*adansoni*	*astensis*	*filosa*	*prietoi*	*rizzae*	*tectula*
Natica																						
virguloides		17	-11	14	**23**	1,3	**-43**	9	-2	10	-6	**-20**	**-22**	**24**	**-25**	**-41**	**-44**	**-45**	**-32**	**-25**	**-38**	**-45**
Cochlis																						
depressofuniculata			**-26**	-3	7	-16	**-52**	-8	-18	-7	**-22**	**-34**	**-35**	8	**-38**	**-51**	**-53**	**-54**	**-44**	**-38**	**-49**	**-54**
epigloafuniculata				**24**	**31**	13	**-35**	**20**	10	**20**	9	-10	-12	**33**	-16	**-34**	**-37**	**-38**	**-24**	-16	**-30**	**-38**
fredianii					10	-13	**-50**	-5	-15	-5	-16	**-31**	**-33**	11	**-36**	**-50**	**-52**	**-52**	**-42**	**-36**	**-47**	**-52**
fulgurata						**-22**	**-55**	-15	**-24**	-14	**-27**	**-38**	**-40**	1	**-42**	**-55**	**-56**	**-57**	**-48**	**-42**	**-52**	**-57**
obliquicallosa							**-43**	8	-3	9	-7	**-21**	**-23**	**23**	**-26**	**-42**	**-44**	**-45**	**-33**	**-26**	**-39**	**-45**
plicatula								**48**	**41**	**48**	**37**	**28**	**26**	**56**	**23**	2	-2	-4	15	**23**	-7	-4
propinqua									-11	1	-15	**-28**	**-29**	16	**-33**	**-47**	**-49**	**-50**	**-39**	**-33**	**-44**	**-50**
pseudoepiglottina										12	-4	-19	**-21**	**25**	**-24**	**-40**	**-43**	**-44**	**-31**	**-24**	**-37**	**-44**
raropunctata											-15	**-28**	**-30**	15	**-33**	**-47**	**-49**	**-50**	**-39**	**-33**	**-44**	**-50**
strictiumbilicata												-15	-17	**28**	**-23**	**-40**	**-42**	**-43**	**-30**	**-23**	**-37**	**-43**
sulcogradata													-3	**39**	-6	**-26**	**-29**	**-30**	-15	-6	**-23**	**-30**
undata														**41**	-4	**-25**	**-28**	**-30**	-13	-4	**-21**	**-30**
vittata															**-43**	**-55**	**-57**	**-59**	**-49**	**-43**	**-53**	**-59**
Tanea																						
dillwyni																**-21**	**-25**	**-26**	-10	0	-17	**-26**
koeneni																	-4	-5	13	**21**	5	-5
Tectonatica/Cryptonatica																						
adansoni																		-2	17	**25**	9	-2
astensis																			18	**26**	10	18
filosa																				10	-9	-18
prietoi																					-17	**-26**
rizzae																						-10
tectula																						

Tab. 2 - Matrix showing percent difference in diameter of the larval shell within species pairs; significant values are boldfaced. All the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper) are listed; *dillwyni*, *adansoni*, *filosa* and *rizzae* also eclosed for comparison.

	virguloides	*depressofuniculata*	*epigloafuniculata*	*fredianii*	*fulgurata*	*obliquicallosa*	*plicatula*	*propinqua*	*pseudoepiglottina*	*raropunctata*	*strictiumbilicata*	*sulcogradata*	*undata*	*vittata*	*dillwyni*	*koeneni*	*adansoni*	*astensis*	*filosa*	*prietoi*	*rizzae*	*tectula*
Natica																						
virguloides		7	**38**	**26**	**47**	-6	**71**	**-21**	**67**	-6	-19	**-27**	-1	**74**	**79**	**47**	**71**	**68**	**71**	**65**	**59**	**71**
Cochlis																						
depressofuniculata			**34**	**22**	**43**	-13	**68**	**-27**	**64**	-13	**-25**	**-32**	8	**72**	**78**	**44**	**69**	**67**	**69**	**63**	**56**	**69**
epigloafuniculata				-16	14	**-42**	**52**	**-51**	**43**	**-42**	**-50**	**-55**	**-38**	**57**	**67**	14	**52**	**48**	**52**	**43**	**33**	**52**
fredianii					**28**	**-31**	**60**	**-42**	**56**	**-31**	**-40**	**-47**	**-26**	**64**	**72**	**28**	**60**	**56**	**60**	**52**	**44**	**60**
fulgurata						**-50**	**44**	**-58**	**37**	**-50**	**-57**	**-61**	**-48**	**51**	**61**	0	**44**	**39**	**44**	**33**	**22**	**44**
obliquicallosa							**72**	-16	**69**	-1	-14	**-23**	5	**76**	**81**	**50**	**72**	**69**	**72**	**67**	**61**	**72**
plicatula								**-77**	-12	**-72**	**-76**	**-79**	**-71**	12	**30**	**-44**	0	-9	0	-17	**-29**	0
propinqua									**74**	16	2	-8	**20**	**80**	**84**	**58**	**77**	**74**	**77**	**72**	**67**	**77**
pseudoepiglottina										**-69**	**-73**	**-76**	**-67**	**22**	**36**	**-39**	9	0	9	-8	**-21**	9
raropunctata											-14	**-22**	5	**76**	**81**	**50**	**72**	**69**	**72**	**67**	**61**	**72**
strictiumbilicata												-10	19	**79**	**83**	**57**	**76**	**74**	**76**	**71**	**67**	**76**
sulcogradata													**26**	**81**	**85**	**62**	**79**	**77**	**79**	**74**	**70**	**79**
undata														**74**	**79**	**47**	**71**	**68**	**71**	**65**	**59**	**71**
vittata															**22**	**-50**	-10	-18	-10	**-25**	**-36**	-10
Tanea																						
dillwyni																**-61**	**-30**	**-36**	**-30**	**-42**	**-50**	**-30**
koeneni																	**44**	**39**	**44**	**33**	**22**	**44**
Tectonatica/Cryptonatica																						
adansoni																		-9	0	-17	**-29**	0
astensis																			9	-8	**-21**	9
filosa																				-17	**-29**	0
prietoi																					-14	17
rizzae																						**29**
tectula																						

Tab. 3 - Matrix showing percent difference in diameter of the first half whorl of the protoconch within species pairs; significant values are boldfaced. All the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper) are listed; *dillwyni*, *adansoni*, *filosa* and *rizzae* also eclosed for comparison.

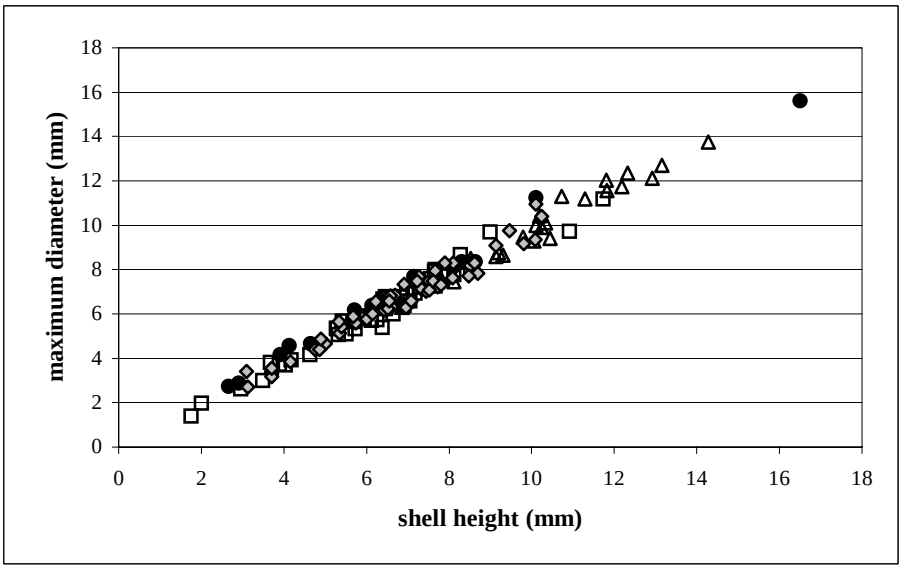


Fig. 10 - Relationship between maximum diameter and shell height (species of *Tectonatica* and *Cryptonatica*); open squares: *astensis*; solid circles: *filosa*; open triangles: *prietoi*; gray-shaded diamonds: *tectula*.

The combined regression for these small-sized species fits in with that of the *raropunctata* group (cf. Pedriali & Robba 2005), with the points representing the shells tightly clustered close to the origin of coordinate axes of that graph. The coefficients of correlation proved high in all the studied taxa (r = 0.89-0.99).

The height of the spire resulted to be well correlated with the shell height (r = 0.75-0.97) in *epigloafuniculata*, *koeneni* and in the *Tectonatica*/*Cryptonatica* species; the correlation for *fredianii* was lower (r = 0.50) but still significant. Measurements of the shells belonging to *epigloafuniculata*, *fredianii* and *koeneni* form a wide scatter (Fig. 11). The slope and elevation of *epigloafuniculata* and *koeneni* are not significantly different from one another and their combined regression overlaps that figured by Pedriali & Robba (2005, text-fig. 8 A) for the *raropunctata* group (*obliquicallosa* excluded). The line for *fredianii* has significantly different slope and intercept (Fig. 11), and denotes that the spire of this species tends to increase in height during growth at a rate lower than that of *koeneni*, *epigloafuniculata* and of the other species in the *raropunctata* group. However, Fig. 11 shows that medium-sized shells of *fredianii* are indistinguishable from those of *epigloafuniculata* and *koeneni* on the basis of the considered pair of characters. As can be seen from Fig. 12, no significant difference does exist for this same relationship between the four species of the *Tectonatica*/*Cryptonatica* group. As can be seen from Fig. 13, the combined regression of *Tectonatica*/*Cryptonatica* species, which has a rather similar slope to the *raropunctata* group, *plicatula* and *obliquicallosa*, has a significantly different elevation. This means that, for a given height of the shell, *Tectonatica* species as well as *filosa* have the spire significantly higher than that of the other considered taxa. Taking into account the findings of Pedriali & Robba (2005, text-fig. 8 B), it appears that *Tectonatica* species and *filosa* cannot be distinguished on the basis of this relationship from *Cochlis vittata* (Gmelin, 1791), which is relatively high-spired too.

The spire angle varies more or less greatly in the taxa considered herein, as does in the other species dealt with by Pedriali & Robba (2005). From Tab. 4 it will be seen that the 95% confidence intervals pertaining to the eighteen Pliocene species of the Naticinae largely overlap to one another. At most, it can be noted that shells with spire angle of less than 99° belong to *astensis*, whereas values of this angle greater than 146° occur only in *Natica virguloides* Sacco, 1890 and *Cochlis raropunctata obliquicallosa* Pedriali & Robba, 2005. The suture, another feature of the spire, is adpressed in all the six taxa covered in this paper.

Aperture. In order to define quantitatively the aperture, Pedriali & Robba (2005) used the relations

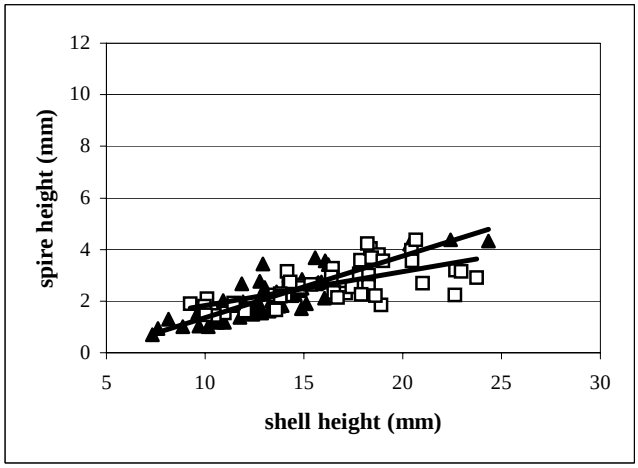


Fig. 11 - Relationship between spire height and shell height (species of *Cochlis and Tanea*, this study); open squares: *fredianii*; solid triangles: *epigloafuniculata* and *koeneni* combined.

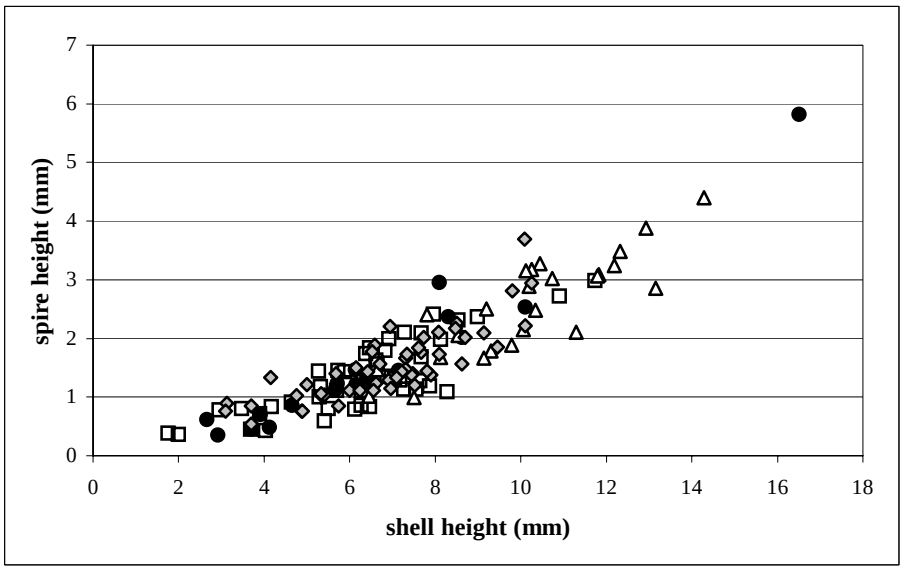


Fig. 12 - Relationship between spire height and shell height (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 10.

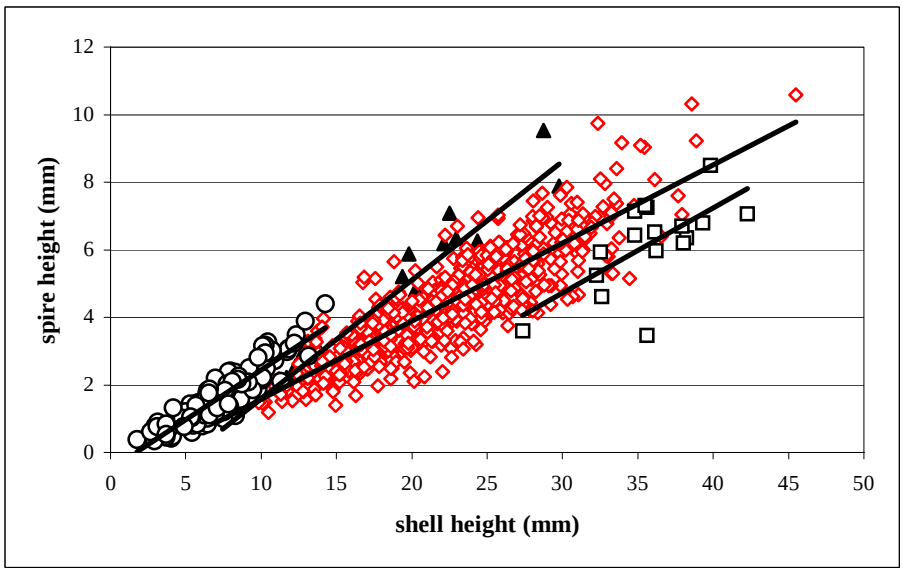


Fig. 13 - Relationship between spire height and shell height (data from Pedriali & Robba 2005 and present paper); open squares: *obliquicallosa*; solid triangles: *plicatula*; red open diamonds: *raropunctata* group *obliquicallosa* excluded; open circles: *Tectonatica* and *Cryptonatica species combined.*

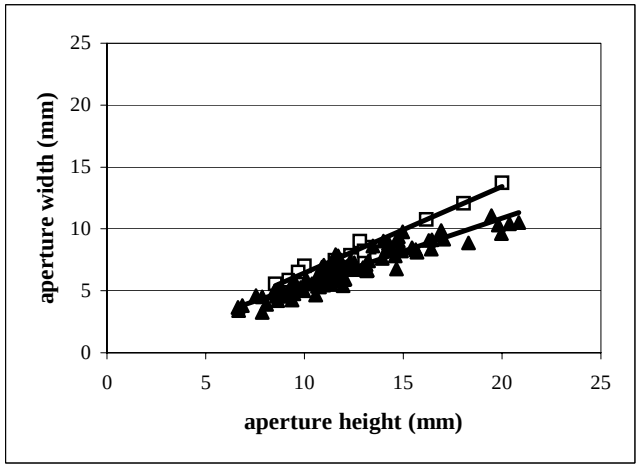


Fig. 14 - Relationships between aperture width and aperture height (species of *Cochlis* and *Tanea*, this study); solid triangles: *epigloafuniculata* and *fredianii* combined; open squares: *koeneni*.

between 1) aperture width and aperture height, 2) aperture height and height of the shell, 3) aperture width and maximum diameter, and 4) the values of the inner lip slope. The parietal callus was another apertural feature considered. Below, we examine these same relations and characters.

The plot of aperture width against aperture height for *epigloafuniculata*, *fredianii* and *koeneni* (not illustrated) shows that the scatters of *epigloafuniculata* and *fredianii* are not significantly different from one another. Instead, their combined slope is significantly shallower than that of *koeneni* (Fig. 14). The regression of the latter taxon perfectly fits in with that of the other species examined by Pedriali & Robba (2005, text-figs. 9 A, 9 B), whereas the aperture of the former two species, for a given height, is ordinarily narrower. As regards the other two pairs of characters (scatters not illustrated

	mean	standard deviation	95% confidence interval
Natica			
virguloides	141°	8	125°-157°
Cochlis			
depressofuniculata	128°	7	114°-142°
epigloafuniculata	126°	7	112°-140°
fredianii	121°	10	101°-141°
fulgurata	128°	9	110°-146°
propinqua	125°	7	111°-139°
raropunctata	125°	9	107°-143°
obliquicallosa	134°	10	114°-154°
strictiumbilicata	115°	5	105°-125°
sulcogradata	130°	7	116°-144°
undata	129°	6	117°-141°
plicatula	122°	8	106°-138°
pseudoepiglottina	116°	8	100°-132°
vittata	117°	8	101°-133°
Tanea			
koeneni	120°	5	110°-130°
Tectonatica			
astensis	110°	18	74°-146°
prietoi	113°	6	101°-125°
tectula	113°	7	99°-127°

Tab. 4 - Spire angle of species involved in the statistical analysis (Pedriali & Robba 2005; present paper).

here), no significant difference could be detected between *epigloafuniculata*, *fredianii* and *koeneni* as well as between them and the other naticine taxa dealt with by Pedriali & Robba (2005). From Fig. 15 through 17 (regression lines omitted to preserve clarity) it appears that *Tectonatica* species and *filosa* neither differ from one another, nor they differ from the taxa considered by the above cited authors. The coefficients of correlation calculated for the three considered relations resulted to be high in all species (r = 0.87-0.99).

The inner lip slope (inclination of the inner lip to the shell axis) varies more or less greatly according to species. The 95% confidence intervals (Tab. 5) largely overlap one another and do not allow any reliable separation between the Pliocene naticine taxa (Pedriali & Robba 2005; present study). The parietal callus of the six taxa appears to be hardly usable as distinguishing character. At most, it can be noted that the parietal callus of *astensis* has the anterior lobe small and subrounded or indistinct (Tab. 6).

