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

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Key words: Taxonomy, Gastropods, Naticinae, Cochlis, Tanea, Tectonatica, Pliocene, Northern and Central Italy.

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 (epiglosseniculata and fredianii) fully match the characters of the genus Cochlis Roding, 1798, one (koeneni) is assigned to the genus Tanea Marwick, 1931, the rest (astenisi, prietoi and teculata) 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 Cryptonautica 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.

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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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 prietoii*, 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 epigloata* 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 *Polimices* Montfort, 1810, *prietoii* was never cited as fossil. From the review of the literature, it appears that only *astensis* and *tectula* were currently re-

Fig. 1 - Sketch map of naticid localities; locality numbers are those in the appendix.
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 (epiglafofuniculata Sacco, 1890 and fredianii sp. n.) belong to the genus Coelobis Röding, 1798, another (dillayni 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 Coelobis 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.

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.

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 whors are sufficient to distinguish species.

As regards the present material, we have found convenient to examine Coelobis 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 epiglafofuniculata, fredianii, koeneni, and to the taxa already treated by Pedriali & Robba (2005) along with Tanea dillayni (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, fisola Phipps, 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 Coelobis species (epiglafofuniculata and fredianii), medium-sized in Tanea dillayni 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-planktrophic larval development. Considering the relations between diameter of the first half whorl (DHW) and number of protoconch whors (Fig. 4) as well as those between 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 whors (Fig. 8) and between the PD/DHW ratio and number of protoconch whors (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 whors 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.

PD/DHW ratio and number of protoconch whors (Fig. 5), it appears that epigloasuniculata, freddani 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 whors and that there is a direct correlation between the PD/DHW ratio and the protoconch whors. Actually, the 1.25 whorled protoconch of freddani has a larger tip (0.25 mm), whereas the 1.5-2 whorled larval shells of epigloasuniculata and koeneni have smaller ones. Conversely, the PD/DHW ratio is higher in koeneni, lower in epigloasuniculata and more so in freddani.

The species of Tectonatica considered herein have small (prieto) 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
serves to distinguish *epigloasfuniculata* from *fredianii*, both from part of the other *Cochlis* species, from *koeneni* and from taxa in the Tectonatica/Cryptonatica group but for *epigloasfuniculata* from *prieti*. For this character, *koeneni* differs from species of *Natia* and *Cochlis* (except for *plicatula*), from *diluvyni* and from *prieti*. Within the Tectonatica/Cryptonatica group, the percent difference in diameter can be used to separate:

- *astensis* from *prieti*;
- *prieti* from *tectula*.

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

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

**Teleconch**

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 scatter relative to taxa of *Cochlis* and *Tanea* (*epigloasfuniculata*, *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 *epigloasfuniculata*, *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 *epigloasfuniculata*, 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).
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**Legend:**
- **Tanea:** T. dillwyni, T. koeneni, T. adansoni, T. astensis, T. filosa, T. prietoi, T. rizzae, T. tectula
- **Natica:** N. virguloides, N. depressofuniculata, N. epigloafuniculata
- **Cochlis:** C. fredianii, C. fulgurata, C. obliquicallosa, C. plicatula, C. propinqua, C. pseudoepiglottina, C. raropunctata, C. strictiumbilicata, C. sulcogradata, C. undata, C. vittata
- **Tectonatica/Cryptonatica:** T. dillwyni, C. koeneni, C. adansoni, C. astensis, C. filosa, C. prietoi, C. rizzae, C. tectula