Umbilical characters. The umbilicus width proved to be significantly correlated with the maximum diameter of the shell in all species (r = 0.67-0.99). When the umbilicus width is regressed against maximum diameter, it appears that *epigloafuniculata*, *fredianii* and *koeneni* can be distinguished from one another. In fact, the graph (Fig. 18) shows that the lines for *epigloafuniculata* and *koeneni* have similar slope, but significantly different elevation, whereas the line for *fredianii*, compared to the other two, has significantly different slope. Thus, for a given diameter of the shell, the umbilicus of *koeneni* is always greater than that of *epigloafuniculata* and, ordinarily, also than that of *fredianii*. Moreover, the amplitude of the umbilical opening increases during growth more faster in the latter taxon than in the former two. Should the graph of Fig. 18 be superimposed to that published by Pedriali & Robba (2005, Fig. 12 A) for this same relation, it will appear that the slopes of the present taxa are significantly shallower and/or less steep than those of the species dealt with by the cited authors. In summary, the umbilicus, compared to the size of the body whorl, is ordinarily smaller in *epigloafuniculata*, *fredianii* and *koeneni* than in the other Pliocene species

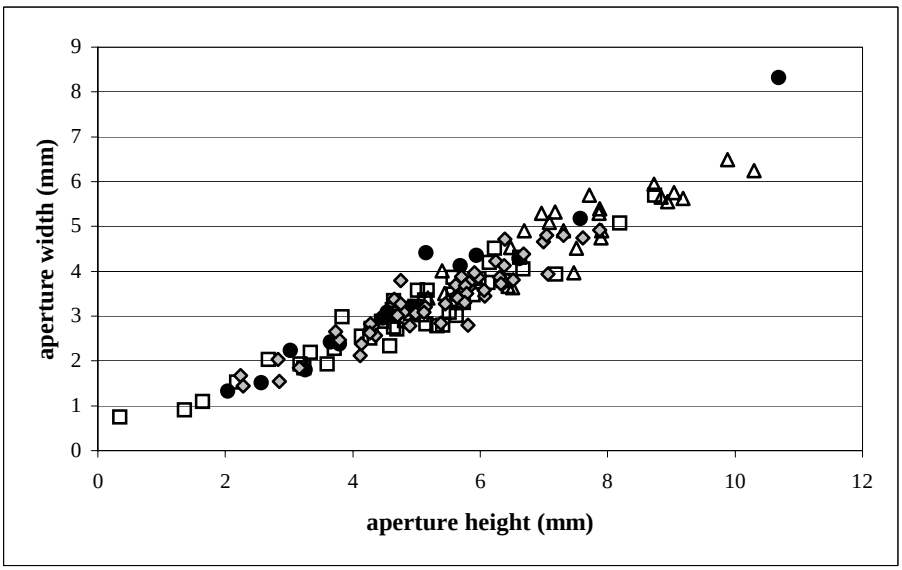


Fig. 15 - Relationships between aperture width and aperture height (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 10.

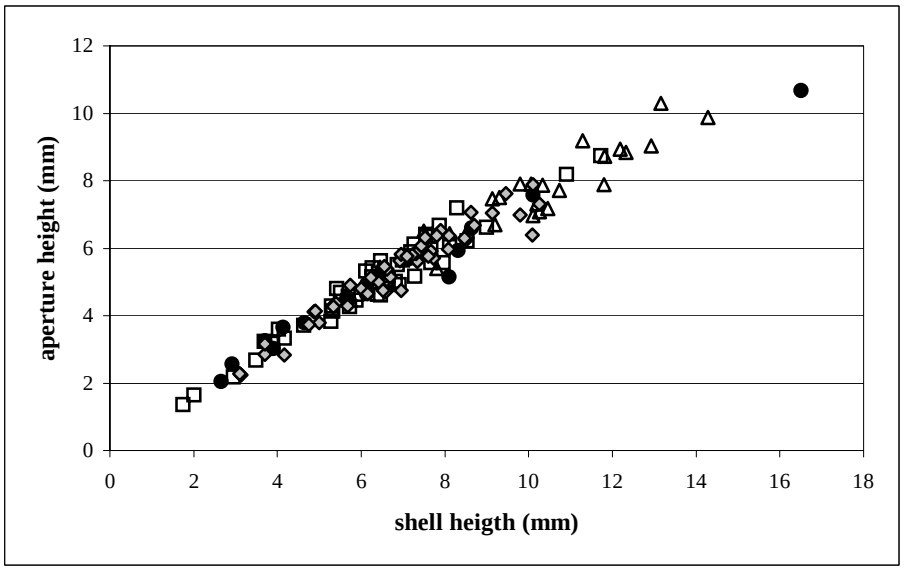


Fig. 16 - Relationship between aperture height and shell height (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 10.

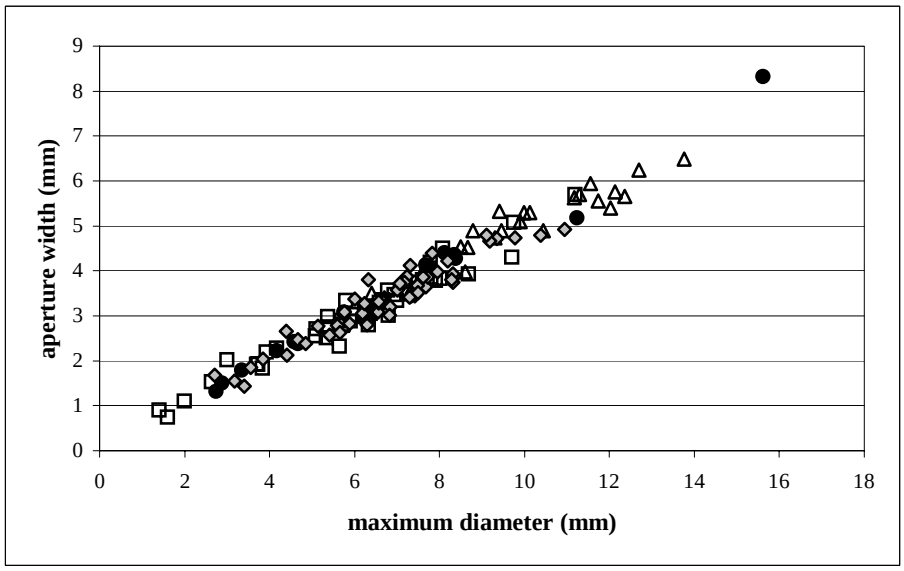


Fig. 17 - Relationship between aperture width and maximum diameter (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 10.

of *Cochlis*, much so in *epigloafuniculata*. The plot of umbilicus width against maximum diameter for *Tectonatica* species and *filosa* (not illustrated here) shows that the scatters of *astensis* and *prietoi* are not significantly different from one another as are those of *filosa* and *tectula*. The combined regression of the former two taxa and that also combined of *filosa* and *tectula* (Fig. 19), having rather similar slopes, differ significantly in elevation; for a given size of the body whorl, the shells of *astensis* and *prietoi* have the umbilicus ordinarily smaller than those of *filosa* and *tectula*.

The correlation between width of the umbilical callus and width of the umbilicus resulted to be significantly high in *epigloafuniculata* (r = 0.88), still significant but lower in *fredianii* (r = 0.31) and *koeneni* (r = 0.61) since in the latter two taxa the width of the umbilical opening is much more variable than the strength of the funicle. As regards the four species in the *Tectonatica/Cryptonatica* group, the correlation is even more significant (r = 0.97-1). The plot of width of the umbilical callus against width of the umbilicus (Fig. 20) shows that *koeneni* can be readily distinguished from the other two species by the significantly greater elevation; for a given umbilical amplitude, the umbilical callus of *koeneni* is significantly wider. As regards *epigloafuniculata* and *fredianii*, the respective regression lines exhibit significantly different slopes; the umbilical callus of the first species widens markedly faster than that of the second as the umbilicus enlarges. Should the scatters of Fig. 20 be superimposed to those presented by Pedriali & Robba (2005, text-fig. 13 A) for the same pair of characters, it will be seen that 1) *koeneni* is not signifi-

	mean	standard deviation	95% confidence interval
Natica			
virguloides	22°	2	18°-26°
Cochlis			
depressofuniculata	30°	6	18°-42°
epigloafuniculata	24°	5	14°-34°
fredianii	22°	5	12°-32°
fulgurata	25°	5	15°-35°
propinqua	30°	6	18°-42°
raropunctata	27°	6	15°-39°
obliquicallosa	25°	6	13°-37°
strictiumbilicata	26°	4	18°-34°
sulcogradata	26°	5	16°-36°
undata	25°	7	11°-39°
plicatula	28°	7	14°-42°
pseudoepiglottina	33°	6	21°-45°
vittata	30°	7	16°-44°
Tanea			
koeneni	18°	4	10°-26°
Tectonatica			
astensis	25°	5	15°-35°
prietoi	22°	3	16°-28°
tectula	24°	7	10°-38°

Tab. 5 - Slope of inner lip of species involved in the statistical analysis (Pedriali & Robba 2005; present paper).

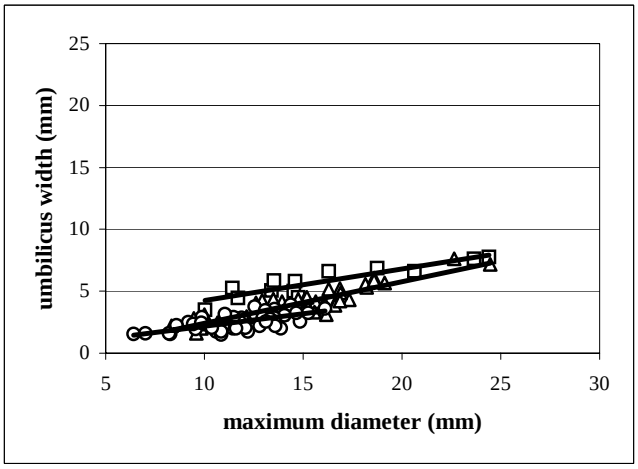


Fig. 18 - Relationships between umbilicus width and maximum diameter (species of *Cochlis* and *Tanea*, this study); open circles: *epigloafuniculata*; open triangles: *fredianii*; open squares: *koeneni*.

cantly different from *Cochlis strictiumbilicata* (Sacco, 1891), 2) the line for *epigloafuniculata* basically conforms to that of *Cochlis plicatula* (Bronn, 1831), and 3) *fredianii* differs from all the other taxa by its markedly less steep slope. The points representing the shells of *astensis*, *filosa*, *prietoi* and *tectula* form elongate scatters showing a close similarity between *astensis* and *prietoi* as well as between *filosa* and *tectula* (Fig. 21). The former species pair tends to have the umbilical callus slightly smaller than that of *filosa* and *tectula*, this

Natica	
virguloides	very thick, overlapping the basal fasciole; anterior lobe well developed, tongue-shaped, obscuring the adapical part of the umbilicus.
Cochlis	
depressofuniculata	moderately thick to thick, subquadrangular, ending some distance from the basal fasciole; anterior lobe indistinct.
epigloafuniculata	thick, subquadrangular, reaching the basal fasciole; anterior lobe absent.
fredianii	moderately thin, slightly narrowing abapically, ending near the basal fasciole but not touching it; anterior lobe indistinct.
fulgurata	thick, short and broad, ending some distance from the basal fasciole; anterior lobe indistinct.
obliquicallosa	thick, slightly narrowing abapically, ending some distance from the basal fasciole; anterior lobe indistinct.
plicatula	quadrangular, rather wide and thin, nearly reaching the basal fasciole; anterior lobe indistinct.
propinqua	rather thick, subquadrangular, never reaching the basal fasciole; anterior lobe indistinct.
pseudoepiglottina	moderately thick, narrowing abapically, ending close to but not in touch with the basal fasciole; anterior lobe indistinct.
raropunctata	moderately thick, slightly narrowing abapically, ending near the basal fasciole but not touching it; anterior lobe very small to indistinct.
strictiumbilicata	thick, narrowing abapically, ending close to but not reaching the basal fasciole; anterior lobe indistinct.
sulcogradata	rather thin and short, ending some distance from the basal fasciole; anterior lobe indistinct.
undata	rather thick, subquadrangular, ending some distance from the basal fasciole; anterior lobe indistinct.
vittata	thin to moderately thick, ending some distance from the basal fasciole; anterior lobe small, pointed.
Tanea	
koeneni	quadrangular, rather wide and thick, ending some distance from the basal fasciole; anterior lobe absent.
Tectonatica	
astensis	quadrangular, rather wide and thick, ending at the level of the basal fasciole; anterior lobe small, subrounded, or indistinct.
prietoi	subrectangular, moderately wide and rather thin, ending at the level of the basal fasciole; anterior lobe absent.
tectula	subquadrate, rather thick; anterior lobe absent.

Tab. 6 - Features of parietal callus of the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper).

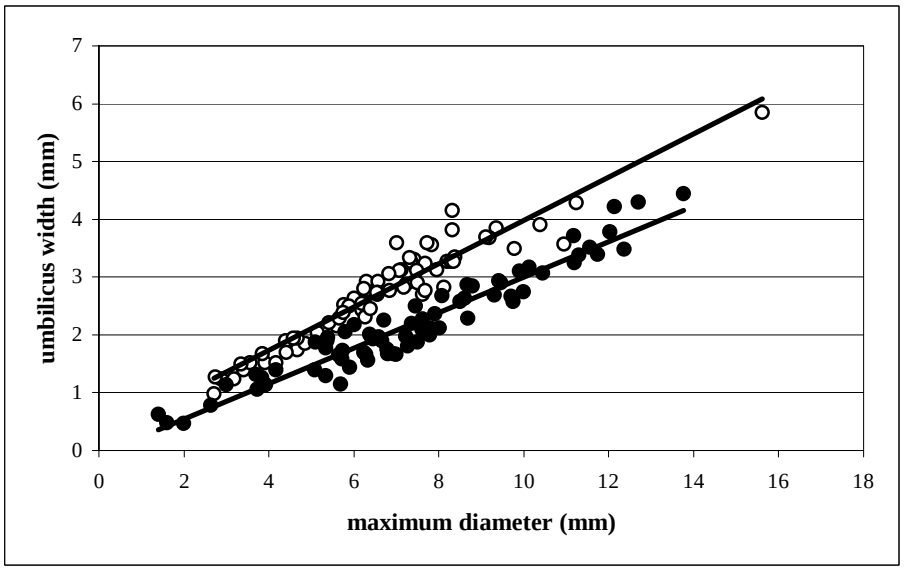


Fig. 19 - Relationships between umbilicus width and maximum diameter (species of *Tectonatica* and *Cryptonatica*); open circles: *filosa* and *tectula combined; solid circles: astensis* and *prietoi* combined.

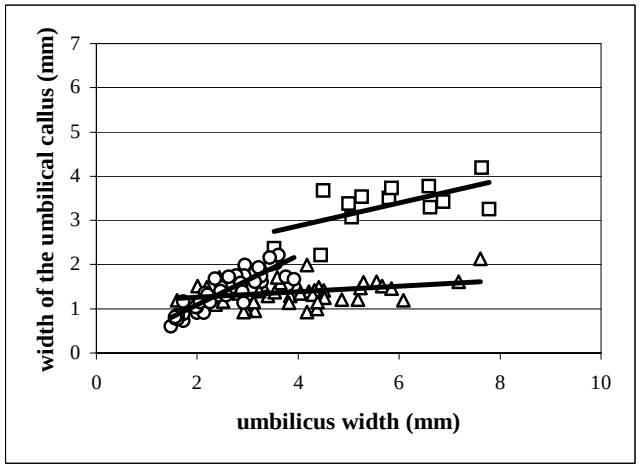


Fig. 20 - Relationship between the width of the umbilical callus and the umbilicus width (species of *Cochlis* and *Tanea*, this study); symbols as in Fig. 18.

becoming more manifest in later growth stages. It is worthy to note that in the latter two taxa, being the umbilicus completely filled by the callus or so, the measurements of the two considered characters are basically coincident. Because of the larger umbilical callus, the regression lines for the species in the *Tectonatica/Cryptonatica* group are markedly steeper than those for all the other naticine taxa and readily distinguish the former taxa from the latter ones (of *Cochlis* and *Tanea*).

The correlation between width of the abapical sulcus and width of the adapical sulcus proved to be significant only in *fredianii* (r = 0.63). The regression for *fredianii* (scatter not illustrated here) has the same slope of the combined regression (Pedriali & Robba 2005, text-fig. 14 A) for the *Cochlis* species *propinqua*

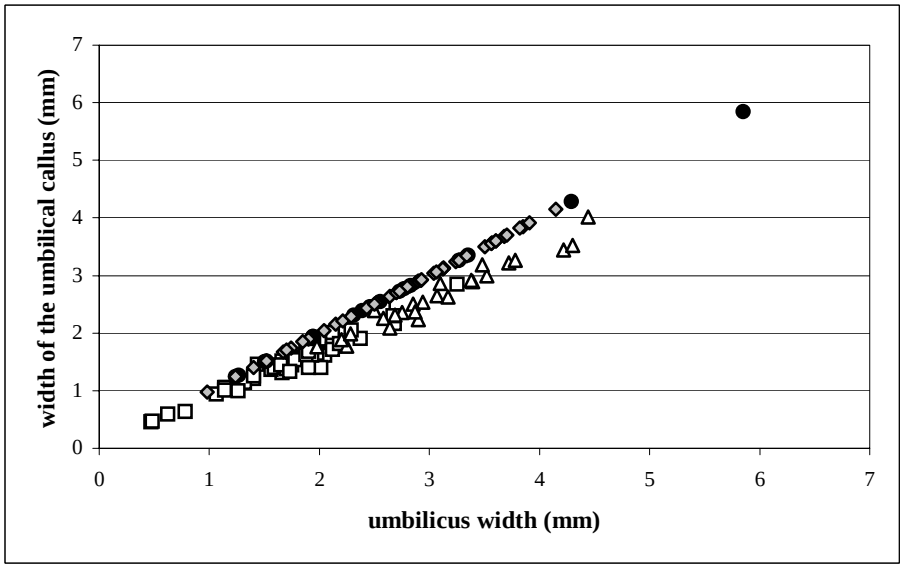


Fig. 21 - Relationship between the width of the umbilical callus and the umbilicus width (species of *Tectonatica* and *Cryptonatica*); symbols as in Fig. 10.

	basal fasciole
Natica	
virguloides	poorly differentiated, marked by the bending of the growth lines
Cochlis	
depressofuniculata	wide, markedly depressed, defined abaxially by the sudden deviation of growth lines
epigloafuniculata	moderately wide, markedly depressed, defined abaxially by the sudden deviation of growth lines.
fredianii	wide, edged abaxially by a low, rounded step.
fulgurata	moderately wide, bluntly rounded, defined abaxially by a low, obtuse angulation
obliquicallosa	wide, sharply edged abaxially by a low step
plicatula	nearly indistinct
propinqua	moderately wide, bounded abaxially by a rounded step
pseudoepiglottina	blunt and rather broad, defined abaxially by a very low step, occasionally only by the sudden deviation of the growth lines
raropunctata	wide, sharply edged abaxially by a low step
strictiumbilicata	moderately wide, not prominent at all, defined abaxially by the sudden bending of the growth lines
sulcogradata	wide and blunt, defined abaxially by the deviation of the growth lines or by a spiral, incised line
undata	wide, triflingly prominent or not prominent at all, defined abaxially by the sudden deviation of the growth lines or by an incised spiral line
vittata	poorly differentiated, defined abaxially by the bending of the growth lines
Tanea	
koeneni	nearly indistinct.
Tectonatica	
astensis	nearly indistinct.
prietoi	nearly indistinct.
tectula	indistinct.