**Note:** The table shows differences in number of perfectly resolved nuclei within species pairs. Differences are indicated with numerical values.
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Tab. 2 - Matrix showing percent difference in diameter of the larval shell within species pairs; significant values are bolded. All the naticine taxa found to occur in the Pliocene (Pedriani & Robba 2005; present paper) are listed; dillwyni, adansoni, filosa and rizzae also enclosed for comparison.
| Species       | Natica virguloides | Cochlis depressofuniculata | Cochlis epigloafuniculata | Frediania fredianii | Fulgurata fulgurata | Obliquicallosa obliquicallosa | Plicatula plicatula | Propinqua propinqua | Pseudoepiglottina pseudoepiglottina | Raropunctata raropunctata | Strictiumbilicata strictiumbilicata | Sulcogradata sulcogradata | Vittata vittata | Dillwyni dillwyni | Koenei koenei | Adansoni adansoni | Filosa filosa | Prietoi prietoi | Rizzaii rizzaii | Tectula tectula |
|--------------|---------------------|-----------------------------|----------------------------|----------------------|---------------------|-------------------------------|---------------------|----------------------|-------------------------------------|----------------------------------|----------------------------------------|--------------------------|-----------------|----------------------|-----------------|----------------------|----------------------|------------------|------------------|---------------------|---------------------|
| Metric       | 71.9                | 26.4                        | 47.9                       | -6.4                 | -13.8               | -15.3                        | -31.8               | -12.7                | -26.9                 | -31.2               | -14.8                    | -10.4                    | 6.2            | 9.3                  | 8.8             | 4.1                  | 1.9                 | -12.4             | -14.8            | -3.3                |
| Width        | 1.1                | 1.1                         | 1.1                        | 1.1                  | 1.1                 | 1.1                          | 1.1                 | 1.1                  | 1.1                   | 1.0                 | 1.1                      | 1.1                      | 1.1            | 1.1                  | 1.1             | 1.1                  | 1.1                 | 1.1                | 1.1              | 1.1                |
| Height       | 1.1                | 1.1                         | 1.1                        | 1.1                  | 1.1                 | 1.1                          | 1.1                 | 1.1                  | 1.1                   | 1.0                 | 1.1                      | 1.1                      | 1.1            | 1.1                  | 1.1             | 1.1                  | 1.1                 | 1.1                | 1.1              | 1.1                |
| Angle        | 1.1                | 1.1                         | 1.1                        | 1.1                  | 1.1                 | 1.1                          | 1.1                 | 1.1                  | 1.1                   | 1.0                 | 1.1                      | 1.1                      | 1.1            | 1.1                  | 1.1             | 1.1                  | 1.1                 | 1.1                | 1.1              | 1.1                |

*Note: The above table shows the differences in measurements of various species. The values are presented in a tabular format for easier comparison.*
The combined regression for these small-sized species fits in with that of the *rarapectata* 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 *epigloasuniculata, koeneni* and in the *Tectonatica/Cryptonatica* species; the correlation for *frediani* was lower \((r = 0.50)\) but still significant. Measurements of the shells belonging to *epigloasuniculata, frediani* and *koeneni* form a wide scatter (Fig. 11). The slope and elevation of *epigloasuniculata* 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 *rarapectata* group (*obliquicallosa* excluded). The line for *frediani* 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, epigloasuniculata* and of the other species in the *rarapectata* group. However, Fig. 11 shows that medium-sized shells of *frediani* are indistinguishable from those of *epigloasuniculata* 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 *rarapectata* group, *placulata* 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 viitata* (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, 1892 and *Cochlis rarapectata 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. 10](image_url) - Relationship between maximum diameter and shell height (species of *Tectonatica* and *Cryptonatica*); open squares: *astensis*; solid circles: *filosa*; open triangles: *frediani*; gray-shaded diamonds: *testula*.

![Fig. 11](image_url) - Relationship between spire height and shell height (species of *Cochlis and Tanae*, this study); open squares: *frediani*; solid triangles: *epigloasuniculata* and *koeneni* combined.
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 *epigloasfuniculata*, *fredianii* and *koeneni* (not illustrated) shows that the scatters of *epigloasfuniculata* 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
here), no significant difference could be detected between *epigloafuniculata*, *frediani* 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 sub-rounded 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*, *frediani* 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 *frediani*, 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 *frediani*. 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*, *frediani* and *koeneni* than in the other Pliocene species.

---

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Natica</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>virguloides</em></td>
<td>141°</td>
<td>8</td>
<td>125°-157°</td>
</tr>
<tr>
<td><strong>Cochlis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>depressosuniculata</em></td>
<td>128°</td>
<td>7</td>
<td>114°-142°</td>
</tr>
<tr>
<td><em>epigloafuniculata</em></td>
<td>126°</td>
<td>7</td>
<td>112°-140°</td>
</tr>
<tr>
<td><em>frediani</em></td>
<td>121°</td>
<td>10</td>
<td>101°-141°</td>
</tr>
<tr>
<td><em>fulgarata</em></td>
<td>128°</td>
<td>9</td>
<td>110°-146°</td>
</tr>
<tr>
<td><em>propinqua</em></td>
<td>125°</td>
<td>7</td>
<td>111°-139°</td>
</tr>
<tr>
<td><em>raropunctata</em></td>
<td>125°</td>
<td>9</td>
<td>107°-143°</td>
</tr>
<tr>
<td><em>obliquecarinosa</em></td>
<td>134°</td>
<td>9</td>
<td>114°-154°</td>
</tr>
<tr>
<td><em>strictumumbilicata</em></td>
<td>115°</td>
<td>5</td>
<td>105°-125°</td>
</tr>
<tr>
<td><em>sulcogradata</em></td>
<td>130°</td>
<td>7</td>
<td>116°-144°</td>
</tr>
<tr>
<td><em>undata</em></td>
<td>129°</td>
<td>6</td>
<td>117°-141°</td>
</tr>
<tr>
<td><em>plicatula</em></td>
<td>122°</td>
<td>8</td>
<td>106°-138°</td>
</tr>
<tr>
<td><em>pseudoepiglottina</em></td>
<td>116°</td>
<td>8</td>
<td>100°-132°</td>
</tr>
<tr>
<td><em>vittata</em></td>
<td>117°</td>
<td>8</td>
<td>101°-133°</td>
</tr>
<tr>
<td><strong>Tanea</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>koeneni</em></td>
<td>120°</td>
<td>5</td>
<td>110°-130°</td>
</tr>
<tr>
<td><strong>Tectonatica</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>astensis</em></td>
<td>110°</td>
<td>18</td>
<td>74°-146°</td>
</tr>
<tr>
<td><em>prietoi</em></td>
<td>113°</td>
<td>6</td>
<td>101°-125°</td>
</tr>
<tr>
<td><em>rectula</em></td>
<td>113°</td>
<td>7</td>
<td>99°-127°</td>
</tr>
</tbody>
</table>