Tab. 7 - Features of basal fasciole of the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper).

(Pecchioli, 1864), *raropunctata* (Sasso, 1827) and *undata* (Sasso, 1827), but its elevation is significantly smaller; for a given breadth of the adapical sulcus, the abapical sulcus is ordinarily narrower in *fredianii* than in the other three taxa. This relationship was not considered for the *Tectonatica*/*Cryptonatica* group since the adapical sulcus of these taxa is not discernible.

Basal fasciole. The basal fasciole was defined by Pedriali & Robba (2005). As regards the six taxa dealt with herein, this shell feature is bounded abaxially by a rounded step in *fredianii*, by the sudden deviation of the growth lines in *epigloafuniculata*, and it is indistinct or nearly so in *koeneni* and the three *Tectonatica* species (Tab. 7).

Outer surface. The bulk of considered taxa have a smooth outer surface bearing only growth lines. A remarkable exception is represented by *koeneni*, which is sculptured with broad, low, axially elongate wrinkles. A faint spiral microstriation was noted on the body whorl of *epigloafuniculata*, *fredianii* and *prietoi*.

Several shells were recovered that still retain the background color and color pattern. This feature of the shell surface is defined for each taxon in Tab. 8, which incorporates also the species dealt with by Pedriali & Robba (2005) included for comparison. From Tab. 8, it will be seen that *epigloafuniculata* and the three *Tectonatica* species have distinctive color patterns, whereas *fredianii* and *koeneni* share their background color and/or color pattern with other naticine taxa.

Operculum. Tab. 9 summarizes and compares the opercular features of all the naticine taxa surely present in the Pliocene deposits of Italy (Pedriali & Robba 2005; present study). From Tab. 9, it will be seen that the opercula of the two species of *Cochlis* (*epigloafuniculata* and *fredianii*) belong to group 1 as defined by Pedriali & Robba (2005, p. 130) in that their outer surface is sculptured with 2 marginal grooves alternating with 2 ridges. The operculum of *epigloafuniculata* resembles only that of *Cochlis depressofuniculata* (Sacco, 1891) in having the outer groove and ridges on a distinctly elevated shelf, but is readily distinguished by the different configuration and strength of grooves and inner ridge (cf. Tab. 9). The operculum of *fredianii* is featured primarily by its sloping inward marginal area; the weak inner groove and ridge constitute additional diagnostic characters. As regards *koeneni*, its opercular sculpture peculiar to the genus *Tanea* Marwick, 1931 (see discussion below) unambiguously distinguishes it from all the other Pliocene Naticinae. Ultimately, the lot of *Tectonatica* species is characterized by the operculum with 1 groove bounding a more or less wide, flat peripheral band. Tab. 9 shows that the three species can be separated from one another on the basis of the features of the central callus. Moreover, the operculum of *prietoi* is readily distinguished in that has the peripheral band bearing 2-3

	background	color pattern
Natica		
virguloides	not observable	**14. *reddish brown dots and 2 spiral rows of large, approximated, irregular spots***
Cochlis		
depressofuniculata	light brown	reddish pattern which may consist of: **1.** uneven, irregularly arranged spots **2. *spirally elongated oval spots*** **3.** triangular spots and/or chevron marks which may fuse to form collabral stripes
epigloafuniculata	light brown	reddish pattern of: **15. *uneven, subquadrangular spots, irregularly arranged into spiral rows***
fredianii	light brown	reddish pattern of: **10.** moderately large, even spots irregularly arranged into collabral rows
fulgurata	pale yellowish brown	reddish pattern which may consist of: **4.** usually crowded, small and even dots often arranged in collabral rows **5. *axial zigzag lines or stripes*** **6. *uneven, variously sized dots and spots arranged in irregular collabral rows*** **7. *spots replaced by chevron markings during growth***
plicatula	***light gray***	***reddish brown pattern of 4 spiral rows of squarish or chevron spots***
propinqua	light brown	reddish pattern of: **8.** dense, undulating, collabral lines or stripes; spots may replace lines in later growth stages (rare occurrence)
pseudoepiglottina	• ***uniform pale brown to pinkish brown without any color pattern*** • pale reddish brown	red pattern which may consist of: **4.** small and even dots roughly arranged in collabral rows **9. *crowded, uneven and irregularly arranged small dots which may fuse adapically to form subsutural chevron markings*** **1.** uneven, variously sized and irregularly arranged spots
raropunctata	brown to light brown	reddish brown pattern which may consist of: **4.** usually crowded, small and even dots often arranged in collabral rows **10.** large, even spots irregularly arranged in collabral rows **1.** uneven, irregularly arranged, large spots **11.** spirally elongated spots **3.** spots and chevron marks occasionally fused to form collabral stripes **12.** irregular spiral broken lines
obliquicallosa	pale brown	**4.** usually crowded, small and even dots often arranged in collabral rows **1.** uneven, irregularly arranged spots **11.** spirally elongated spots **12.** irregular spiral broken lines
strictiumbilicata	pale brown	reddish pattern of: **1.** uneven, irregularly arranged spots
sulcogradata	light brown	reddish brown pattern which may consist of: **4.** usually crowded, small and even dots often arranged in collabral rows **10.** large, even spots irregularly arranged in collabral rows **11.** spirally elongated spots
undata	pale brown	reddish pattern which may consist of: **8.** gently undulating collabral lines occasionally interrupted or partially replaced by variously shaped spots **13. *axially elongated, oval spots arranged in collabral rows***
vittata	***pinkish white***	**16. *reddish brown irregular reticulated pattern of interconnected polygons and 2-3 spiral rows of brown spots; a subsutural dark band is also present***
Tanea		
koeneni	uniform pale brown	apparently without any color pattern
Tectonatica		
astensis	pale brown; protoconch light grey	**17. *dark brown subsutural band***
prietoi	***mottled pale brown***	**18. *alternating brown and whitish spots forming 3 weak spiral rows***
tectula	pale brown	**19. *reddish brown, undulating collabral lines associated with a dark brown subsutural band***

Tab. 8 - Background color and color patterns of the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper).

longitudinal furrows; that of *tectula* by the very fine to faint inner groove.

Concluding remarks on the characters of the Pliocene Naticinae

This chapter records all the skeletal characters dealt with in the previous one in order to point out whether and when they are significant in species recognition, with reference to the eighteen taxa of the Naticinae obtained from the investigated Pliocene deposits (Pedriali & Robba 2005; present study). For convenience of the reader, we recall that the taxa involved in this analysis are: *Natica virguloides* Sacco, 1890, *Cochlis depressofuniculata* (Sacco, 1891), *C. epigloafuniculata* (Sacco, 1890), *C. fredianii* sp. n., *C. fulgurata* (Meneghinii in Pecchioli, 1864), *C. plicatula* (Bronn, 1831), *C. propinqua* (Pecchioli, 1864), *C. pseudoepiglottina* (Sacco, 1890), *C. raropunctata raropunctata* (Sasso, 1827), *C. raropunctata obliquicallosa* Pedriali & Robba, 2005, *C. strictiumbilicata* (Sacco, 1891), *C. sulcogradata* Pedriali & Robba, 2005, *C. undata* (Sasso, 1827), *C. vittata* (Gmelin, 1791), *Tanea dillwyni koeneni* (Sacco, 1891),

Tectonatica astensis (Sacco, 1890), *T. prietoi* (Hidalgo, 1873) and *T. tectula* (Sacco, 1890).

1. *Protoconch*. From Tab. 10 it will be seen that the three measurable characters of the larval shell combined readily distinguish *epigloafuniculata*, *fredianii*, *fulgurata*, *pseudoepiglottina*, *undata*, *vittata*, *koeneni* and *prietoi* from one another and from all the other naticine taxa considered. Concerning these latter, the protoconch appears not to be species-diagnostic since it does not differ significantly from that of one up to four of the other taxa. The present study confirms the conclusion of Pedriali & Robba (2005), i.e. that only a moderate number of species can be characterized by means of respective protoconch measurements and that identical larval shells do occur in species belonging to different genera (in the present case *Natica*, *Cochlis* and *Tectonatica*). These findings refer to the Naticinae; at the present state of the research, we cannot state whether the conclusion is to be extended to the whole Naticidae.

2. *Shell shape*. The statistical analyses have shown that the globose shells of the considered Pliocene taxa have quite similar shape and that no species recognition is possible on the basis of this character (cf. text-figs. 7 A and 7 B of Pedriali & Robba 2005 along with Fig. 10 of present paper). This result contradicts the statements of the authors, in particular of Marincovich (1977) and Majima (1989), who have accorded basic importance to the shell shape. The height of the spire is rather variable within species. The relation between spire height and shell height (cf. text-figs. 8A, 8 B of Pedriali & Robba 2005 and Fig. 13 of present paper) usually did not provide any clear cut between species. The height of the spire appears to be species-diagnostic only in the case of *obliquicallosa* which is definitely low-spired. The spire angle proved to be of no relevance. Ultimately, the suture, ordinarily adpressed, is more or less deeply channeled only in *fulgurata* and serves to characterize this species. In summary, the shell shape and related features appear to be of low significance, being species-diagnostic in very few instances.

3. *Aperture*. The proportions of the D-shaped aperture resulted to be meaningless as are the relations of aperture height and aperture width respectively with shell height and maximum diameter. The inner lip slope varies much in all species and the respective confidence intervals (Tab. 5) overlap to one another preventing any diagnostic use. The parietal callus (Tab. 6) appears to have no relevance in terms of shape and thickness. The anterior lobe of the parietal callus is ordinarily indistinct or clearly absent. A remarkable exception concerns *virguloides* in which the anterior lobe is well developed and extends to cover the adapical part of the umbilicus. This is a genus level character (of *Natica*) that readily distinguishes *virguloides* from the other Pliocene Naticinae. The anterior lobe is small and pointed in *vittata* and, when distinct, small and subrounded in *astensis*. It can be concluded that the anterior lobe of the parietal callus is the unique apertural feature bearing diagnostic significance, at least occasionally.

4. *Umbilical characters*. The amplitude of the umbilical opening, related to the size of the body whorl, usually serves to distinguish pairs or larger groups of species (Pedriali & Robba 2005; present study). The greatest values of the umbilicus width were noted to occur in *sulcogradata*, whereas the smallest ones pertain to *epigloafuniculata* and the two taxa can be readily distinguished from one another on this basis.

The funicle, absent in *virguloides* (a feature of the genus *Natica*), appears to be rather variable in terms of breadth and prominence, both between species and within a species. Only *fulgurata* can be distinguished by its thin to medium funicle having an angular top. The strength of the umbilical callus (strictly related to that of the funicle) compared to the amplitude of the umbilicus ordinarily permits to distinguish species pairs or groups of taxa (see previous chapter). The outline of the umbilical callus showed to be of slight diagnostic relevance; basically, it serves to separate species in which the outline is reverse S-shaped (e.g., *epigloafuniculata*, *astensis* and *prietoi*) from the others having the umbilical callus with more or less prominently arched outline. Exception are *obliquicallosa* and *undata*; the former can be readily distinguished by the outline of the umbilical callus obliquely extended to merge into the parietal callus, the latter by the large to very large umbilical callus having a prominently arched outline. Finally, the position of the umbilical callus (which strongly influences the relation between width of the abapical sulcus and width of the adapical sulcus) resulted to be unrelevant in species recognition (Pedriali & Robba 2005; present paper).

Once again, our findings do not support the extensive use of the umbilical features in recognizing species made by most workers. The study of the Pliocene Naticinae, based primarily on statistical analyses (Pedriali & Robba 2005; present paper), demonstrates that the umbilical characters can be used diagnostically for a quite limited number of species.

5. *Basal fasciole*. This character is never species-diagnostic. As can be seen from Tab. 7, three main aspects occur in the naticine taxa dealt with, each of them shared by five or more species.

	central callus	marginal outer sculpture	outer groove	middle groove	inner groove	outer ridge	middle ridge	inner ridge
Natica	operculum with 1 to 3 marginal ridges							
virguloides	short, nearly perpendicular to the inner margin , ***bounded adapically by a step***	2 grooves, 2 ridges	broad and deep, with ***gently concave bottom*** and subvertical sides		similar to the outer one, deeper	rather sharp		***robust***, with flatly convex top and ***vertical sides***
Cochlis	operculum with 2 to 3 marginal ridges							
plicatula	bent toward the inner margin	***2 ridges separated by a groove***		rather deep, asymmetric in cross section		robust and rather sharp, sloping inward		strong, flat-topped, vertical or sloping inward
fulgurata	elongate	2 grooves, 2 ridges	***broad and shallow, regularly arched in cross section***		***attenuated, markedly narrower***	sharp		***rather strong, flat-topped***
strictiumbilicata	elongate, prominent	2 grooves, 2 ridges	***deep, with flat bottom and vertical, concave sides***		***of equal breadth, deeper, with vertical outer side and inward sloping inner side***	rather thin, moderately sharp		***massive, with bluntly rounded top and slightly concave sides***
sulcogradata	elongate	2 grooves, 2 ridges	wide, arched in cross section, with dense granules sometimes forming 1-2 secondary thin ridges		equally wide, ***bounded adaxially by an abrupt angulation***	sharp to round-topped		***laminar with toothed edge***
undata	***broad***	2 grooves, 2 ridges	***wide and shallow, arched in cross section***		***similar to the outer one***	***sharp, subvertical***		***similar to the outer one***
raropunctata	elongate, prominent	2 grooves, 2 ridges; marginal area ***horizontal***	***rather wide, moderately deep, sometimes obsolescent, may bear longitudianl rows of granules***		***usually narrower and less excavated, sometimes attenuated or obsolete***	sharp to round-topped		usually well developed, thin to thick, with sharp to flat top, seldom obsolete
obliquicallosa	operculum indistinguishable from that of *raropunctata*							
fredianii	rather short	2 grooves, 2 ridges; marginal area ***sloping inward***	wide and shallow		***a faint depression asymmetrical in cross section***	sharp and moderately prominent		***poorly developed***
propinqua	broad	2 grooves, 2 ridges; marginal area ***bearing outer groove and ridge sloping outward***	moderately excavated, angular in cross section		narrower and shallower, attenuated to obsolete in larger specimens	sharp		sharply or roundly edged, reclinate toward the inner groove

depressofuniculata	elongate	2 grooves, 2 ridges; ***outer groove and ridges on distinctly elevated shelf***	***wide and shallow***, sloping adaxially, bearing longitudinal rows of granules		***of variable breadth, exceedingly shallow to obsolescent***	thin and moderately prominent		***identical to the outer one***, bent toward the inner furrow
epigloafuniculata	elongate	2 grooves, 2 ridges; ***outer groove and ridges on distinctly elevated shelf***	***narrow and deep***, bearing oblique rows of granules		***very wide and rather deep***	thin and prominent		***thick, flat-topped***, bent toward the inner furrow
pseudoepiglottina	***bent toward inner margin***	***3 grooves, 3 ridges; ridges, median and outer grooves on elevated, sloping inward shelf***	rather narrow and shallow	similar to the outer one	wider and deeper, with subvertical outer side	blunt and low	***sharp, thinner, occasionally thread-like***	similar to the outer one
vittata	***short, nearly oval***	***3 grooves, 3 ridges; ridges, median and outer grooves on elevated, sloping inward shelf***	narrow, well incised, attenuated during growth	similar to the outer one	wider, moderately excavated, with outer side subvertical or sloping outward	thin, flat-topped	***wider, flat topped***	similar to the outer one
Tanea	operculum with 1 groove bounding a broad, more or less swollen marginal area bearing a median groove							
koeneni	arched toward the inner margin	***1 groove, 1 ridge***			moderately narrow, deep, with sloping outer side and vertical, step-like inner one	***very robust, swollen, with a deep and narrow median groove***		
Tectonatica	operculum with 1 groove bounding a more or less wide peripheral band							
astensis	***broad and short, parallel to the abaxial margin***	1 groove bounding a wide peripheral band			***narrow to moderately wide, more or less deep***			
prietoi	***subtriangular, oblique***	1 groove bounding a wide, flat ***peripheral band bearing 2-3 longitudinal furrows***			more or less narrow, shallow to moderately deep			
tectula	***flat, bean-shaped, bounded adaxially by a semicircular, flat-topped ridge***	1 groove bounding a rather wide peripheral band			***very fine to faint***			

Tab. 9 - Opercular features of the naticine taxa found to occur in the Pliocene (Pedriali & Robba 2005; present paper).

	number of whorls	diameter	diameter of the initial half whorl
Natica			
1. *virguloides*	7, 9, 15, 16, 17, 18	5, 7, 12, 13, 14, 15, 16, 17, 18	3, 4, 5, 7, 8, 9, 12, 14, 15, 16, 17, 18
Cochlis			
2. *depressofuniculata*	7, 9, 13, 14, 15, 16, 17, 18	3, 7, 11, 12, 13, 15, 16, 17, 18	3, 4, 5, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18
3. *epigloafuniculata*	7, 9, 14, 16, 17, 18	2, 4, 5, 7, 8, 10, 14, 15, 16, 18	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18
4. *fredianii*	7, 9, 13, 14, 15, 16, 17, 18	3, 7, 12, 13, 15, 16, 17, 18	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
5. *f ulgurata*	7, 9, 13, 14, 15, 16, 17, 18	1, 3, 6, 7, 9, 11, 12, 13, 15, 16, 17, 18	1, 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18
6. *obliquicallosa*	7, 9, 13, 14, 15, 16, 17, 18	5, 7, 12, 13, 14, 15, 16, 17, 18	3, 4, 5, 7, 9, 12, 14, 15, 16, 17, 18
7. *plicatula*	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 17	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 15
8. *propinqua*	7, 9, 13, 14, 15, 16, 17, 18	3, 7, 12, 13, 15, 16, 17, 18	1, 2, 3, 4, 5, 7, 9, 13, 14, 15, 16, 17, 18
9. *pseudoepiglottina*	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 16, 18	5, 7, 13, 14, 15, 16, 17, 18	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15
10. *raropunctata*	7, 9, 13, 14, 15, 16, 17, 18	3, 7, 12, 13, 15, 16, 17, 18	3, 4, 5, 7, 9, 12, 14, 15, 16, 17, 18
11. *strictiumbilicata*	7, 9, 13, 14, 15, 16, 17, 18	2, 5, 7, 14, 15, 16, 17, 18	2, 3, 4, 5, 7, 9, 14, 15, 16, 17, 18
12. *sulcogradata*	7, 9, 13, 14, 15, 16, 17, 18	1, 2, 4, 5, 6, 7, 8, 10, 14, 15, 16, 18	1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14, 15, 16, 17, 18
13. *undata*	2, 4, 5, 6, 7, 8, 10, 11, 12, 14, 16, 17, 18	1, 2, 4, 5, 6, 7, 8, 9, 10, 14, 15, 16, 18	3, 4, 5, 7, 8, 9, 12, 14, 15, 16, 17, 18
14. *vittata*	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 16, 18	1, 3, 6, 7, 9, 11, 12, 13, 15, 16, 17, 18	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 17
Tanea			
15. *koeneni*	1, 2, 4, 5, 6, 7, 8, 10, 11, 12, 16, 17, 18	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17	1, 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18
Tectonatica			
16. *astensis*	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 15
17. *prietoi*	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 18	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15
18. *tectula*	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 15

Tab. 10 - Summarized differences in protoconch measurements. Figures refer to species (left of first column) and denote those species which are distinguished from that on the left of each row, on the basis of the considered protoconch measurements (columns 2 through 4). All the studied Pliocene Naticinae (Pedriali & Robba 2005; present paper) are listed.