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

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-
<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>standard deviation</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natica</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>virgaloides</td>
<td>22°</td>
<td>2</td>
<td>18°-26°</td>
</tr>
<tr>
<td>Cochlis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>depressofuniculata</td>
<td>30°</td>
<td>6</td>
<td>18°-42°</td>
</tr>
<tr>
<td>epigloaefuniculata</td>
<td>24°</td>
<td>5</td>
<td>14°-34°</td>
</tr>
<tr>
<td>freedianii</td>
<td>22°</td>
<td>5</td>
<td>12°-32°</td>
</tr>
<tr>
<td>fulgarata</td>
<td>25°</td>
<td>5</td>
<td>15°-35°</td>
</tr>
<tr>
<td>propinqua</td>
<td>30°</td>
<td>6</td>
<td>18°-42°</td>
</tr>
<tr>
<td>raropunctata</td>
<td>27°</td>
<td>6</td>
<td>15°-39°</td>
</tr>
<tr>
<td>obliquicallosa</td>
<td>25°</td>
<td>6</td>
<td>13°-37°</td>
</tr>
<tr>
<td>strictumbilicata</td>
<td>26°</td>
<td>4</td>
<td>18°-34°</td>
</tr>
<tr>
<td>sulcogradata</td>
<td>26°</td>
<td>5</td>
<td>16°-36°</td>
</tr>
<tr>
<td>undata</td>
<td>25°</td>
<td>7</td>
<td>11°-39°</td>
</tr>
<tr>
<td>plicatula</td>
<td>28°</td>
<td>7</td>
<td>14°-42°</td>
</tr>
<tr>
<td>pseudoepiglottina</td>
<td>33°</td>
<td>6</td>
<td>21°-45°</td>
</tr>
<tr>
<td>vittata</td>
<td>30°</td>
<td>7</td>
<td>16°-44°</td>
</tr>
<tr>
<td>Tanea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>koeneni</td>
<td>18°</td>
<td>4</td>
<td>10°-26°</td>
</tr>
<tr>
<td>Tectonatica</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>astensis</td>
<td>25°</td>
<td>5</td>
<td>15°-35°</td>
</tr>
<tr>
<td>prietoi</td>
<td>22°</td>
<td>3</td>
<td>16°-28°</td>
</tr>
<tr>
<td>tectula</td>
<td>24°</td>
<td>7</td>
<td>10°-38°</td>
</tr>
</tbody>
</table>

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

Natica: virgaloides - 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.

epigloaefuniculata - thick, subquadrangular, reaching the basal fasciole; anterior lobe absent.

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

fulgarata - thick, short and broad, ending some distance from the basals 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.

strictumbilicata - 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 callos of the naticine taxa found to occur in the Pliocene (Pedrioli & Robba 2005; present paper).
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 Tectonatia/Cryptonatia 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 frediani (r = 0.63). The regression for frediani (scatter not illustrated here) has the same slope of the combined regression (Pedriali & Robba 2005, text-fig. 14 A) for the Cochlis species propinquus.
<table>
<thead>
<tr>
<th>Natica</th>
<th>basal fasciole</th>
</tr>
</thead>
<tbody>
<tr>
<td>virguloides</td>
<td>poorly differentiated, marked by the bending of the growth lines</td>
</tr>
<tr>
<td>depressosomniculata</td>
<td>wide, markedly depressed, defined abaxially by the sudden deviation of growth lines</td>
</tr>
<tr>
<td>epiglosofuniculata</td>
<td>moderately wide, markedly depressed, defined abaxially by the sudden deviation of growth lines</td>
</tr>
<tr>
<td>frediani</td>
<td>wide, edge abaxially by a low, rounded step.</td>
</tr>
<tr>
<td>fulgurata</td>
<td>moderately wide, bluntly rounded, defined abaxially by a low, obtuse angulation</td>
</tr>
<tr>
<td>obliquicallosa</td>
<td>wide, sharply edge abaxially by a low step.</td>
</tr>
<tr>
<td>plicatula</td>
<td>nearly indistinct.</td>
</tr>
<tr>
<td>propina</td>
<td>moderately wide, bounded abaxially by a rounded step.</td>
</tr>
<tr>
<td>pseudoepiglottina</td>
<td>blunt and rather broad, defined abaxially by a very low step, occasionally only by the sudden deviation of the growth lines</td>
</tr>
<tr>
<td>raropunctata</td>
<td>wide, sharply edge abaxially by a low step.</td>
</tr>
<tr>
<td>strictimblicata</td>
<td>moderately wide, not prominent at all, defined abaxially by the sudden bending of the growth lines</td>
</tr>
<tr>
<td>sulcogradata</td>
<td>wide and blunt, defined abaxially by the deviation of the growth lines or by a spiral, incised line</td>
</tr>
<tr>
<td>undata</td>
<td>wide, triflingly prominent or not prominent at all, defined abaxially by the sudden deviation of the growth lines or by an incised spiral line</td>
</tr>
<tr>
<td>vittata</td>
<td>poorly differentiated, defined abaxially by the bending of the growth lines.</td>
</tr>
<tr>
<td>Tanea</td>
<td>nearly indistinct.</td>
</tr>
<tr>
<td>Tectonatica</td>
<td>nearly indistinct.</td>
</tr>
<tr>
<td>koeneni</td>
<td>nearly indistinct.</td>
</tr>
<tr>
<td>prietoi</td>
<td>nearly indistinct.</td>
</tr>
<tr>
<td>tectula</td>
<td>indistinct.</td>
</tr>
</tbody>
</table>

Tab. 7 - Features of basal fasciole of the natice taxa found to occur in the Pliocene (Pedrali & 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 *frediani* 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 Pedrali & Robba (2005). As regards the six taxa dealt with herein, this shell feature is bounded abaxially by a rounded step in *frediani*, by the sudden deviation of the growth lines in *epiglosofuniculata*, 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 microstriaion was noted on the body whorl of *epiglosofuniculata*, *frediani* 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 Pedrali & Robba (2005) included for comparison. From Tab. 8, it will be seen that *epiglosofuniculata* and the three *Tectonatica* species have distinctive color patterns, whereas *frediani* 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 (Pedrali & Robba 2005; present study). From Tab. 9, it will be seen that the opercula of the two species of *Cochlis* (*epiglosofuniculata* and *frediani*) belong to group 1 as defined by Pedrali & Robba (2005, p. 130) in that their outer surface is sculptured with 2 marginal grooves alternating with 2 ridges. The operculum of *epiglosofuniculata* resembles only that of *Cochlis depressosomniculata* (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 *frediani* 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 Na ticinae. 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
<table>
<thead>
<tr>
<th>Natica</th>
<th>background</th>
<th>color pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>virguloides</td>
<td>not observable</td>
<td>14. reddish brown dots and 2 spiral rows of large, approximated, irregular spots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cochlis</th>
</tr>
</thead>
</table>
| depressofuniculata | light brown | reddish pattern which may consist of:
1. uneven, irregularly arranged spots
2. spiral elongated oval spots
3. spiral elongated spots and/or chevron marks which may fuse to form collabral stripes |
| epiglosanopiculata | light brown | reddish pattern which may consist of:
15. uneven, subquadrangular spots, irregularly arranged into spiral rows |
| freedianii | light brown | reddish pattern of:
10. moderately large, even spots irregularly arranged into collabral rows |
| fulgarata | 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 |
| propinquata | light brown | reddish pattern of:
8. dense, undulating, collabral lines or stripes; spots may replace lines in later stages (rare occurrence) |
| pseudoepiglottina | • uniform pale brown to pinkish brown without any color pattern
• pale reddish brown | red pattern which may consist of:
9. crowded, uneven and irregularly arranged small dots which may fuse adaxially to form subcostal serrations |
| 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
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 |
| strictumbilicata | 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 subcostal dark band is also present |