6. *Outer surface*. Few species have a distinctive sculpture and the diagnostic value of this character is purely occasional. From Tab. 8, summarizing the background color and color patterns observed in the naticine taxa dealt with (Pedriali & Robba 2005; present paper), it will be seen that the color is a significant feature, species-diagnostic in several instances. In fact, *virguloides*, *epigloafuniculata*, *plicatula*, *vittata*, *astensis*, *prietoi* and *tectula* have quite distinctive color patterns that separate them from one another and from the rest of the taxa.

7. *Operculum*. As already pointed out by Pedriali & Robba (2005), this calcified plate appears to be species-specific and stands as the most relevant diagnostic character for the Naticinae; the present study fully confirm that statement (see Tab. 9). When two taxa have identical (or basically similar) opercula, our approach was to consider one of them as a subspecies of the other. Examples in this respect are *obliquicallosa*, which was regarded as a subspecies of *Cochlis raropunctata* (cf. Pedriali & Robba 2005) and *koeneni*, which is considered (present paper) a subspecies of *Tanea dillwyni* (Payraudeau, 1826).

Tab. 11 summarizes the distinguishing features of the eighteen naticine taxa found to occur in the Pliocene. As can be seen from it, should the characters be ranked, the operculum comes first and is the primary element, sufficient to distinguish each species. The protoconch and the color pattern are the second and third relevant attributes that can be used diagnostically for several taxa (respectively 8 and 7), but not always. The other shell features appear to be useful tools in separating species only occasionally, as it occurs with *virguloides*, *fulgurata*, *obliquicallosa*, *plicatula*, *undata*, *vittata*, *koeneni*, *astensis* and *tectula* that can be characterized also on the basis of one to three of these features.

Tab. 11 - Summary of distinguishing characters. Diagnostic characters are indicated by solid circles; additional useful characters are indicated by open circles. All the studied Pliocene Naticinae (Pedriali & Robba 2005; present paper) are listed.

	protoconch (NW, PD, DHW combined)	**spire height**	**suture**	**aperture** (proportions)	**parietal callus** (anterior lobe)	**umbilicus** (width)	**funicle** (presence/absence, all features)	**umbilical callus** (presence/absence, all features)	**sculpture**	**color**	**operculum**
Natica											
virguloides					●		●	●		●	●
Cochlis											
depressofuniculata										○	●
epigloafuniculata	●			○		○				●	●
fredianii	●			○				○			●
fulgurata	●		●				●			○	●
obliquicallosa		●						●			
plicatula									●	●	●
propinqua											●
pseudoepiglottina	●									○	●
raropunctata											●
strictiumbilicata											●
sulcogradata	○					○					●
undata	●							●		○	●
vittata	●	○			●					●	●
Tanea											
koeneni	●								●		
Tectonatica											
astensis		○			●					●	●
prietoi	●	○								●	●
tectula		○						●		●	●

Five species, i.e. *depressofuniculata*, *propinqua*, *raropunctata*, *strictiumbilicata* and *sulcogradata* lack distinctive shell characters and do require operculate specimens in order to be confidently identified. One note is to be made to Tab. 11 where the operculum of *koeneni* is not indicated as diagnostic since it is strikingly similar to that of *dillwyni* (see above); however, the operculum distinguishes *koeneni* from all the other Pliocene naticine species listed in Tab. 11.

Generic classification

This chapter aims to discuss the generic assignment of the species covered in this paper and follows the same approach adopted by Pedriali & Robba (2005), i.e. it considers 1) the generic allocation of the species made by previous authors, 2) the interpretation of the considered genera provided in major accounts published so far, and 3) the type-species of the involved genera in order to define the characters of these latter. In the following, ample reference will be made to Bouchet & Waren (1993) who, in the frame of a revision of Recent northeast Atlantic bathyal and abyssal Mesogastropoda, thoroughly treated the naticids, to some major revisions concerning both modern and Cenozoic naticids (Kilburn 1976; Marinchovich 1977; Majima 1989), and to Kabat (1991) who reviewed the genus level names of the Naticidae.

The six taxa studied herein exhibit quite different sculptural features of the outer surface of the operculum and, on this basis, can be distributed into three lots. Lot 1 includes *epigloafuniculata* and *fredianii* that have the operculum sculptured with 2 marginal grooves alternating with 2 ridges. Lot 2 contains only *koeneni* whose operculum bears 1 marginal groove followed by a broad, swollen marginal area bisected by a median groove. Lot 3 is comprised of *astensis*, *prietoi* and *tectula* that have the operculum with 1 groove bounding a wide marginal area.

Of the species in lot 1, *epigloafuniculata* was proposed by Sacco (1890) as a variety of *millepunctata* Lamarck, 1822, the latter assigned to the pre-Linnean genus *Natica* Adanson, 1757. One year later (1891), Sacco used the subgenus (of *Natica* Adanson) "*Natica* (sensu stricto) vel *Nacca* Risso, 1826". According to Kabat (1991), *Nacca* Risso is junior subjective synonym of the valid genus *Natica* Scopoli, 1777. The unique subsequent quotation of *epiglofuniculata* (Ferrero Mortara et al. 1984) retained the assignment to *Natica* Scopoli. As regards *fredianii*, it is proposed herein as new and, obviously, has no previous records. Taking into account the characters of *Natica* as defined by Pedriali & Robba (2005), the application of this genus to *epigloafuniculata* is untenable since *epigloafuniculata* lacks the anterior lobe of the parietal callus and has a well developed funicle, attributes that do occur in *fredianii* as well. On the basis of these characters and of the opercular features (2 marginal grooves alternating with 2 ridges), both *epigloafuniculata* and *fredianii* appear to fit in with the description of the genus *Cochlis* Röding, 1798 published by Pedriali & Robba (2005). The genus *Cochlis* was thoroughly discussed by the cited authors and does not require further comments.

Lot 2 includes *koeneni* which is regarded herein as a subspecies of the Recent Mediterranean *Natica dillwyni* Payraudeau, 1826 on the basis of the remarkable opercular similarity. After his creation, the first taxon was currently assigned to *Natica*. Rasmussen (1956) attributed it to *Polynices* Montfort, 1810; it is of note that *Polynices* is an error for *Polinices* (cf. Kabat 1991). Payraudeau's species was allocated either in *Natica* or in *Naticarius* Duméril, 1806. Considering that both *koeneni* and *dillwyni* have a calcareous operculum sculp-

tured with 1 marginal groove followed by a broad outer ridge bisected by a median groove, it appears that none of the cited assignments is acceptable. In fact, the species of *Natica* have the operculum with 1-3 marginal ridges, those of *Naticarius* have many ribs to the operculum and the Polinicinae possess a corneous (instead of calcareous) operculum. Thus, *koeneni* and *dillwyni* are in the need of a different (new) generic allocation.

Among the valid genera listed by Kabat (1991), *Tanea* Marwick, 1931 resulted to be the most suitable. The authors put much emphasis on the pointed, unicuspidate rachidian plates as primary distinguishing character for the genus (cf. Kilburn 1976 and Majima 1989). According to the figures published by the latter authors, *Tanea* species exhibit a medium to thick funicle. Concerning the operculum, Kilburn (1976) noted that "as far as can be determined, always bears one to three marginal ridges as in most species of *Natica* s.s.". Majima (1989) stated that *Tanea* has "smooth operculum except for one or two marginal grooves". These quite concise descriptions fail to univocally define the opercular sculpture of *Tanea* and could be misleading.

The type-species of *Tanea* is *Natica zelandica* Quoy & Gaimard, 1832 by original designation. We have examined several specimens of *Natica zelandica* (Pl. 1, fig. 12) and could note that the species is featured by: 1) shell globose, moderately high-spired, 2) anterior lobe of the parietal callus small to indistinct, 3) umbilicus wide, largely filled by the thick funicle, 4) umbilical callus broad and prominent, 5) operculum with 1 narrow groove bounding a broad, flatly convex marginal area bearing a submedian shallow furrow (Pl. 3, fig. 7). Taking into account also the species described and/or figured by Kilburn (1976) and Majima (1989) and surely referable to *Tanea*, the significant characters of the genus can be summarized as follows: 1) spire moderately to greatly elevated, 2) anterior lobe of the parietal callus usually small, sometimes indistinct, 3) funicle moderate to thick (ordinarily thick), 4) operculum as described above; depending on species, a variability does exist as regards the breadth and depth of the inner groove, the swelling of the marginal area and the position of the median groove present over the latter. The radula being unavailable with fossil shells, the operculum stands as the major distinguishing attribute of the genus *Tanea*. We note that the opercular features of both *dillwyni* and *koeneni* perfectly fit in with those of *Tanea* outlined above as do their umbilical characters; accordingly, these taxa are herein assigned to the genus *Tanea*. *Tanea* was hitherto used to allocate several Indo-Pacific species. *Tanea dillwyni* seems to be the unique Mediterranean Recent species of the genus; further investigation could prove that other species are present in the European Cenozoic deposits, but this is beyond the scope of the present study.

Of the three species in lot 3, *astensis* and *prietoi* were originally included in the genus *Natica*. During the last decades, the former was currently regarded to belong to *Tectonatica* Sacco, 1890 whereas the latter was kept under *Natica* up to now. The third species (*tectula*) is the type of *Tectonatica* by monotypy (see also Kabat 1991). *Tectonatica* was erected (as a subgenus of *Natica*) to accommodate small naticids having the umbilicus completely filled or nearly so with a callus (in this respect, Sacco's diagnosis of 1890 reads "..umbilicus callo columellari expanso, semilunato, fere omnino tectus."). *Tectonatica* was later on considered as a full genus. From the discussion below, it will be clear that also *astensis* and *prietoi* are to be assigned to *Tectonatica* because of their opercular characters (see descriptions in the systematic account).

The use of *Tectonatica* made herein raises the problem of the relations between *Tectonatica* and *Cryptonatica* Dall, 1892 since some workers regarded *Cryptonatica* as a junior synonym of *Tectonatica* (Cossmann 1925; Wenz 1941 in 1938-1944; Wrigley 1949 among the others), whereas other authors considered them to be fully distinct genera (Marincovich 1977; Oyama 1985; Golikov & Sirenko 1988; Majima 1989; Bouchet & Waren 1993). According to the latter authors, the umbilicus entirely closed by the umbilical callus is the main distinguishing character of *Cryptonatica* and separates it from *Tectonatica* that has an open or partly open umbilicus. Kabat (1991), in his review of the genus level names of the Naticidae, did not mention any character, but just listed both *Cryptonatica* and *Tectonatica* as valid. In order to make clarity as regards the value of the umbilical attributes, the type-species of both genera are to be referred to. Concerning *Cryptonatica*, we concur with Bouchet & Waren (1993) in considering *Natica clausa* Broderip & Sowerby, 1829 (= *Nerita affinis* Gmelin, 1791) as type species of this genus by subsequent designation (Dall 1909). We have examined several specimens of *Cryptonatica affinis* along with the lectotype, 174 paralectotypes and over 1300 additional specimens of *Tectonatica tectula* (the type of *Tectonatica*) and can state that the umbilicus of both species is usually filled by the umbilical callus; occasionally a semicircular groove (bounding the umbilical callus) or an abapical chink may exist. These findings demonstrate that the umbilical characters hardly provide the ground for separating *Cryptonatica* from *Tectonatica*; in these circumstances, having been introduced two years later, *Cryptonatica* would be a synonym of *Tectonatica*. However, in proposing *Cryptonatica*, Dall (1892) clearly made reference to "..forms with a smooth calcareous operculum..". A review of the relevant literature shows that species either assigned to *Cryptonatica* or to *Tectonatica* can be assembled into two groups on the basis of the opercular features (Tab. 12). The first group,

including *Cryptonatica affinis* (the type of *Cryptonatica*), contains species having a well developed umbilical callus (ordinarily filling the umbilicus) and a smooth operculum. The second, headed by *Tectonatica tectula* (the type of *Tectonatica*), is comprised of species characterized by the umbilicus either completely filled by the umbilical callus or more or less widely open, and by the operculum with a distinct groove bounding a wide, usually smooth marginal area. Thus, the operculum appears to be a persistent character useful in distinguishing *Cryptonatica* from *Tectonatica*. On the basis of this evidence, we think that *Cryptonatica* can be retained to house those species that possess a smooth operculum (as originally stated by Dall 1892). The species having a *Cryptonatica*-like or somewhat more reduced umbilical callus and the operculum with one peripheral groove belong to *Tectonatica*. From the third (lowermost) section of Tab. 12, it can be seen that the generic assignment of some species is uncorrect or doubtful since authors disregarded the operculum and adopted a rather broad or not univocal genus concept of both *Cryptonatica* and *Tectonatica*.

Systematic account

Also in this second paper we follow a traditional (non-cladistic) classification. The suprageneric arrangement is that adopted in major revisions of the Family Naticidae published during the last decades (Kilburn 1976; Marincovich 1977; Majima 1989; Kabat 1991).

The bulk of the studied material is housed in the Museo di Paleontologia dell'Università, Milano, Italy (MPUM in the following) and in the Museo G. Cortesi, Castell'Arquato, Italy (MGC in the following); the rest is kept in the authors' collection as reference material. Abbreviations for other collections/institutions are: MGPT, Bellardi-Sacco collection in Museo di Geologia e Paleontologia dell'Università di Torino, Italy; MNCNM, Hidalgo collection in Museo Nacional de Ciencias Naturales, Madrid; PPMM, Magenes collection, Milano, Italy; NP, authors' collection, Dipartimento di Scienze Geologiche e Geotecnologie, Milano-Bicocca, Italy.

The synonymies ordinarily refer to the Pliocene. The citations, which are verifiable in that enclose adequate description and/or illustration of species, and other quotations referring to material that has been directly examined by the present authors, were included in the synonymies. Other citations, poorly documented or not documented at all, are listed too as uncertain references in order to provide a most complete framework of species.

Symbols for shell dimensions (see also Fig. 2 of Pedriali & Robba 2005) are: DHW, diameter of the first half whorl of the protoconch; PD, diameter of the protoconch; PW, number of protoconch whorls; H, height of the shell; D, maximum diameter; SH, height of the spire; AH, height of the aperture; AW, width of the aperture; UW, width of the umbilicus; WUC, width of the umbilical callus; WAD, width of the adapical sulcus; WAB, width of the abapical sulcus; IS, inner lip slope; SA, spire angle. Unless otherwise stated, for each dimension, ranges in the upper row are 95% confidence intervals, figures in the lower row are average values.

Family Naticidae Forbes, 1838

Subfamily Naticinae Forbes, 1838

Genus *Cochlis* Röding, 1798

Cochlis epigloafuniculata (Sacco, 1890) stat. n., comb. n.

Pl. 1, fig. 1-6; Pl. 2, fig. 14, 21, 22; Pl. 3, fig. 12

1890 *Natica (Natica) millepunctata* var. *epigloafuniculata* Sacco, p. 28.

1891 *Natica (Natica) millepunctata* var. *epigloafuniculata* - Sacco, p. 48, pl. 2, fig. 9.

1891 *Natica (Natica) epiglottina* var. *exfuniculata* Sacco, p. 60, pl. 2, fig. 28.

1984 *Natica millepunctata* var. *epigloafuniculata* – Ferrero Mortara et al., p. 28.

1984 *Natica epiglottina* var. *exfuniculata* - Ferrero Mortara et al., p. 31.

Type material. The lectotype of *Natica (Natica) millepunctata* var. *epigloafuniculata* Sacco (here designated): the shell figured by Sacco (1891, pl. 2, fig. 9) and refigured herein (Pl. 1, fig. 1), MGPT BS.029.01.012 (Colli Astesi); 2 paralectotypes, MGPT BS.029.01.012/01 (Stazzano); 7 paralectotypes, MGPT BS.029.01.012/02 (S. Agata Fossili); 1 paralectotype, MGPT BS.029.01.012/03 (Borzoli); 13 paralectotypes, MGPT BS.029.01.012/04 (Savona); 1 paralectotype, MGPT BS.029.01.012/05 (Monte Capriolo); 2 paralectotypes, MGPT BS.029.01.012/06 (Clavesana).

Other type material. The lectotype of *Natica (Natica) epiglottina* var. *exfuniculata* Sacco (here designated): the shell figured by Sacco (1891, pl. 2, fig. 28) and refigured herein (Pl. 1, fig. 6), MGPT BS.029.01.036 (Savona); 8 paralectotypes, MGPT BS.029.01.036/01 (Savona).

Material erroneously referred to as *Natica epiglottina* var. *pseudoepiglottina* Sismonda, 1847 in MGPT. Benevagienna: 1 spm. (MGPT BS.029.01.029/10) figured herein (Pl. 1, fig. 2); Savona Fornaci: 1 spm. (MGPT BS.029.01.029/03).

Material erroneously referred to as *Natica epiglottina* var. *millepunctatoides* Sacco, 1890 in MGPT. Rio Torsero: 1 spm. (MGPT BS.029.01.038/03).

Other material examined. Bussana Vecchia: 11 spms. (private collections); Orciano Pisano: 48 spms. (MPUM 9477), 4 spms. (MPUM 9478-9481), 3 spms. (NP 9564), 2 spms. (MGC 575), 5 spms. (private collection).

Characters

Protoconch: small, depressed turbiniform, of 1.5-1.75 slightly convex, smooth whorls, tip small.

Shell: globose, moderately depressed, solid, hardly exceeding 15 mm in height.

Spire: low-conical, rather depressed, whorls moderately convex.

Suture: fine, incised, adpressed.

Body whorl: inflated, somewhat depressed, moderately produced and expanded toward the aperture, with distinct subsutural shelf.

Aperture: D-shaped, height averaging 2 times the width.

Parietal callus: thick, subquadrangular, reaching the basal fasciole; anterior lobe absent.

Umbilicus: rather small.

Funicle: a broad, very low cord separated from the basal fasciole by a wide and shallow depression.

Umbilical callus: markedly depressed and thick, located at the middle of the columellar lip, with slightly sinuous outline obliquely extended adapically to merge into the parietal callus.

Basal fasciole: moderately wide, markedly depressed, defined abaxially by the sudden deviation of growth lines.

Surface: with dense and fine, gently prosocline growth lines, slightly stronger on subsutural shelf and basal fasciole; a faint spiral striation is noted on the body whorl.

Color: background light-brown with reddish pattern of uneven, subquadrangular spots, irregularly arranged into spiral rows.