<table>
<thead>
<tr>
<th>Tanea</th>
</tr>
</thead>
<tbody>
<tr>
<td>koenem</td>
</tr>
<tr>
<td>Tectonatica</td>
</tr>
<tr>
<td>asteris</td>
</tr>
<tr>
<td>prionia</td>
</tr>
<tr>
<td>tectula</td>
</tr>
</tbody>
</table>

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. epiglosanopiculata (Sacco, 1890), C. freedianii sp. n., C. fulgarata (Menghini in Pechcioli, 1864), C. plicatula (Bronn, 1831), C. propinquata (Pechcioli, 1864), C. pseudoepiglottina (Sacco, 1890), C. raropunctata raropunctata (Sasso, 1827), C. raropunctata obliquicallosa Pedriali & Robba, 2005, C. strictumbilicata (Sacco, 1891), C. sulcogradata Pedriali & Robba, 2005, C. undata (Sasso, 1827), C. vittata (Gmelin, 1791), Tanea diluvium koenem (Sacco, 1891),
Tectonatica astensis (Sacco, 1892), 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 epiglosofuniculata, ferdiamii, fulgurata, pseudopiglottina, 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 Pedrali & 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, Coblis 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 Pedrali & 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. 8 A, 8 B of Pedrali & 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 obliquuscallosa which is definitely low-spired. The spire angle proved to be of no relevance. Ultimately, the structure, ordinarily adressed, is more or less deeply channelled 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 (Pedrali & Robba 2005; present study). The greatest values of the umbilicus width were noted to occur in sulcogradata, whereas the smallest ones pertain to epiglosofuniculata 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., epiglosofuniculata, astensis and prietoi) from the others having the umbilical callus with more or less prominently arched outline. Exception are obliquuscallosa 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 (Pedrali & 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 (Pedrali & 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.
<table>
<thead>
<tr>
<th>Natica</th>
<th>central callus</th>
<th>marginal outer sculpture</th>
<th>outer groove</th>
<th>middle groove</th>
<th>inner groove</th>
<th>outer ridge</th>
<th>middle ridge</th>
<th>inner ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>virguloides</td>
<td>short, nearly perpendicular to the inner margin. <strong>bowed adapically by a step</strong></td>
<td>2 grooves, 2 ridges</td>
<td>broad and deep, with gently concave bottom and subvertical sides</td>
<td>similar to the outer one, deeper</td>
<td>rather sharp</td>
<td>robust, with flatly convex top and vertical sides</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| 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 |
| strictumblemica | 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 broadly rounded top and slightly concave sides |
| subcogradata  | elongate | 2 grooves, 2 ridges | wide, arched in cross section, with dense granules sometimes forming 1-2 secondary thin ridges | equally wide, bowed adaxially by an abrupt angulation | sharp | 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 longitudinal rows of granules | usually narrower and less excavated, sometimes attenuated or obsolete | sharp | to round-topped |
| obliquicallosa | operculum indistinguishable from that of <em>ruropunctata</em> |             |              |              |              | usualy well developed, thin to thick, with sharp to flat top, seldom obsolete |
| fredianii     | rather short | 2 grooves, 2 ridges; marginal area sloping inward | wide and shallow |              |              | sharp |              | 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 |</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Morphology</th>
<th>Width and Shallow Sloping</th>
<th>Depth</th>
<th>Marginal Area</th>
<th>Margin</th>
<th>Grooves</th>
<th>Outer Grooves and Ridges</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>depressofuniculata</td>
<td>elongate</td>
<td>wide and shallow, sloping adaxially, bearing longitudinal rows of granules</td>
<td>of variable breadth, exceedingly shallow to obsolescent</td>
<td>thin and moderately prominent</td>
<td>identical to the outer one, bent toward the inner furrow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>epigloafuniculata</td>
<td>elongate</td>
<td>narrow and deep, bearing oblique rows of granules</td>
<td>very wide and rather deep</td>
<td>thin and prominent</td>
<td></td>
<td></td>
<td></td>
<td>thick, flat-topped, bent toward the inner furrow</td>
</tr>
<tr>
<td>pseudoepiglottina</td>
<td>bent toward inner margin</td>
<td>rather narrow and shallow</td>
<td>similar to the outer one</td>
<td>wider and deeper, with subvertical outer side</td>
<td>blunt and low</td>
<td>sharp, thinner, occasionally thread-like</td>
<td>similar to the outer one</td>
<td></td>
</tr>
<tr>
<td>vittata</td>
<td>short, nearly oval</td>
<td>narrow, well incised, attenuated during growth</td>
<td>similar to the outer one</td>
<td>wider, moderately excavated, with outer side-subvertical or sloping outward</td>
<td>thin, flat-topped</td>
<td>wider, flat topped</td>
<td>similar to the outer one</td>
<td></td>
</tr>
<tr>
<td>Tanea</td>
<td>operculum with 1 groove bounding a broad, more or less swollen marginal area bearing a median groove</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>koeneni</td>
<td>arched toward the inner margin</td>
<td>1 groove, 1 ridge</td>
<td>moderately narrow, deep, with sloping outer side and vertical, step-like inner one</td>
<td>very robust, swollen, with a deep and narrow median groove</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tectonatica</td>
<td>operculum with 1 groove bounding a more or less wide peripheral band</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>astensis</td>
<td>broad and short, parallel to the abaxial margin</td>
<td>1 groove bounding a wide peripheral band</td>
<td>narrow to moderately wide, more or less deep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prietoi</td>
<td>subtriangular, oblique</td>
<td>1 groove bounding a wide, flat peripheral band bearing 2-3 longitudinal furrows</td>
<td>more or less narrow, shallow to moderately deep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tectula</td>
<td>flat, bean-shaped, bounded adaxially by a semicircular, flat-topped ridge</td>
<td>1 groove bounding a rather wide peripheral band</td>
<td>very fine to faint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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**, **epiglauferculata**, **plicatula**, **vittata**, **astensis**, **prietoi** and **tecutula** 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 **tecutula** that can be characterized also on the basis of one to three of these features.
Five species, i.e. *depressofuniculata*, *propinqua*, *raropunctata*, *strictumbilicata* and *sulcogradata* lack distinctive shell characters and do require opercular 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 Pedrili & 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 *epiglosofuniculata* and *frediani* 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, *epiglosofuniculata* 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* (sensus stricto) vel *Natica* Risso, 1826.” According to Kabat (1991), *Natica Risso* is junior subjective synonym of the valid genus *Natica* Scopoli, 1777. The unique subsequent quotation of *epiglosofuniculata* (Ferrero Morfara et al. 1984) retained the assignment to *Natica* Scopoli. As regards *frediani*, it is proposed herein as new and, obviously, has no previous records. Taking into account the characters of *Natica* as defined by Pedrili & Robba (2005), the application of this genus to *epiglosofuniculata* is untenable since *epiglosofuniculata* lacks the anterior lobe of the parietal callus and has a well developed funicle, attributes that do occur in *frediani* as well. On the basis of these characters and of the opercular features (2 marginal grooves alternating with 2 ridges), both *epiglosofuniculata* and *frediani* appear to fit in with the description of the genus *Cochlis* Röding, 1798 published by Pedrili & 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 *Polymes* (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 opercular 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 *Naticea* have the operculum with 1-3 marginal ridges, those of *Naticarius* have many ribs to the operculum and the Poliniciinae possess a cornose (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 *Naticea* 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 *Naticea zelandica* Quoy & Gaimard, 1832 by original designation. We have examined several specimens of *Naticea 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 *Naticea*. During the last decades, the former was currently regarded to belong to *Tectonica* Sacco, 1890 whereas the latter was kept under *Naticea* up to now. The third species (*tectula*) is the type of *Tectonica* by monotypy (see also Kabat 1991). *Tectonica* was erected (as a subgenus of *Naticea*) 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 columnaari expanso, semilunato, fere omnino tectus.").

*Tectonica* 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 *Tectonica* because of their opercular characters (see descriptions in the systematic account).

The use of *Tectonica* made herein raises the problem of the relations between *Tectonica* and *Cryptonica* Dall, 1892 since some workers regarded *Cryptonica* as a junior synonym of *Tectonica* (Cossmann 1925; Wenz 1941 in 1938-1944; Wrigley 1949 among the others), whereas other authors considered them to be fully distinct genera (Marcinovich 1977; Oyama 1985; Golikov & Sirenko 1988; Majima 1989; Bouchet & Warren 1993). According to the latter authors, the umbilicus entirely closed by the umbilical callus is the main distinguishing character of *Cryptonica* and separates it from *Tectonica* 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 *Cryptonica* and *Tectonica* 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 *Cryptonica*, we concur with Bouchet & Warren (1993) in considering *Naticea 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 *Cryptonica affinis* along with the lectotype, 174 paralectotypes and over 1300 additional specimens of *Tectonica tectula* (the type of *Tectonica*) 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 *Cryptonica* from *Tectonica*; in these circumstances, having been introduced two years later, *Cryptonica* would be a synonym of *Tectonica*. However, in proposing *Cryptonica*, Dall (1892) clearly made reference to "...forms with a smooth calcareous operculum.". A review of the relevant literature shows that species either assigned to *Cryptonica* or to *Tectonica* 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 calyx (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 calyx 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 calyx 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 incorrect 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; Marinovich 1977; Majima 1989; Kabat 1991).