Operculum:

species	reference	umbilical callus	operculum	remarks
Natica (Cryptonatica) clausa Broderip & Sowerby, 1829	Marincovich, 1977	large, semicircular, completely filling the umbilicus or separated from the umbilical wall by a narrow groove	smooth	**type-species of *Cryptonatica***
Cryptonatica clausa (Broderip & Sowerby, 1829)	Majima, 1989			
Cryptonatica affinis (Gmelin, 1791) = *Natica clausa* Broderip & Sowerby, 1829	Bouchet & Waren, 1993			
Cryptonatica clausa (Broderip & Sowerby, 1829)	Saito in Okutani, 2000			
Natica (Tectonatica) bougei Sowerby, 1908	Cernohorsky, 1972	large, semicircular, completely filling the umbilicus	smooth	
Tectonatica filosa (Philippi, 1845)	Bouchet & Waren, 1993	large, semicircular, separated from the umbilical wall by a narrow groove, slightly wider abapically	smooth	
Cryptonatica ichishiana (Shibata, 1970)	Majima, 1989	large, semicircular, completely filling the umbilicus	smooth	
Natica (Tectonatica) janthostoma Deshayes, 1839	Marincovich, 1977	large, semicircular, separated from the umbilical wall by a groove of variable breadth, wider adapically	smooth or with weak marginal striations	
Cryptonatica janthostoma (Deshayes, 1839)	Majima, 1989			
Cryptonatica janthostoma (Deshayes, 1839)	Saito in Okutani, 2000			
Natica (Cryptonatica) pusilla Say, 1822	Abbott, 1954	large, semicircular, separated from the umbilical wall by a narrow groove	smooth	
Tectonatica pusilla Say, 1822	Warmke & Abbott, 1961			
Cryptonatica ranzii (Kuroda, 1961)	Saito in Okutani, 2000	large, semicircular, completely filling the umbilicus	smooth	
Natica (Tectonatica) robillardi Sowerby, 1893	Cernohorsky, 1972	large, semicircular, completely filling the umbilicus	smooth	
Natica (Tectonatica) tecta Anton, 1839	Kilburn, 1976	large, semicircular, completely filling the umbilicus	smooth	
Cryptonatica wakkanaiensis Habe & Ito, 1984	Saito in Okutani, 2000	large, semicircular, completely filling the umbilicus	smooth	
Cryptonatica zenryumaruae Habe & Ito, 1976	Saito in Okutani, 2000	large, semicircular, completely filling the umbilicus	smooth	
Tectonatica tectula (Sacco, 1891)	Pavia, 1980; our specimens	large, semicircular, separated from the umbilical wall by a narrow to moderate groove in the mid-abapical part	1 fine, shallow groove bounding the smooth marginal area	**type-species of *Tectonatica***
Tectonatica astensis (Sacco, 1891)	Pavia, 1980; our specimens	rather large, subtriangular, separated from the umbilical wall by a moderate to wide groove in the mid-abapical part	1 fine, shallow groove bounding the smooth marginal area	
Cryptonatica figurata (Sowerby, 1914)	Saito in Okutani, 2000	large, semicircular, separated from the umbilical wall by a narrow groove	1 fine, shallow groove bounding the smooth marginal area	
Cryptonatica hirasei (Pilsbry, 1905)	Saito in Okutani, 2000	large, semicircular, completely filling the umbilicus	1 fine, shallow groove bounding the smooth marginal area	
Cryptonatica operculata (Jeffreys, 1885)	Bouchet & Waren, 1993	large, semicircular, separated from the umbilical wall by a narrow groove	1 fine, shallow groove bounding the smooth marginal area	

species	reference	umbilical callus	operculum	remarks
Tectonatica prietoi (Hidalgo, 1873)	our specimens	moderate to small, separated from the umbilical wall by a wide groove	1 fine, shallow groove bounding the marginal area; marginal area with 2-3 fine grooves	
Tectonatica rizzae (Philippi, 1844)	Bouchet & Waren, 1993	moderate, subtriangular, separated from the umbilical wall by a rather wide groove in the mid-abapical part	1 fine, shallow groove bounding the smooth marginal area	
Cryptonatica adamsiana (Dunker, 1859)	Majima, 1989	small to large, nearly semicircular, separated from the umbilical wall by a moderate to broad groove	with 2 well developed marginal grooves	neither *Cryptonatica* nor *Tectonatica*; according to the fugure of the operculum, probably *Tanea*
Cryptonatica bathybii (Friele, 1879)	Bouchet & Waren, 1993	poorly developed	undescribed	umbilical characters not consistent with neither *Cryptonatica* nor *Tectonatica*
Natica (Tectonatica) janthomostoides (Kuroda & Habe, 1949)	Marincovich, 1977	large, semicircular, usually separated from the umbilical wall by a groove of variable breadth	with 2 well developed marginal grooves	neither *Cryptonatica* nor *Tectonatica*; according to the fugure of the operculum, probably *Tanea*
Cryptonatica andoi (Nomura, 1935) = *Tectonatica Janthomostoides* Kuroda & Habe, 1949	Majima, 1989; Saito in Okutani, 2000			
Natica (Cryptonatica) oregonensis (Conrad, 1865)	Marincovich, 1977	large, semicircular, separated from the umbilical wall by a narrow groove	with 1 low marginal ridge	probably neither *Cryptonatica* nor *Tectonatica*
Natica (Tectonatica) simplex Sowerby, 1897	Kilburn, 1976	large, semicircular, usually separated from the umbilical wall by a narrow groove at least abapically, completely filling the umbilicus in some shells	with numerous, fine marginal threads	figure of the operculum needed

Tab. 12 - Umbilical callus (shape, magnitude) and opercular features of species assigned to *Cryptonatica* or *Tectonatica* by selected authors. Only well readable illustrations and/or precise descriptions were considered.

- rather thin;
- central callus distinct, moderately elongate, tongue-shaped;
- inner margin nearly straight, with blunt granules;
- inner surface flat, nucleus not protruding;
- outer surface slightly concave, with 2 marginal furrows and 2 ribs; outer furrow and ribs on a distinctly elevated, horizontal shelf;
- outer groove rather narrow and moderately deep, bearing granules that tend to form oblique rows;
- inner groove very wide, rather deep, with slightly concave bottom;
- outer ridge thin and prominent, sharp-edged;
- inner ridge thick, slightly bent toward the inner furrow, flat-topped, as wide as one half the inner groove.

Dimensions (mm):

DHW	PD	H	D	SH	AH	AW
0.19-0.23	0.76-0.84	8.33-17.33	7.60-16.04	0.60-3.32	7.26-14.46	3.56-7.92
0.21	0.80	12.83	11.82	1.96	10.86	5.74
UW	WUC	WAD	WAB	IS	SA	
1.27-3.83	0.60-2.20	0.17-1.13	0.06-0.94	14°-34°	112°-140°	
2.55	1.40	0.65	0.50	24°	126°	

Remarks. The present taxon was originally proposed (Sacco 1890) as a variety of *Natica millepunctata* Lamarck, 1822. On the basis of the distinctive opercular features, it appears that 1) it is manifestly unrelated to *millepunctata*, and 2) it is advisable to treat *epigloafuniculata* as a distinct species belonging to the genus *Cochlis* Röding, 1798. Sacco (1891) shortly described and named *Natica epiglottina* var. *exfuniculata* that unambiguously appears to have subspecific rank from its original publication (ICZN 1999, art. 45.6). We have examined Sacco's material in MGPT and were not able to find out any significant difference in respect to *Cochlis epigloafuniculata*. Accordingly, we include *exfuniculata* in the synonymy of the present species. It is of note that the name *epigloafuniculata* bears priority having been validly proposed one year earlier.

Among the Pliocene *Cochlis* species of Italy described so far (Pedriali & Robba 2005; this paper), *Cochlis depressofuniculata* (Sacco 1891) is the only one with which *Cochlis epigloafuniculata* can be compared

on account of a general shell similarity. *Cochlis epigloafuniculata* differs from *Cochlis depressofuniculata* in having: 1) protoconch with significantly greater diameter (26% difference) and smaller diameter of the first half whorl (34% difference); 2) smaller teleoconch size; 3) parietal callus somewhat more elongate; 4) smaller umbilicus; 5) umbilical callus merging into the parietal callus without any notch in between; 6) operculum similarly structured, but with deeper outer groove, much wider inner groove, and markedly thicker inner ridge. The operculum stands as the most relevant character and distinguishes *Cochlis epigloafuniculata* from the other *Cochlis* species.

Stratigraphic occurrence. *C. epigloafuniculata* appears to occur for the first time in the Tortonian of Piedmont. Pliocene records are from Zanclean and/or Early Piacenzian deposits of Piedmont, Liguria and Tuscany.

Cochlis fredianii sp. n.

Pl. 1, figs. 7, 8; Pl. 2, figs. 15, 23

Derivation of name. The species is named after Piero Frediani who provided a wealth of material relevant to this study.

Holotype. Ponte a Elsa: MPUM 9482 (Pl. 1, fig. 7).

Paratypes. Ponte a Elsa: 1 spm., MPUM 9483 (Pl. 1, fig. 8); 1 spm., MPUM 9484 (Pl. 3, fig. 13); 50 spms., MPUM 9485; 32 spms., NP 9565; 2 spms., MGC 576.

Preservation. The material is fairly well preserved.

Type-locality. Ponte a Elsa (see Appendix).

Horizon. Gray sandy to silty clay of Piacenzian age.

Diagnosis. Globose, low-spired and moderately depressed shell with rather wide umbilicus, thin funicle and small umbilical callus separated from the parietal callus by a wide, shallow reverse J-shaped notch; marginal area of the operculum sloping inward, with 2 ridges and 2 grooves.

Characters

Protoconch: small, depressed-turbiniform of 1.25 convex and smooth whorls, tip small.

Shell: globose and stout, moderately depressed, rather thin.

Spire: low-conical, moderately depressed, whorls convex.

Suture: linear, occasionally slightly incised, adpressed.

Body whorl: inflated, somewhat depressed, moderately produced and clearly expanded toward the aperture, with distinct, subhorizontal subsutural shelf.

Aperture: D-shaped, height averaging 1.8 times the width.

Parietal callus: moderately thin, slightly narrowing abapically, ending near the basal fasciole but not touching it; anterior lobe indistinct.

Umbilicus: rather wide.

Funicle: a thin, low cord separated from the basal fasciole by a shallow, usually narrow furrow.

Umbilical callus: small, moderately thick, with flatly arched outline, located nearly at the abapical one-fourth of the columellar lip and separated from the parietal callus by a very shallow, wide, reverse J-shaped notch.

Basal fasciole: wide, edged abaxially by a low, rounded step.

Surface: with dense and fine, gently prosocline growth lines, slightly stronger on subsutural shelf and basal fasciole; an exceedingly faint spiral striation is noted on the body whorl.

Color: background light-brown with reddish pattern, which may consist of moderately large, even spots irregularly arranged into collabral rows.

Operculum:

- rather thin;
- central callus well developed, tongue-shaped, moderately prominent, never reaching half the height of the operculum;
- inner margin straight, with more or less distinct, blunt transverse ridges;
- inner surface nearly flat, nucleus not protruding;
- outer surface slightly concave, with 2 marginal grooves and 2 ridges; marginal area distinctly sloping inward;
- outer groove wide and shallow;
- inner groove a faint asymmetrical depression;
- outer ridge sharp, moderately elevated;
- inner ridge poorly developed.

PLATE 1

Fig. 1 - *Cochlis epigloafuniculata* (Sacco, 1890). Lectotype (here designated). Colli Astesi. MGPT BS.029.01.012; a) apertural side, b) abapertural side.

Fig. 2 - *Cochlis epigloafuniculata* (Sacco, 1890). The shell assigned to *Natica epiglottina* var. *pseudoepiglottina* Sismonda, 1847 in Bellardi-Sacco collection. Benevagienna. MGPT BS.029.01.029/10; apertural side.

Fig. 3 - *Cochlis epigloafuniculata* (Sacco, 1890). Orciano Pisano. MPUM 9478; apertural side.

Fig. 4 - *Cochlis epigloafuniculata* (Sacco, 1890). Orciano Pisano. MPUM 9479; apertural side.

Fig. 5 - *Cochlis epigloafuniculata* (Sacco, 1890). Paralectotype. S. Agata Fossili. MGPT BS.029.01.012/02; apertural side.

Fig. 6 - *Cochlis epigloafuniculata* (Sacco, 1890). Lectotype (here designated) of *Natica (Natica) epiglottina* var. *exfuniculata* Sacco, 1891. Savona. MGPT BS.029.01.036; apertural side.

Fig. 7 - *Cochlis fredianii* sp. n. Ponte a Elsa. Holotype, MPUM 9482; a) apertural side, b) abapertural side.

Fig. 8 - *Cochlis fredianii* sp. n. Ponte a Elsa. Paratype, MPUM 9483; apertural side.

Fig. 9 - *Tanea dillwyni koeneni* (Sacco, 1891). Monsindoli. MPUM 9488; a) apertural side, b) abapertural side, c) top view.

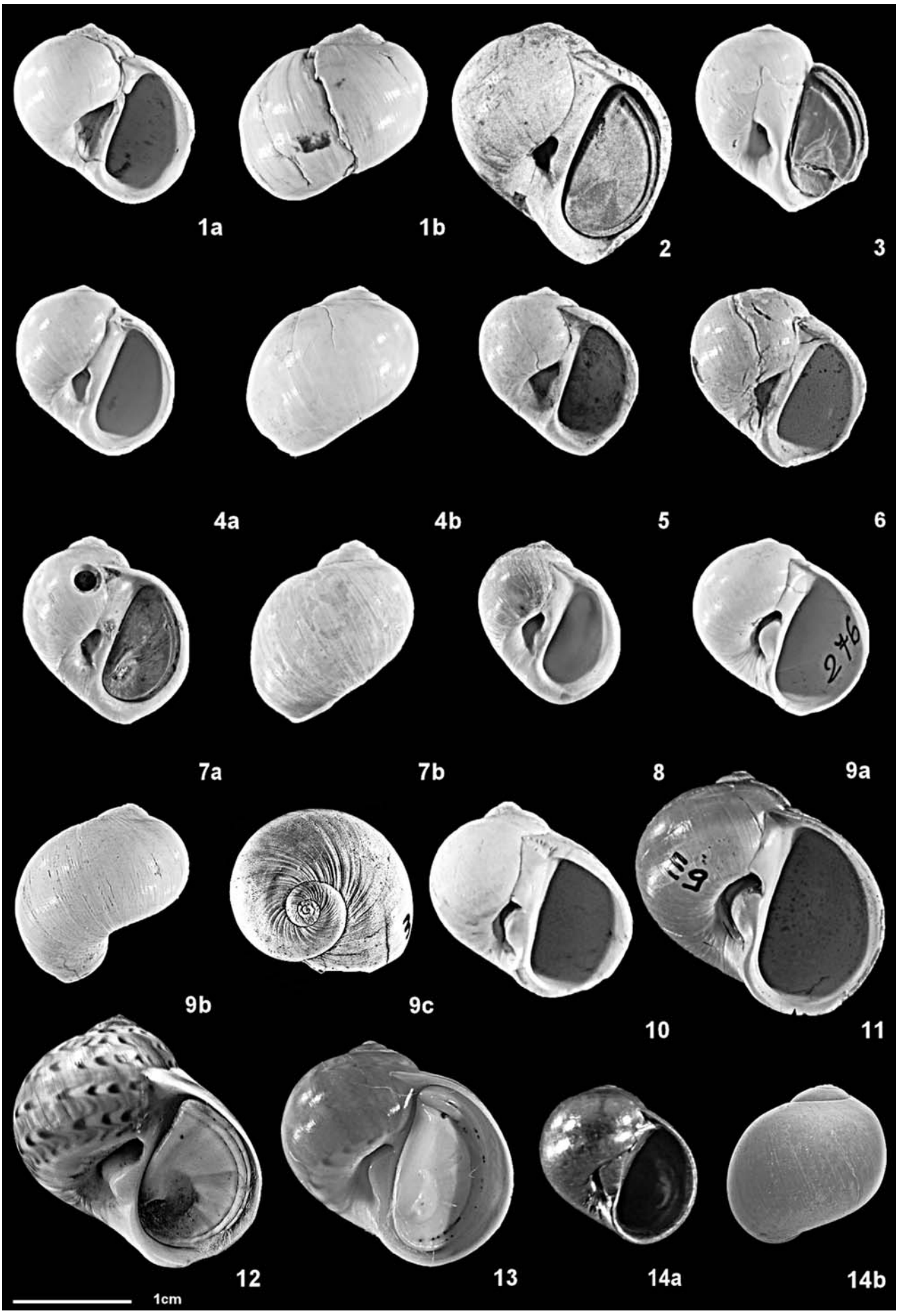
Fig. 10 - *Tanea dillwyni koeneni* (Sacco, 1891). Lugagnano. MGC 577, apertural side.

Fig. 11 - *Tanea dillwyni koeneni* (Sacco, 1891). Rio Torsero. MPUM 9487; apertural side.

Fig. 12 - *Tanea zelandica* (Quoy and Gaimard, 1832). Mahia, New Zealand. Private collection; apertural side.

Fig. 13 - *Tanea dillwyni* (Payraudeau, 1826). Porto Alabe, Tresnurághes, Sardegna. Private collection; apertural side.

Fig. 14 - *Tectonatica astensis* (Sacco, 1890). Benestare. Topotype, MPUM 9491; a) apertural side, b) abapertural side.


1a
1b
2
3
4a
4b
5
6
7a
7b
8
9a
9b
9c
10
11
12
13
14a
14b
1cm

Dimensions (mm):

DHW	PD	H	D	SH	AH	AW
0.23-0.27	0.59-0.63	8.58-23.82	7.79-22.19	1.12-4.20	6.38-20.07	3.97-11.37
0.25	0.61	16.20	14.99	2.66	13.54	7.67
UW	WUC	WAD	WAB	IS	SA	
1.14-7.06	0.87-1.91	0.00-4.33	0.02-1.34	12°-32°	101°-141°	
4.10	1.39	2.03	0.68	22°	121°	

Remarks. The present new species appears to be related only to *Cochlis raropunctata raropunctata* (Sasso, 1827), but differs from it in having: 1) protoconch with significantly smaller (31% difference) diameter of the first half whorl; 2) body whorl less produced and more expanded toward the aperture; 3) smaller umbilicus; 4) umbilical callus more depressed and placed more abapically; 5) thinner operculum with shorter central callus, marginal area sloping inward instead of horizontal, and inner ridge distinctly less developed.

Stratigraphic occurrence. *C. fredianii* sp. n. was recovered by the present authors only from Piacenzian deposits at Ponte a Elsa (Pisa Province).

Genus *Tanea* Marwick, 1931

Tanea dillwyni koeneni (Sacco, 1891) stat. rev., comb. n.

Pl. 1, figs. 9-11; Pl. 2, fig. 16; Pl. 3, figs. 8, 14

1882 *Natica plicatella* - von Koenen, p. 229, pl. 5, figs. 6, 7, not fig. 9 (operculum of *Natica plicatula* Bronn, 1831).

1891 *Natica (Natica) epiglottina* var. *koeneni* Sacco, p. 63.

1925 *Natica koeneni* - Kautsky, p. 68, pl. 6, fig. 18.

1956 *Polynices (Polynices) koeneni* - Rasmussen, p. 60, pl. 4, fig. 7.

1960 *Natica (Natica) koeneni* - Anderson, p. 92, pl. 4, fig. 2.

1968 *Natica koeneni* - Rasmussen, p. 117.

1969 *Natica koeneni* - Janssen, p. 173, pl. 1, fig. 6; pl. 7, fig. 22 (holotype: the shell originally figured by von Koenen, 1882).

Type material. Not seen (holotype in Bundsanstalt für Geowissenschaften und Rohstoffe, Berlin-Spandau, Germany, unavailable and possibly doomed; Andrea Heinke, personal communication 2004).

Material examined. Savona: 12 spms. referred to as *Natica dillwyni* var. *plicatula* Bronn by Sacco (1891), MGPT BS.029.01.043/02; Zinola: 7 spms. referred to as *Natica dillwyni* var. *plicatula* Bronn by Sacco (1891), MGPT BS.029.01.043/03; Cassine: 1 spm. (MPUM 9486); Rio Torsero: 1 spm. (MPUM 9487); Bacedasco: 3 spms. (private collection), 1 spm. (MGC Bagatti collection); Castell'Arquato: 2 spms. (MGC Bagatti collection); Lugagnano: 1 spm. (MGC 577), 1 spm. (private collection); Monsindoli: 1 spm. (MPUM 9488), 9 spms. (MPUM 9489), 3 spms. (NP 9566), 3 spms. (private collection); Lullingen, Germany: 1 spm. (MPUM 9490).

Characters

Protoconch: medium-sized, depressed turbiniform of 2 convex, smooth whorls, tip small.