The bulk of the studied material is housed in the Museo di Paleontologia dell’Università, Milan, 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: MGPF, Bellardi-Sacco collection in Museo di Geologia e Paleontologia dell’Università di Torino, Italy; MNCNM, Hidalgo collection in Museo Nazionale di Scienze Naturali, Madrid; PPMN, Magese collection, Milan, Italy; NP, authors’ collection; Dipartimento di Scienze Geologiche e Geotecnologie, Milano-Bicocca, Italy.

The synonymy ordinance refers to the Pliocene. The citations, which are verifiable in that they emphasize accurate 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 synonymy. Other citations, poorly documented or not documented at all, are listed 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: D, 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 calyx; WAD, width of the adoral edge; WAB, width of the abapical edge; 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 Roding, 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) epigloafuniculata var. exsulcata Sacco, p. 60, pl. 2, fig. 28.
1984 Natica millepunctata var. epigloafuniculata - Ferrara Mortara et al., p. 28.
1984 Natica epigloafuniculata var. exsulcata - Ferrara Mortara et al., p. 31.

Type material. The lectotype of Natica (Natica) millepunctata var. epigloafuniculata Sacco (here designated): the shell figured by Sacc (1891, pl. 2, fig. 9) and figured herein (Pl. 1, fig. 1), MGPF BS.029.01.012 (Colli Artesi); 2 paratypes, MGPF BS.029.01.012/01 (Stazzano); 7 paratypes, MGPF BS.029.01.012/02 (S. Agata Fossili); 1 paratypotype, MGPF BS.029.01.012/03 (Borzeii); 15 paratypes, MGPF BS.029.01.012/04 (Savona); 1 paratypotype, MGPF BS.029.01.012/05 (Monte Capriolo); 2 paratypes, MGPF BS.029.01.012/06 (Clavesana).

Other type material. The lectotype of Natica (Natica) epigloafuniculata var. exsulcata Sacco (here designated): the shell figured by Sacco (1891, pl. 2, fig. 28) and figured herein (Pl. 1, fig. 6), MGPF BS.029.01.036 (Savona); 8 paratypes, MGPF BS.029.01.036/01 (Savona).

Material erroneously referred to as Natica epigloafuniculata pseudoporphiglottina Sissmon, 1847 in MGPF. Benvengia: 1 spm. (MGPF BS.029.01.029/10) figured herein (Pl. 1, fig. 2); Savona: 1 spm. (MGPF BS.029.01.029/05).

Material erroneously referred to as Natica epigloafuniculata var. millepunctatusoides Sacco, 1890 in MGPF. Rio Torsero: 1 spm. (MGPF BS.029.01.038/05).

Other material examined. Busana Vecchia: 11 spms. (private collections); Orsino Pirano: 48 spms. (MPUM 9477), 4 spms. (MPUM 9478-9481), 3 spms. (NP 9364), 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, whors moderately convex.
Suture: fine, incised, adpressed.
Body whorl: inflated, somewhat depressed, moderately produced and expanded toward the aperture, with distinct subapertural shell.
Aperture: D-shaped, height averaging 2 times the width.
Parietal callus: thick, subquadangular, 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 columnellar 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 proscline growth lines, slightly stronger on subapertural shell and basal fasciole; a faint spiral striaion is noted on the body whorl.
Color: background light-brown with reddish pattern of uneven, subquadangular spots, irregularly arranged into spiral rows.