Shell: depressed globose, rather thick.

Spire: conical, moderately elevated, whorls convex.

Suture: linear, adpressed.

Body whorl: inflated, somewhat depressed, moderately extended and slightly expanded toward the aperture; subsutural shelf obscure or lacking.

Aperture: D-shaped, height about 1.5 times the width.

Parietal callus: quadrangular, rather wide and thick, ending some distance from the basal fasciole; anterior lobe absent.

PLATE 2

Fig. 1 - *Tectonatica astensis* (Sacco, 1890). Pradalbino II. MPUM 9497; apertural side.

Fig. 2 - *Tectonatica astensis* (Sacco, 1890). Montegibbio. MPUM 9496; apertural side.

Fig. 3 - *Tectonatica prietoi* (Hidalgo, 1873). Lectotype (designated by Templado et al., 1993). Isla del Aire, Menorca. MNCNM 15.05/758; a) apertural side, b) abapertural side.

Fig. 4 - *Tectonatica prietoi* (Hidalgo, 1873). Paralectotype. Isla del Aire, Menorca. MNCNM 15.05/5171; apertural side.

Fig. 5 - *Tectonatica prietoi* (Hidalgo, 1873). Bibbiano. MPUM 9506; a) apertural side, b) abapertural side.

Fig. 6 - *Tectonatica prietoi* (Hidalgo, 1873). Montaione. MPUM 9510; apertural side.

Fig. 7 - *Tectonatica tectula* (Sacco, 1890). Lectotype (here designated). Villalvernia. MGPT BS.029.04.001; a) apertural side, b) abapertural side.

Fig. 8 - *Tectonatica tectula* (Sacco, 1890). San Lorenzo in Collina. MPUM 9522; apertural side.

Fig. 9 - *Tectonatica tectula* (Sacco, 1890). Montegibbio. MPUM 9518; apertural side.

Fig. 10 - *Cryptonatica filosa* (Philippi, 1845). Malaga, Spain. MPUM 9528; apertural side.

Fig. 11 - *Cryptonatica filosa* (Philippi, 1845). Bovetto. MPUM 9529; apertural side.

Fig. 12 - *Tectonatica rizzae* (Philippi, 1844). Malaga, Spain. Private collection; apertural side.

Fig. 13 - *Tectonatica adansoni* (Blainville, 1825). Senegal. MPUM 9530; apertural side.

Fig. 14 - *Cochlis epigloafuniculata* (Sacco, 1890). Orciano Pisano. MPUM 9480; umbilicus.

Fig. 15 - *Cochlis fredianii* sp. n. Ponte a Elsa; umbilicus of paratype in Pl. 1, fig. 9.

Fig. 16 - *Tanea dillwyni koeneni* (Sacco, 1891). Monsindoli; umbilicus of specimen in Pl. 1, fig.10.

Fig. 17 - *Tectonatica astensis* (Sacco, 1890). Pradalbino II; umbilicus of specimen in Pl. 2, fig. 1.

Fig. 18 - *Tectonatica prietoi* (Hidalgo, 1873). Montaione. MPUM 9511; umbilicus.

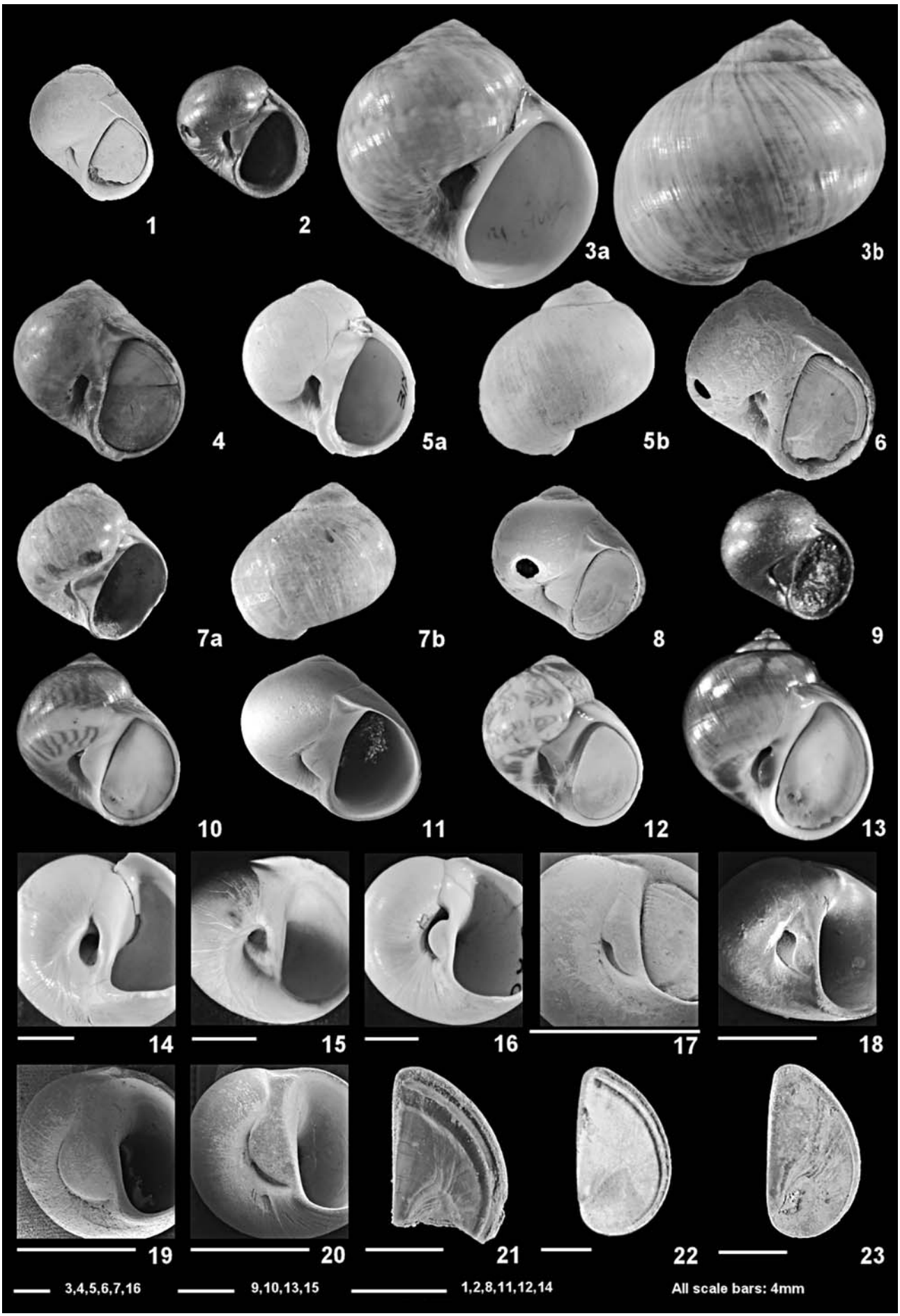
Fig. 19 - *Tectonatica tectula* (Sacco, 1890). San Lorenzo in Collina. MPUM 9523; umbilicus.

Fig. 20 - *Tectonatica tectula* (Sacco, 1890). San Lorenzo in Collina. MPUM 9524; umbilicus.

Fig. 21 - *Cochlis epigloafuniculata* (Sacco, 1890). Orciano Pisano; operculum of specimen in Pl. 1, fig. 3.

Fig. 22 - *Cochlis epigloafuniculata* (Sacco, 1890). Benevagienna; operculum of specimen in Pl. 1, fig. 2.

Fig. 23 - *Cochlis fredianii* sp. n. Ponte a Elsa; operculum of specimen in Pl. 1, fig. 8.


1
2
3a
3b
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5a
5b
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7a
7b
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16
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21
22
23
3,4,5,6,7,16
9,10,13,15
1,2,8,11,12,14
All scale bars: 4mm

Umbilicus: rather wide, largely filled by the funicle.

Funicle: broad, prominent, separated from the basal fasciole by a moderate to narrow furrow.

Umbilical callus: large, rather thick, usually prominent, semicircular in outline, located at the middle of the columellar lip and separated from the parietal callus by a narrow and shallow, reverse J-shaped notch; the open space between the umbilical callus and the umbilical periphery is usually narrow, of the same breadth throughout or slightly wider adapically.

Basal fasciole: nearly indistinct.

Surface: with prosocline growth lines that are slightly bent and change into broad, low wrinkles adapically; the wrinkles extend to the abapical suture on the spire whorls and develop on the adapical one-third of the body whorl.

Color: uniform pale brown, apparently without any pattern.

Operculum:

- rather thick, broad;
- central callus tongue-shaped, rather wide, long and moderately arched toward the inner margin;
- inner margin thick, bluntly rounded, with more or less manifest transverse wrinkles;
- inner surface flat, with coarse radial growth markings, nucleus slightly sunken;
- outer surface also flat, with 1 marginal groove followed by a broad marginal area;
- groove moderately narrow and deep, flat-bottomed, asymmetric in cross-section, with sloping outer side and vertical, step-like inner one;
- marginal area markedly swollen to form a very robust ridge bearing a deep and narrow median groove.

Dimensions (mm):

DHW	PD	H	D	SH	AH	AW
0.18*	1.21*	7.39-24.19	7.22-24.82	0.78-5.22	6.17-19.41	3.71-13.07
* 1 protoconch measurable		15.79	16.02	3.00	12.79	8.39
UW	WUC	WAD	WAB	IS	SA	
3.21-7.85	2.24-4.44	0.27-2.87	0.00-1.31	10°-26°	110°-130°	
5.53	3.34	1.57	0.65	18°	120°	

Remarks. von Koenen (1882) described and figured a shell under the name *Natica plicatella* Bronn and clearly made reference to page 72 of Bronn's paper of 1831, i.e. the page containing the original description of *Natica plicatula*; no mention is made in that page of the name *plicatella*. From von Koenen text, it appears that the name *plicatella* was used under the authority of Mayer (1858). Actually, this latter author (p. 391) treated *Natica plicatula* Bronn, but in the caption to plate 11 listed the species as *Natica plicatella*. Thus, the name *plicatella* is to be considered an error for *plicatula*. Sacco (1891), on the basis of von Koenen's specimen, validly proposed the var. *koeneni* and attributed it to *Natica epiglottina* Lamarck, 1804. Later on, *koeneni* was regarded as a distinct species (see the above synonymy) and assigned to the genus *Natica* Scopoli, 1777. *Natica koeneni* closely resembles the Recent *Tanea dillwyni* (Payraudeau, 1826) in terms of general shell shape (see Pl. 1, fig. 13), funicle and opercular characters, but Payraudeau's species has the protoconch of slightly more than 3 whorls instead of 2 and lacks the subsutural wrinkles. On the basis of the remarkable opercular similarity, we consider *koeneni* as a subspecies of *Tanea dillwyni*.

The present subspecies superficially resembles *Cochlis plicatula* (Bronn, 1831), but differs in having coarser axial wrinkles extending to the abapical suture on the spire whorls and occupying the adapical one-third on the body whorl. Other significant differences are: 1) protoconch of 2 instead of 3 whorls; 2) umbilical callus rather large, semicircular and located about at the middle of the inner lip, whereas it is asymmetric, roundly triangular and placed more abapically in *plicatula*; 3) operculum with 1 marginal groove followed by 1 broad markedly convex ridge, whereas there are 2 ridges separated by a groove in *plicatula*.

Stratigraphic occurrence. Earliest occurrences of *T. dillwyni koeneni* are from the Hemmorian (Late Burdigalian/Early Langhian) of Northwestern Europe; the species was also recovered from Langenfeldian (Late Serravallian/Early Tortonian), Syltian and Gramian (Late Tortonian) of the same area. Pliocene occurrences in Italy are from Zanclean deposits of Piedmont, Liguria, Emilia and Tuscany. *T. dillwyni koeneni* seems not to have survived subsequent to the Zanclean.

Genus *Tectonatica* Sacco, 1890

Tectonatica astensis (Sacco, 1890)

Pl. 1, fig. 14; Pl. 2, figs 1, 2, 17; Pl. 3, figs 1, 2, 15-17

1880 *Natica minor* Seguenza, p. 111.

1890 *Natica (Naticina) pulchella* var. *astensis* Sacco, p. 31.

1891 *Natica (Naticina) pulchella* var. *astensis* - Sacco, p. 77, pl. 2, fig. 50.

1976 *Lunatia? astensis* - Pavia, p. 137 (pars), pl. 4, figs. 28, 30, 31, 33 (lectotype), 35; pl. 5, figs. 10, 12; not pl. 4, fig. 32 (= *Natica prietoi* Hidalgo, 1873).

1980 *Tectonatica astensis* - Pavia, p. 257 (pars), pl. 7, figs. 3, 4, 8; not pl. 7, figs. 5-7 (= *Natica prietoi* Hidalgo, 1873).

1980 *Tectonatica tectula* - Pavia, p. 259 (pars), pl. 7, figs. 10-11 (not *tectula* Sacco, 1890).

1984 *Naticina pulchella* var. *astensis* - Ferrero Mortara et al., p. 34, pl. 3, fig. 13 (lectotype).

1991 *Natica minor* - Vazzana, p. 106, pl. 2, fig. 13.

1992 *Natica (Tectonatica) astensis* - Cavallo & Repetto, text-fig. 125 (only the operculum).

1996 *Natica (Tectonatica) astensis* - Pedriali, p. 7 (pars), pl. 2, fig. 9; not pl. 2, fig. 10 (= *Natica prietoi* Hidalgo, 1873).

1997 *Tectonatica astensis* - Lacroce, p. 27, pl. 2, fig. 7.

2000 *Tectonatica astensis* - Lacroce, p. 32.

2004 *Tectonatica astensis* - Repetto & Lacroce, p. 193.

Uncertain references

Lunatia? astensis - Pavia, 1976: p. 137 (pars), pl. 4, fig. 34.

Natica astensis - Bogi & Cauli, 1998: p. 134.

Natica (Tectonatica) astensis - Cavallo & Repetto, 1992: text-fig. 125 (only the shell); - Tabanelli & Segurini, 1995: p. 9; - Mancini, 1997: p. 41, 42, 43.

Tectonatica astensis - Montefameglio et al., 1980: p. 189, 196; - Pavia, 1980: p. 257 (pars), text-fig. 2C; - Aimassi & Ferrero Mortara, 1983: p. 186; - Aimone & Ferrero Mortara, 1983: p. 295; - Tropeano et al., 1984: p. 58; - Bernasconi, 1989: p. 58, 74; - Pavia et al., 1989: p. 544, 567, 568; - Barbarino & Scarselli, 1992: p. 412; - Basilici et al., 1997: p. 43.

Type material. The lectotype of *Naticina pulchella* var. *astensis* Sacco (designated by Pavia, 1976): the shell figured by Sacco (1891, pl. 2, fig. 50), MGPT BS.029.02.034 (Colli Astesi); 2 paralectotypes, MGPT BS.029.02.034/01 (Colli Astesi); 7 paralectotypes, MGPT BS. 029.02.034/03 (Zinola); 2 paralectotypes, MGPT BS. 029.02.034/05 (Colli Astesi).

Other type material. The original material of *Natica minor* Seguenza, 1879 was lost during the 1908 Messina earthquake.

Topotypes of *Natica minor* Seguenza, 1879. Benestare (Reggio Calabria): 1 spm., MPUM 9491; 1 spm., MPUM 9492; 1 spm., MPUM 9493; 8 spms., MPUM 9494.

Other material examined. Colli Astesi: 5 shells previously referred to as *Natica (Tectonatica) tectula* Sacco by Sacco (1890), MGPT BS.029.04.001/06; Cossato: 2 spms. (NP 9572); Villalvernia: 1 spm. (PPMM 51782); Volpedo: 2 spms. (NP 9584); Bussana Vecchia: 16 spms. (private collections); Caranchi: 14 spms. (private collection); Rio Torsero: 15 spms. (NP 9581), 104 spms. (private collection); Arda: 6 spms. (NP 9569); Bacedasco: 1 spm. (NP 9567); Badagnano: 7 spms. (NP 9568); Campore: 5 spms. (MPUM 9495), 30 spms. (NP 9570); Diolo: 5 spms. (NP 9573); Montegibbio: 1 spm. (MPUM 9496); Pradalbino I: 3 spms. (NP 9578); Pradalbino II: 1 spm. (MPUM 9497), 1 spm. (MPUM 9498), 1 spm. (MPUM 9499), 20 spms. (MPUM 9500), 41 spms. (NP 9579), 6 spms. (private collection); Rio Rosello: 2 spms. (MPUM 9501), 3 spms. (NP 9580), 13 spms. (PPMM 51783-51795); San Lorenzo in Collina: 9 spms. (MPUM 9502), 41 spms. (NP 9582), 2 spms (MGC 578); Torrente Stirone: 3 spms. (NP 9583); Bibbiano: 2 spms. (PPMM 51796-51797); Ciuciano: 4 spms. (MPUM 9503), 43 spms. (NP 9571); Il Campino: 11 spms. (PPMM 51798-51808); Linari: 7 spms. (NP 9575); Monsindoli: 5 spms. (MPUM 9504), 27 spms. (NP 9576); Orciano Pisano: 2 spms. (MPUM 9505), 12 spms. (NP 9577); Guidonia: 2 spms. (NP 9574); Altavilla Milicia: 1 spm. (NP 9624), 3 spms. (private collection).

Characters

Protoconch: medium-sized, depressed turbiniform of 2.75-3 convex, smooth whorls, tip small.

Shell: globose, rather depressed and thin.

Spire: conical, moderately elevated, whorls convex.

Suture: linear, adpressed.

Body whorl: inflated, somewhat depressed, moderately extended and slightly expanded toward the aperture; subsutural shelf poorly defined.

Aperture: D-shaped, height about 1.6 times the width.

Parietal callus: quadrangular, rather wide and thick, ending at the level of the basal fasciole; anterior lobe small, subrounded, or indistinct.

Umbilicus: a comma-like chink, wider adapically and gradually narrowing downward.

Funicle: broad and low, separated from the basal fasciole by a very narrow furrow.

Umbilical callus: large, rather thick, located at the mid abapical part of the columellar lip, bounded adaxially by an oblique, reverse S-shaped outline and merging into the parietal callus at the level of the anterior lobe.

Basal fasciole: nearly indistinct.

Surface: with prosocline growth lines.

Color: uniform pale brown, with darker subsutural band; protoconch light grey.

Operculum:

- rather thin;
- central callus distinct, moderately thick, broad and short, parallel to the abaxial margin;
- inner margin slightly arched, with blunt transverse ridges adapically;
- inner surface gently convex, nucleus not protruding or slightly so;
- outer surface concave, with 1 marginal groove bounding a wide peripheral band;
- groove narrow to moderately wide, more or less deep.

Dimensions (mm):

DHW	PD	H	D	SH	AH
0.09-0.13	1.18-1.38	2.41-10.25	1.93-10.17	0.11-2.59	1.65-8.13
0.11	1.28	6.33	6.05	1.35	4.89
AW	UW	WUC	IS	SA	
1.06-5.02	0.61-2.85	0.53-2.45	15°-35°	74°-146°	
3.04	1.73	1.49	25°	110°	

Remarks. Seguenza (1880) proposed *Natica minor* on the basis of Tortonian specimens from Benestare (Reggio Calabria). We have seen several topotypes of *Natica minor* Seguenza and can state that this taxon is indistinguishable from *Natica (Naticina) pulchella* var. *astensis* Sacco, 1890. Consequently, the name *minor* would bear priority over *astensis*, the latter being a junior synonym. However, the same name *minor* was formerly applied by Lea (1833, p. 107) to a new species also assigned to *Natica*. Thus, both Seguenza's and Lea's names are primary homonyms (ICZN 1999, art. 53.3) and that of Seguenza is to be considered permanently invalid (ICZN 1999, art. 57.2). Since *astensis* Sacco is the available synonym of *minor* Seguenza, the former stands as the valid name of the present species (ICZN 1999, art. 60.2).

The Pleistocene and Recent *Tectonatica rizzae* (Philippi, 1844) is the most closely related species. It differs in having less sinuous outline of the umbilical callus and more widely open abapical part of the umbilicus (Pl. 2, fig. 12). The operculum is basically similar except for the bean-shaped central callus placed abapically and distinctly swollen (Pl. 3, fig. 3). We recall that *Natica settepassii* Gaglini in Settepassi, 1985 is currently regarded as a synonym of *Tectonatica rizzae*.

Stratigraphic occurrence. Earliest records of *T. astensis* were from Tortonian deposits of Montegibbio and Benestare. The species occurs commonly in Zanclean and Piacenzian units throughout Italy; Late Pliocene occurrences are scanty and refer only to the Torrente Stirone Section. *T. astensis* results not to have survived subsequent to the Pliocene. It seems to have been replaced by the closely related *Tectonatica rizzae* (Philippi, 1844) in the Pleistocene.

Tectonatica prietoi (Hidalgo, 1873) comb. n.

Pl. 2, figs 3-6, 18; Pl. 3, figs 4-6, 18-21

1873 *Natica prietoi* Hidalgo, p. 332 (one specimen is illustrated in pl. 20 B, figs. 2, 3 of the atlas dated 1870; see remarks).

1980 *Tectonatica astensis* - Pavia, p. 257 (pars), pl. 7, figs. 5-7 (not Sacco, 1890).

1991 *Natica adansoni* - Poppe & Goto, p. 121, pl. 17, fig. 11 (not Blainville, 1825).

1992 *Natica (Tectonatica) tectula* - Cavallo & Repetto, text-fig. 126 (operculum), not the shell (= *Natica (Tectonatica) tectula* Sacco, 1890).

1996 *Natica (Tectonatica) astensis* - Pedriali, p. 7 (pars), pl. 2, fig. 10 (not Sacco, 1890).

1997 *Natica (Natica) adansoni* - Giannuzzi-Savelli et al., figs 748, 810 (not Blainville, 1825).

1997 *Natica (Natica) prietoi* - Giannuzzi-Savelli et al., fig. 794.

1998 *Natica prietoi* - Gubbioli & Nofroni, p. 21, text-figs 1, 2.

1999 *Tectonatica astensis* - Forli et al., p. 115, 116, pl. 2, fig. 4 (not Sacco, 1890).

Uncertain references

Lunatia? astensis - Pavia, 1976: p. 137 (pars), pl. 4, fig. 32.

Type material. The lectotype of *Natica prietoi* Hidalgo (designated by Templado et al. 1993; Oscar Soriano, personal communication 2006): the shell figured by Hidalgo (1870, pl. 20B, figs. 2, 3) and refigured herein (pl. 2, fig. 3), MNCNM 15.05/758 (Isla del Aire, Menorca); 1 paralectotype, MNCNM 15.05/5171 (Isla del Aire, Menorca) also refigured herein (pl. 2, fig. 4).

Material examined. Villalvernia: 16 shells previously referred to as *Natica (Naticina) pulchella* var *astensis* by Sacco (1890), MGPT BS.029.02.034/04; Villalvernia: 1 spm. (NP 9599); Bussana Vecchia: 3 spms. (private collections); Arda: 2 spms. (NP 9588); Badagnano: 1 spm. (NP 9585); Arda II: 1 spm. (NP 9625); Torrente Stirone: 1 spm. (NP 9598); Barca: 1 spm. (NP 9586); Bibbiano: 1 spm. (MPUM 9506), 1 spm. (MPUM 9507), 1 spm. (MPUM 9508), 5 spms. (MPUM 9509), 34 spms. (NP 9587), 2 spms. (MGC 579); Ciuciano: 1 spm. (NP 9590); Il Campino: 42 spms. (NP 9591); La Serra: 3 spms. (NP 9592); Linari: 1 spm. (NP 9593); Montaione: 1 spm. (MPUM 9510), 1 spm. (MPUM 9511), 18 spms. (MPUM 9512), 51 spms. (NP 9594); Montenero: 10 spms. (NP 9595); Ponte a Elsa: 1 spm. (MPUM 9513), 24 spms. (NP 9596); Spicchio: 8 spms. (NP 9589); Bovetto: 1 spm. (MPUM 9514), 2 spms. (NP 9597); Ravagnese: 6 spms. (private collection); Messina Strait (Recent): 1 spm. (private collection); Malaga, Spain (Recent): 1 spm. (MPUM 9515).

Characters

Protoconch: small to medium, depressed turbiniform of 2.5-2.75 convex, smooth whorls, tip small.

Shell: globose, rather thick.

Spire: conical, moderately elevated, whorls convex.

Suture: linear, adpressed.

Body whorl: inflated, somewhat depressed, moderately extended and very slightly expanded toward the aperture; subsutural shelf obscure or lacking.

Aperture: D-shaped, height about 1.7 times the width.

Parietal callus: subrectangular, moderately wide and rather thin, ending at the level of the basal fasciole; anterior lobe absent.

Umbilicus: similar to that of *Tectonatica astensis* (Sacco, 1890), but more widely open.

Funicle: broad and low, separated from the basal fasciole by a narrow furrow.

Umbilical callus: large, rather thick, located at the mid abapical part of the columellar lip, bounded adaxially by a reverse S-shaped outline and merging into the parietal callus at the anterior angle of the latter.

Basal fasciole: nearly indistinct.

Surface: with prosocline growth lines; a faint spiral striation occurs on the body whorl.

PLATE 3

Fig. 1 - *Tectonatica astensis* (Sacco, 1890). Pradalbino II; operculum of specimen in Pl. 2, fig. 1.

Fig. 2 - *Tectonatica astensis* (Sacco, 1890). Benestare. MPUM 9492; operculum.

Fig. 3 - *Tectonatica rizzae* (Philippi, 1844). Archi. MPUM 9531; operculum.

Fig. 4 - *Tectonatica prietoi* (Hidalgo, 1873). Bibbiano. MPUM 9507; operculum.

Fig. 5 - *Tectonatica prietoi* (Hidalgo, 1873). Detail of the operculum in fig. 4.

Fig. 6 - *Tectonatica prietoi* (Hidalgo, 1873). Malaga, Spain (Recent). MPUM 9515; operculum.

Fig. 7 - *Tanea zelandica* (Quoy and Gaimard, 1832). North Island, Seatoun, Wellington, New Zealand. MPUM 9532; operculum.

Fig. 8 - *Tanea dillwyni koeneni* (Sacco, 1891). Cassine. MPUM 9486; operculum.

Fig. 9 - *Tectonatica tectula* (Sacco, 1890). Masserano. MPUM 9516; operculum.

Fig. 10 - *Cryptonatica filosa* (Philippi, 1845). Bovetto. MPUM 9533; operculum.

Fig. 11 - *Cryptonatica filosa* (Philippi, 1845). Malaga, Spain; operculum of specimen in Pl. 2, fig. 10.

Fig. 12 - *Cochlis epigloafuniculata* (Sacco, 1890). Orciano Pisano. MPUM 9481; protoconch.

Fig. 13 - *Cochlis fredianii* sp. n. Ponte a Elsa. MPUM 9484; protoconch.

Fig. 14 - *Tanea dillwyni koeneni* (Sacco, 1891). Rio Torsero; protoconch of specimen in Pl. 1, fig. 12.

Fig. 15 - *Tectonatica astensis* (Sacco, 1890). Pradalbino II. MPUM 9498; protoconch.

Fig. 16 - *Tectonatica astensis* (Sacco, 1890). Pradalbino II. MPUM 9499; protoconch.

Fig. 17 - *Tectonatica astensis* (Sacco, 1890). Benestare. MPUM 9493; protoconch.

Fig. 18 - *Tectonatica prietoi* (Hidalgo, 1873). Ponte a Elsa. MPUM 9513; protoconch.

Fig. 19 - *Tectonatica prietoi* (Hidalgo, 1873). Bibbiano. MPUM 9508; protoconch.

Fig. 20 - *Tectonatica prietoi* (Hidalgo, 1873). Bovetto. MPUM 9514; protoconch.

Fig. 21 - *Tectonatica prietoi* (Hidalgo, 1873). Malaga, Spain; protoconch of specimen whose operculum is figured in Pl. 3, fig. 6.

Fig. 22 - *Tectonatica tectula* (Sacco, 1890). Bibbiano. MPUM 9526; protoconch.

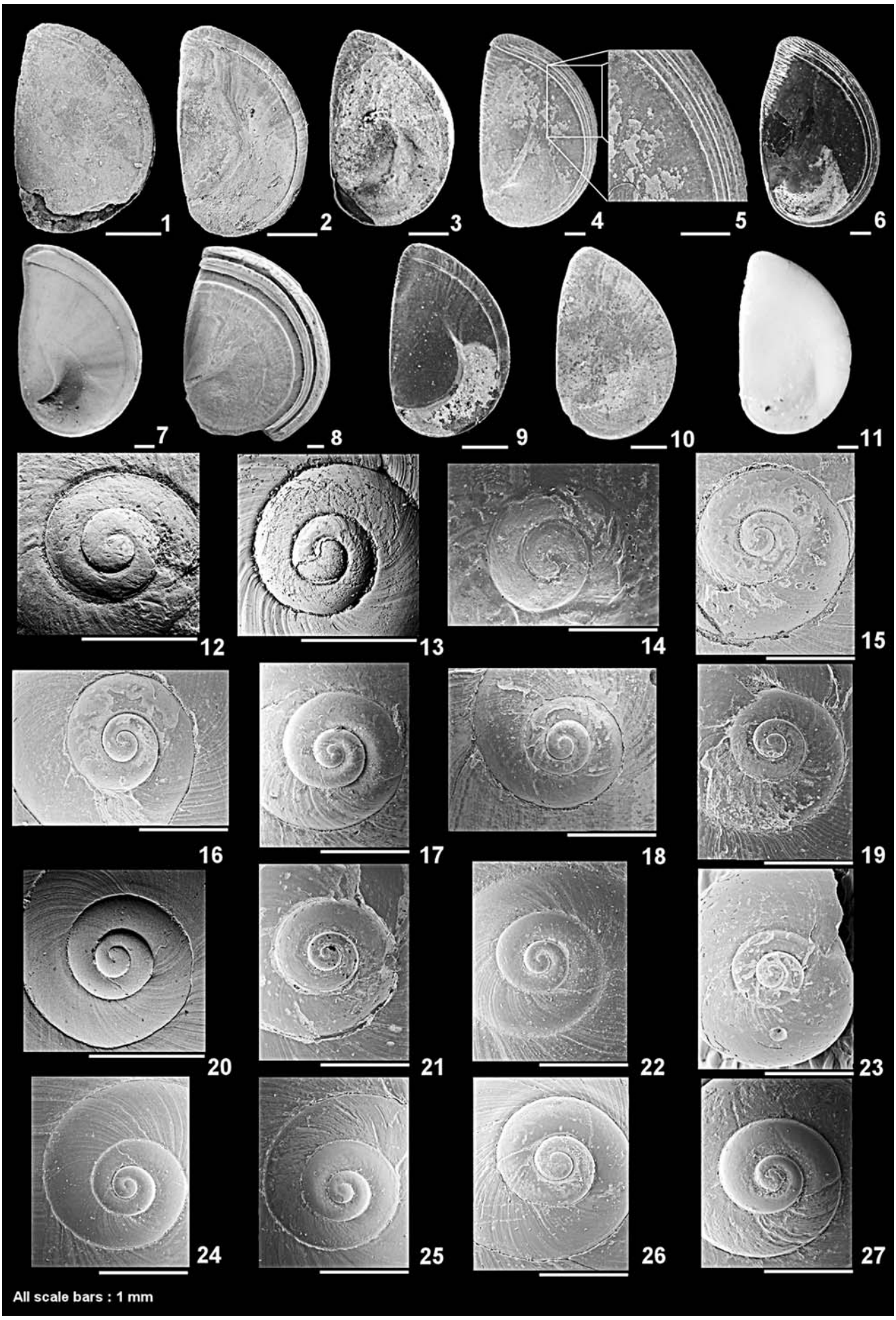
Fig. 23 - *Tectonatica tectula* (Sacco, 1890). Rio Rosello. MPUM 9520; protoconch.

Fig. 24 - *Cryptonatica filosa* (Philippi, 1845). Bovetto; protoconch of specimen in Pl. 2, fig. 11.

Fig. 25 - *Cryptonatica filosa* (Philippi, 1845). Malaga, Spain; protoconch of specimen in Pl. 2, fig. 10.

Fig. 26 - *Tectonatica rizzae* (Philippi, 1844). Malaga, Spain; MPUM 9534; protoconch.

Fig. 27 - *Tectonatica adansoni* (Blainville, 1825). Senegal; protoconch of specimen in Pl. 2, fig. 13.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All scale bars : 1 mm

Color: uniform pale brown, no pattern preserved; live specimens exhibit a light brown mottled background with 3 weak spiral rows of alternating brown and whitish spots.

Operculum:

- rather thick;
- central callus rather thick, subtriangular, oblique, hardly reaching half the height of the operculum;
- inner margin slightly arched, with blunt transverse ridges adapically;
- inner surface gently convex, nucleus slightly sunken;
- outer surface moderately concave abaxially, with 1 marginal groove bounding a wide peripheral band;
- groove more or less narrow, shallow to moderately deep;
- peripheral band flat, bearing 2-3 longitudinal furrows.

Dimensions (mm):

DHW	PD	H	D	SH	AH
0.10-0.14	0.85-1.05	6.13-14.21	5.90-13.90	0.83-4.27	4.91-10.27
0.12	0.95	10.17	9.90	2.55	7.59
AW	UW	WUC	IS	SA	
3.22-6.70	1.76-4.40	1.48-3.80	16°-28°	101°-125°	
4.96	3.08	2.64	22°	113°	

Remarks. *Natica prietoi* was validly proposed by Hidalgo (1873) who published a thorough description of it and some comments. At the foot, Hidalgo mentioned a work by himself entitled "Moluscos marinos de España" (sic) and, referring to *Natica prietoi*, wrote "elle sera représentée sur la planche 20 B (fig. 2, 3) de cette publication", thus implicitly asserting that the latter was still to be issued. Actually, the plate 20 B is contained in the atlas having a similar but more extended title (see references), dated 1870 on the front cover. We were unable to ascertain whether the atlas, intended to be published in 1870, was actually issued later than 1873. Should the 1870 date be correct, the name *Natica prietoi* in the atlas would be *nomen nudum* validated later on in 1873.

Tectonatica prietoi was regarded as a synonym of *Natica adansoni* Blainville, 1825 (cf. Giannuzzi-Savelli et al. 1997, p. 19, foot-note 3). We concur with Gubbioli & Nofroni (1998) in considering Hidalgo's species and that of Blainville as distinct. Actually, *Natica adansoni* (Pl. 2, fig. 13) differs in that has 1) larger protoconch with significantly greater diameter (Pl. 3, fig. 27), 2) more globose shell, 3) spire usually more elevated, 4) umbilical callus more expanded abapically and largely filling the umbilicus, and 5) the operculum with slenderer central callus, more convex inner margin and markedly depressed peripheral band, separated from the marginal groove by a rounded step. Finally, fresh shells of the two species show quite different color pattern.

Compared to *Tectonatica astensis* (Sacco, 1890), the present species ordinarily attains twice to three times the size of the former, has significantly smaller protoconch (26% difference in diameter) and exhibits a more widely open umbilicus; the grooved peripheral band of the operculum is another, relevant distinguishing character.

Stratigraphic occurrence. *T. prietoi* was hitherto unrecorded from the Pliocene, likely having been mistaken for *Tectonatica astensis* (Sacco, 1890) or *Tectonatica tectula* (Sacco, 1890). Actually, our findings denote that it is moderately common in Zanclean and Piacenzian deposits of Piedmont, Liguria, Emilia, Tuscany and Latium, less so in the Gelasian of the Torrente Stirone Section. Examination of the literature shows that the species was never quoted from Quaternary deposits. Our recoveries from Arda II, Bovetto and Ravagnese (see appendix) demonstrate its occurrence in the Pleistocene. *T. prietoi* is still living in the Western Mediterranean and Eastern Atlantic as far south as Guinea.

Tectonatica tectula (Sacco, 1890)

Pl. 2, figs 7-9, 19, 20; Pl. 3, figs 9, 22, 23

1890 *Natica (Tectonatica) tectula* Sacco, p. 33.
1891 *Natica (Tectonatica) tectula* - Sacco, p. 81, pl. 2, fig. 53.
1956 *Natica tectula* - Moroni, p. 106, pl. 9, fig. 55.
1958 *Natica (Naticina) tectula* - Sorgenfrei, p. 190, pl. 38, fig. 122.
1979 *Tectonatica tectula* - Martinell, p. 136, pl. 4, figs 6-8.
1979 *Tectonatica tectula* - Pavia & Robba, p. 554.
1980 *Tectonatica tectula* - Pavia, p. 259 (pars), pl. 7, figs 9, 13; not pl. 7, figs. 10-11 (= *Natica (Naticina) pulchella* var. *astensis* Sacco, 1890).
1984 *Tectonatica tectula* - Ferrero Mortara et al., p. 35.
1992 *Natica (Tectonatica) tectula* - Cavallo & Repetto, text-fig. 126, not the operculum (= *Natica prietoi* Hidalgo, 1873).
1996 *Natica (Tectonatica) tectula* - Pedriali, p. 8, pl. 2, figs 11-13; pl. 3, fig. 1.
1997 *Tectonatica tectula* - Lacroce, p. 27, pl. 2, fig. 6.
1999 *Tectonatica tectula* - Forli et al., p. 115, pl. 2, fig. 5.
2004 *Tectonatica tectula* - Repetto & Lacroce, p. 193.

Uncertain references

Natica tectula - Sismonda, 1842: p. 27; - Sismonda, 1847: p. 51; - Bronn, 1848: p. 788; - d'Orbigny, 1852: p. 38, n. 572; - Doderlein, 1864: p. 18; - Coppi, 1869: p. 64, n. 259; - Coppi, 1881: p. 62, n. 531; - Ruggieri, 1957: p. 43; - Repetto, 1997: p. 60; - Lacroce & Repetto, 1998: p. 148.

Natica (Lunatia) tectula - Brugnone, 1880: p. 117.

Natica (Tectonatica) tectula - Ferrero & Merlino, 1992: p. 129, 132; - Tabanelli & Segurini, 1995: p. 9; - Ferrero et al., 1998: p. 45, 46, 48.

Natica (Tectonatica) tectula mut. *bearnensis* - Cossmann & Peyrot, 1919: p. 416, pl. 11, figs. 43-44.

Polynices (Tectonatica) tectulus - Ruggieri, 1949: p. 26.

Tectonatica tectula - Zuffardi Comerci, 1929: p. 3; - Glibert, 1963: p. 104; - Moroni & Paonita, 1964: p. 14, text-fig. 14; - Moroni & Torre, 1966: p. 4, 19, text-fig. 2; - Pavia, 1976: p. 110, 112, 137; - Menesini, 1977: p. 256, 262; - Montefameglio et al., 1980: p. 178, 189; - Pavia, 1980: p. 259 (pars), pl. 7, fig. 12; - Aimone & Ferrero Mortara, 1983: p. 284, 295, 303, 309; - Tropeano et al., 1984: p. 58; - Gonzáles Delgado, 1987: p. 92, 96, 105, 110, 112, 115, 118; - Pavia et al., 1989: p. 544, 563, 566, 568; - Barbarino & Scarselli, 1992: p. 412; - Ragaini & Mariani, 1992: p. 8, 19; - Basilici et al., 1997: p. 43, 44.

Type material. The lectotype of *Natica (Tectonatica) tectula* Sacco (here designated): the shell figured by Sacco (1891, pl. 2, fig. 53) and refigured herein (Pl. 2, fig. 7), MGPT BS.029.04.001 (Villalvernia); 11 paralectotypes, MGPT BS.029.04.001/01 (Villalvernia); 4 paralectotypes, MGPT BS.029.04.001/02 (Colli Torinesi); 2 paralectotypes, MGPT BS.029.04.001/03 (Savona Fornaci); 64 paralectotypes, MGPT BS.029.04.001/04 (Masserano); 22 paralectotypes, MGPT BS.029.04.001/05 (unknown locality, Piacenzian); 71 paralectotypes, MGPT BS.029.04.001/06 (Colli Astesi).

Other material examined. Borelli: 6 spms. (NP 9619); Cossato: 5 spms. (NP 9605); Masserano: 1 spm. (MPUM 9516); Villalvernia: 4 spms. (NP 9617), 160 spms. (PPMM 51001-51160); Volpedo: 10 spms. (MPUM 9517), 34 spms. (NP 9618); Bussana Vecchia: 1 spm. (private collection); Rio Torsero: 4 spms. (private collection); Arda: 4 spms. (NP 9603); Bacedasco: 2 spms. (NP 9600); Badagnano: 1 spm. (NP 9601), 124 spms. (PPMM 51161-51284); Balzo del Musico: 112 spms. (NP 9610); Montegibbio: 1 spm. (MPUM 9518), 5 spms. (NP 9620); Montezago: 21 spms. (NP 9612); Pradalbino I: 3 spms. (NP 9613); Pradalbino II: 13 spms. (MPUM 9519), 47 spms. (NP 9614), 1 spm. (MGC 580), 1 spm. (private collection); Rio Rosello: 1 spm. (MPUM 9520), 5 spms. (MPUM 9521), 52 spms. (NP 9615), 362 spms. (PPMM 51285-51646); San Lorenzo in Collina: 1 spm. (MPUM 9522), 1 spm. (MPUM 9523), 1 spm. (MPUM 9524), 22 spms. (MPUM 9525), 119 spms. (NP 9616), 2 spms. (MGC 581); Vigoleno: 9 spms. (NP 9621); Bibbiano: 1 spm. (MPUM 9526), 4 spms. (NP 9602); Casa Cuccule: 1 spm. (NP 9607); Ciuciano: 2 spms. (NP 9604); Il Campino: 5 spms. (MPUM 9527), 34 spms. (NP 9606), 130 spms. (PPMM 51647-51776); Linari: 4 spms. (NP 9608); Marcialla: 5 spms. (PPMM 51777-51781); Montaione: 20 spms. (NP 9609); Montenero: 1 spm. (NP 9611); Altavilla Milicia: 1 spm. (NP 9622), 2 spms. (private collection); Bonares, Huelva, Spain: 4 spms. (NP 9623).

Material examined for comparison. Bovetto: 16 spms. (MPUM 9535) of *Natica filosa* Philippi, 1845.

Characters

Protoconch: small to medium, depressed turbiniform of 2.75-3 convex, smooth whorls, tip small.

Shell: globose, rather thin.

Spire: conical, depressed, whorls gently convex.

Suture: linear, adpressed.

Body whorl: inflated, moderately extended but not expanded toward the aperture; subsutural shelf obscure or lacking.

Aperture: D-shaped, height about 1.6 times the width.

Parietal callus: subquadrate, rather thick.

Umbilicus: usually filled by the umbilical callus, occasionally a semicircular groove or an abapical chink.

Funicle: not visible.

Umbilical callus: large and thick, moderately prominent, located at the middle of the columellar lip, semicircular in outline and not separated from the parietal callus.

Basal fasciole: indistinct.

Surface: with prosocline growth lines.

Color: background uniform pale brown with darker subsutural band and a pattern of reddish-brown, undulating collabral lines.

Operculum:

- rather thin;
- central callus flat, bean-shaped, bounded adaxially by a semicircular, flat-topped ridge;
- inner margin slightly arched, with blunt transverse ridges adapically;
- inner surface gently convex, nucleus not protruding;
- outer surface concave, with 1 distinct marginal groove bounding a rather wide peripheral band;
- groove very fine to faint.

Dimensions (mm):

DHW	PD	H	D	SH
0.08-0.12	1.10-1.46	3.37-10.37	3.03-10.31	0.33-2.73
0.10	1.28	6.87	6.67	1.53
AH	AW	UW = WUC	IS	SA
2.72-7.96	1.63-5.07	1.26-4.30	10°-38°	99°-127°
5.34	3.35	2.78	24°	113°

Remarks. The name *tectula* was created by Bonelli (1826) to designate naticid shells with the umbilicus filled by a callus, and simply listed (n. 3480) in the manuscript catalogue of the Zoological Museum of Turin. The name *tectula* was just cited later on by Sismonda (1842, 1847), Bronn (1848) and d'Orbigny (1852). Sacco (1890) first published a concise diagnosis of *tectula*, thus making available the name, and is to be considered the author of the species.

Natica filosa Philippi, 1845 is strikingly similar as regards the shell characters (Pl. 2, fig. 10, 11); at most, the adult specimens exhibit an umbilical chink somewhat wider than that of the present species. However, *filosa* can be easily differentiated from *tectula* on the basis of the moderately thick operculum that lacks the marginal groove (Pl. 3, figs. 10, 11) and is characteristic of the genus *Cryptonatica* Dall, 1892. The Recent *Natica affinis* Gmelin, 1791 and *Natica operculata* Jeffreys, 1885 are closely similar too. The former differs in that has a smooth operculum, the latter in having a 2-whorled protoconch with markedly greater diameter of the first half whorl and the operculum with narrow, half crescent-shaped central callus.

Stratigraphic occurrence. *T. tectula* is a rather long-ranging and widely distributed taxon. Reliable Miocene records were from Hemmoorian (Late Burdigalian/Early Langhian) of Denmark (Arnum Formation), Middle Miocene of Piedmont, Late Miocene of Spain and Italy. The species occurs commonly in Zanclean and Piacenzian deposits of Italy and Spain, whereas its presence in the Gelasian is very scanty. The rare quotations from the Pleistocene need to be confirmed; these could actually refer to *Cryptonatica filosa* (Philippi, 1845).

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APPENDIX (Locality data)

Piedmont

1. **Borelli,** Moncucco Torinese (Torino Province). A small outcrop, approximately 150 m northeast of the hamlet named Borelli (formerly Tetti Borelli), exposes medium to coarse sand of late Early Messinian age. For additional information, reference to Pavia (1991).

2. Cassine (Alessandria Province). Active quarry (brick factory) south-southwest of Cassine, at the junction of the road from S. Andrea to road 30 connecting Alessandria to Acqui Terme. Gray, unbedded silty clay belonging to the Argille di Lugagnano (Lugagnano Clay) of Zanclean age. For additional information, reference to Robba (1990).

3. Cossato (Biella Province). Diggings in the village, on the left bank of Torrente Strona, have exposed 0.50 m of fine, gray fine sand of Middle Pliocene age. For additional information, reference to Aimone & Ferrero Mortara (1983).

4. Masserano (Biella Province). Exposure on the left bank of Torrente Osterla, south-southwest of the village of Masserano. Sand overlain by gray silty sand of Middle Pliocene age. For additional information, reference to Aimone & Ferrero Mortara (1983).

5. Villalvernia (Alessandria Province). Exposure on the right bank of the stream Rio Vaccaruzza, northeast of the village of Villalvernia. Fine sand, more or less clayey, pertaining to the uppermost part of the Argille di Lugagnano; the age is likely Piacenzian. For additional information, reference to Brambilla (1976).

6. Volpedo (Alessandria Province). A 30.5 m thick section exposed on the left side of the stream Rio Limbione, between La Cascinetta and Cascina Piani, 2 km east of the village of Volpedo. Silty sand is the dominant lithotype, with minor intercalations of sandy silt and sandstone, likely forming the transition between the Argille di Lugagnano and the Sabbie di Asti (Asti Sand); this section was assigned a general Pliocene age. For additional information, reference to Benigni & Corselli (1982).

Liguria

7. **Bussana Vecchia**, Sanremo (Imperia Province). Active quarry north of Bussana Vecchia, about 200 m beyond the A 10 highway connecting Genova to the state border at Ventimiglia. The quarry exposes a 14 m thick section of gray, unbedded clayey silt belonging to the Argille di Ortovero (Ortovero Clay); the age is late Zanclean to early Piacenzian.

8. **Caranchi**, Albenga (Savona Province). The outcrop, presently hindered by a slide, is located on the right side of the stream Rio Torsero, along a rodlet about 0.4 km west of Casa Bruno. Gray silty clay belonging to the Argille di Ortovero; the age is MPL 4, i.e. early Piacenzian (cf. Violanti 1987 and Bernasconi & Robba 1994).

9. **Rio Torsero**, Albenga (Savona Province). The Pliocene deposits crop out on both sides of the stream Rio Torsero, where the A 10 highway bridges the stream, southwest of the village of Ceriale near Albenga. The section exposes 8.50 m of light gray, very sandy clayey silt forming the uppermost part of the Argille di Ortovero. The clayey silt yielded planktonic foraminiferal assemblages pointing toward a MPL3 to MPL4, i.e. a late Zanclean to early Piacenzian age. For addi-

tional information, reference to Violanti (1987) and Bernasconi & Robba (1994).

Emilia

10. **Arda,** Castell'Arquato (Piacenza Province). At the foot of gully on the left side of Torrente Arda, along the road connecting Castell'Arquato to Lugagnano, approximately 2 km southwest of the former village. Gray sandy clay belonging to the Argille di Lugagnano (Lugagnano Clay) of Piacenzian age (cf. Rio et al. 1988).

11. **Arda II**, Castell'Arquato (Piacenza Province). Right bank of Torrente Arda, approximately 330 m downstream of the bridge leading to Castell'Arquato. Silty clay interbedded with sandy layers of Early Pleistocene age (cf. Dominici 2004 and Brunetti & Vecchi 2005).

12. **Bacedasco** (Piacenza Province). Gully on the left side of Torrente Ongina, south of Costa Stradivari, about 1.5 km southwest of the village of Bacedasco. Gray sandy clay (Argille di Lugagnano) of Piacenzian age (cf. Rio et al. 1988 and Raffi et al. 1989).

13. **Badagnano** (Piacenza Province). Gully named Rio dei Carbonari, on the right side of Torrente Chero, about 0.5 km southeast of the village of Badagnano. Gray sandy clay belonging to the Formazione di Castell'Arquato (Castell'Arquato Formation); the age is likely Piacenzian (cf. Raffi 1982).

14. **Balzo del Musico,** Monte S. Pietro (Bologna Province). Slope cut (presently hindered by a wall) for housing project on the left of the road connecting Rivabella to Monte S. Pietro, about 0.35 km southwest of Landa. Gray clayey sand of Late Pliocene age. The locality was dealt with by Busacchi (1896).

15. **Campore**, Salsomaggiore Terme (Parma Province). Active quarry near Campore (northeastern outskirts of Salsomaggiore Terme). The quarry exposes a 50 m thick section of silty clay of Piacenzian age (cf. Raffi & Taviani 1983 and Bertolaso & Palazzi 1997).

16. **Castell'Arquato** (Piacenza Province). Outcrop (presently hindered by a gabion barrier) on the right bank of Torrente Arda, at the bridge leading to Castell'Arquato. Gray sand of the lower member of the Formazione di Castell'Arquato; the age is Piacenzian (cf. Raffi 1982 and Raffi et al. 1989).

17. **Diolo** (Piacenza Province). Cliff on the left side of Torrente Chiavenna, right southwest of the village of Diolo. Gray sandy clay (Argille di Lugagnano) of Piacenzian age (cf. Raffi 1982).

18. **Lugagnano** (Piacenza Province). Large active quarry (R.D.B. brick factory) approximately 1,2 km southeast of Lugangnano. Gray clay (Argille di Lugagnano) of Zanclean age (cf. Rio et al. 1988).

19. **Montegibbio**, Sassuolo (Modena Province). Gully on the right side of the stream named Rio delle Bagole and small exposure about 400 m south of Cà del Chierico, coinciding respectively with collecting sites C_2 and C_3 of Davoli (1972). Gray clayey marl belonging to the Formazione del Termina (Termina Formation); the age is Tortonian.

20. **Montezago** (Piacenza Province). Small gully near Chiesa di Montezago. Yellow, medium sand (lower member of the Castell'Arquato Formation) of early Piacenzian age (cf. Raffi 1982).

21. **Pradalbino I** (Bologna Province). Gully southwest of the ruined church of Pradalbino, 4.5 km south southeast of Crespellano. Bluish-gray, sandy clay of Late Pliocene age. For additional information, reference to Bongiorni (1963).

22. **Pradalbino II** (Bologna Province). Wide gully northeast of the ruined church of Pradalbino exposing bluish-gray silty clay of Late Pliocene age. For additional information, reference to Bongiorni (1963).

23. **Rio Rosello**, near Sariano (Piacenza Province). Right bank of Rio Rosello, about 280 m south west of Case Badini di Sopra. Lenticular body of clayey sand belonging to the Monte Zago Unit of Piacenzian age. For additional information, reference to Pedriali & Robba (2001).

24. **San Lorenzo in Collina** (Bologna Province). Wide gully north of the church of the village of San Lorenzo in Collina, east of Pradalbino. According to the Geological Map of Italy (scale 1:100,000, Sheet 87, Bologna), the age of the bluish-gray clay is Late Pliocene.

25. **Torrente Stirone** (Parma Province). A Plio-Pleistocene section crops out on both banks of the stream, southwest of the town of Fidenza. The naticids were recovered northwest of the church named San Nicomede, from the lower part of level 3 of Papani & Pelosio (1963); the clayey lithotype is of Piacenzian age. For additional information, reference to Papani & Pelosio (1963) and Pelosio & Raffi (1977).

26. **Vigoleno**, Vernasca (Piacenza Province). Excavation along the road, between the cemetery and the hamlet of Vigoleno. Yellowish marly clay of Tortonian age (cf. Venzo & Pelosio 1963).

Tuscany

27. **Barca**, Castelnuovo Berardenga (Siena Province). Excavation near Barca, approximately 4 km west of Castelnuovo Berardenga. Yellow, medium sand presumably of Early Pliocene age.

28. **Bibbiano**, Poggibonsi (Siena Province). Outcrops (Pietrafitta, Fosso di Libbiano, Podere Melograni, Poggio alla Staffa) around the village of Bibbiano, 4 km southwest of Poggibonsi. Yellow medium sand, locally gray sandy clay reported to be of Middle Pliocene age (Bogi et al. 2002).

29. **Casa Cuccule,** Larniano (Siena Province). Deep plowings in the farm area have unearthed fossiliferous light-gray clay of Late Pliocene age (Bogi et al. 2002).

30. **Ciuciano** (Siena Province). Deep plowings in the area locally called Uliveta, 0.4 km west of the village of Ciuciano have unearthed yellowish rather fine sand of Early Pliocene age. For additional information, reference to Forli & Dell'Angelo (2000).

31. **Il Campino**, Rapolano Terme (Siena Province). Small outcrop in the area locally named Terre Rosse, along the road connecting Siena to Monte S. Savino, approximately 1.5 km near the junction to road 326. Yellow clayey sand of late Zanclean age. For additional information, reference to Laghi (1984).

32. **La Serra**, San Miniato (Pisa Province). Small quarry adjacent to the hamlet of La Serra. Light-gray sandy clay and clayey fine sand of Middle Pliocene age. For additional information, reference to Benvenuti et al. (1997).

33. **Linari**, Barberino Val d'Elsa (Firenze Province). Deep plowings 0.5 km south of the hamlet of Linari, on the left of the road leading to state road 429, have unearthed yellow medium sand of Middle Pliocene age (Bogi et al. 2002).

34. **Marcialla**, Barberino Val d'Elsa (Firenze Province). Slope cut west of the village of Marcialla and adjacent to it. Gray clayey sand of Early-Mid Pliocene age (cf. Dominici et al. 1997).

35. **Monsindoli** (Siena Province). Quarry close to the village of Monsidoli. Gray clay of Early Pliocene age (cf. Manganelli et al. 2004).

36. **Montaione** (Firenze Province). Deep plowings in front of the country-house Villa Filicaia, approximately 0.5 km southeast of the village of Montaione, have unearthed gray medium to coarse pebbly sand belonging to the unit named Sabbie di Gambassi (Gambassi Sand). According to Dominici et al. (1997), the age is Early Pliocene. For additional information, reference to Della Bella & Scarponi (2001).

37. **Montenero**, Castel del Piano (Grosseto Province). Decommissioned small quarry approximately 1.7 km southeast of Montenero. The naticids were recovered from a 50 cm thick layer of black to gray clay of Zanclean age. For additional information, reference to Forli et al. (1999).

38. **Orciano Pisano** (Pisa Province). Deep plowings all around an electric power substation, approximately 1.5 km southwest of the

village of Orciano Pisano, have unearthed brown-greenish clay of Zanclean age.

39. **Ponte a Elsa**, San Miniato (Pisa Province). Quarry west of Ponte a Elsa and adjacent to it. Grey sandy to silty clay forming the basal part of the exposed section. The age is Late Pliocene. For further information, reference to Valleri et al. (1990).

40. **Spicchio**, Empoli (Firenze Province). Decommissioned quarry of a brick factory in the northern suburbs of Empoli, near the small village of Spicchio. Gray sandy clay of Early-Mid Pliocene age (cf. Dominici et al. 1997).

Latium

41. **Guidonia** (Roma Province). Wide quarry near Guidonia, in the locality named Formello. Dark-gray clay and sandy clay of Zanclean or early Piacenzian age. For further information, reference to Mancini (1997).

Calabria

42. **Benestare** (Reggio di Calabria Province). Outcrops northwest of Benestare, on the northern slope of Poggio Frandina, along a right tributary stream of Torrente Baracalli. Bluish-gray clay and jellowish sandy clay of Tortonian age. For further information, reference to Vazzana (1991).

43. **Bovetto**, Croce Valanidi (Reggio di Calabria Province). Small excavations in the area named Trombaca, between Vallone Bovetto and Fiumara d'Arno, about 1 km north-northwest of Croce Valanidi. Gray-brown "*Strombus* sand" with fine gravel and pebbles; the age is Tyrrhenian. For further information, reference to Bonfiglio (1972).

44. **Ravagnese** (Reggio di Calabria Province). Excavations (presently hindered by buildings) in the area named Galluccio, about 700 m east of Ravagnese. Gray-brown "*Strombus* sand" with fine gravel and pebbles; the age is Tyrrhenian. For further information, reference to Bonfiglio (1972).

Sicily

45. **Altavilla Milicia** (Palermo Province). Cliff on the right bank of Milicia River, close to the northwestern end of Altavilla Milicia, corresponding to collecting site 5 of Moroni & Paonita (1964). Section, over 40 m thick, of yellow sand ("Altavilla Sand" of Ruggieri et al. 1967) with abundant fossil mollusks. The reported age is Early Pliocene. For further information, reference to Moroni & Paonita (1964) and Ruggieri et al. (1967).