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Reference</th>
<th>Umbilical Callus</th>
<th>Operculum</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tectonatica prietoi</em></td>
<td>(Hidalgo, 1873)</td>
<td>moderate to small, separated from the umbilical wall by a wide groove</td>
<td>1 fine, shallow groove bounding the marginal area; marginal area with 2-3 fine grooves</td>
<td></td>
</tr>
<tr>
<td><em>Tectonatica rizzae</em></td>
<td>(Philippi, 1844)</td>
<td>moderate, subtriangular, separated from the umbilical wall by a rather wide groove in the mid-abapical part</td>
<td>1 fine, shallow groove bounding the smooth marginal area</td>
<td></td>
</tr>
<tr>
<td><em>Cryptonatica adamsiana</em></td>
<td>(Dunker, 1859)</td>
<td>small to large, nearly semicircular, separated from the umbilical wall by a moderate to broad groove</td>
<td>with 2 well developed marginal grooves</td>
<td>neither <em>Cryptonatica</em> nor <em>Tectonatica</em>; according to the figure of the operculum, probably <em>Tanea</em></td>
</tr>
<tr>
<td><em>Cryptonatica bathybii</em></td>
<td>(Friele, 1879)</td>
<td>poorly developed</td>
<td>undescribed</td>
<td></td>
</tr>
<tr>
<td><em>Natica (Tectonatica) janthomosoides</em></td>
<td>(Kuroda &amp; Habe, 1949)</td>
<td>large, semicircular, usually separated from the umbilical wall by a groove of variable breadth</td>
<td>with 2 well developed marginal grooves</td>
<td>neither <em>Cryptonatica</em> nor <em>Tectonatica</em>; according to the figure of the operculum, probably <em>Tanea</em></td>
</tr>
<tr>
<td><em>Cryptonatica andoi</em></td>
<td>(Nomura, 1935)</td>
<td>large, semicircular, usually separated from the umbilical wall by a groove of variable breadth</td>
<td>with 2 well developed marginal grooves</td>
<td></td>
</tr>
<tr>
<td><em>Natica (Cryptonatica) oregonensis</em></td>
<td>(Conrad, 1865)</td>
<td>large, semicircular, separated from the umbilical wall by a narrow groove</td>
<td>with 1 low marginal ridge</td>
<td>probably neither <em>Cryptonatica</em> nor <em>Tectonatica</em></td>
</tr>
<tr>
<td><em>Natica (Tectonatica) simplex</em></td>
<td>(Sowerby, 1897)</td>
<td>large, semicircular, usually separated from the umbilical wall by a narrow groove at least abapically, completely filling the umbilicus in some shells</td>
<td>with numerous, fine marginal threads</td>
<td>figure of the operculum needed</td>
</tr>
</tbody>
</table>

**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 *epigloasfiniculata* as a distinct species belonging to the genus *Coehlis* Röding, 1798. Sacco (1891) shortly described and named *Natica epigloasfiniculata*. 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 *Coehlis epigloasfiniculata*. Accordingly, we include *exfuniculata* in the synonymy of the present species. It is of note that the name *epigloasfiniculata* bears priority having been validly proposed one year earlier.

Among the Pliocene *Coehlis* species of Italy described so far (Pedriali & Robba 2005; this paper), *Coehlis depressofuniculata* (Sacco 1891) is the only one with which *Coehlis epigloasfiniculata* can be compared.
on account of a general shell similarity. *Coclis epigloa-
funiculata* differs from *Coclis depressofuniculata* in hav-
ing: 1) protoconch with significantly greater di-
meter (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 si-
milarly 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 *Coclis epigloafuniculata* from the 
other *Coclis* 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.

**Coclis frediani** 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 Esla: MPUM 9482 (Pl. 1, fig. 7).

**Paratypes.** Ponte a Esla: 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 Esla (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 pro-
duced and clearly expanded toward the aperture, with distinct, subhor-
izontal substernal shell.
- 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 flabby 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 proconine growth lines, 
  slightly stronger on substernal shell 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 
collateral 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 trans-
verse 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 - *Coclis epigloafuniculata* (Sacco, 1890). Lectotype (here designated). Colli Astesi. MGPT B5.029.01.02; a) apertural side, b) abapertural side.

Fig. 2 - *Coclis epigloafuniculata* (Sacco, 1890). The shell as-
signed to *Natia epiglotina var. pseudoglotina* Sim-
monds, 1847 in Bellardi-Sacco collection. Beneva-
ghienn. MGPT B5.029.01.09/10; apertural side.

Fig. 3 - *Coclis epigloafuniculata* (Sacco, 1890). Orciano Pisa-
no. MPUM 9478; apertural side.

Fig. 4 - *Coclis epigloafuniculata* (Sacco, 1890). Orciano Pisa-
no. MPUM 9479; apertural side.

Fig. 5 - *Coclis epigloafuniculata* (Sacco, 1890). Paraleceto-
type. S. Agata Fossili. MGPT B5.029.01.02/02; apert-
ural side.

Fig. 6 - *Coclis epigloafuniculata* (Sacco, 1890). Lectotype (here designated) of *Natia (Natica) epiglotina var. exfuniculata* Sacco, 1891. Savona. MGPT B5.029.01.036; apertural side.

Fig. 7 - *Coclis frediani* sp. n. Ponte a Esla. Holotype, 
MPUM 9482; a) apertural side, b) abapertural side.

Fig. 8 - *Coclis frediani* sp. n. Ponte a Esla. Paratype, 
MPUM 9483; apertural side.

Fig. 9 - *Tanea diluviiyoni korenzi* (Sacco, 1891). Monánzdoli. 
MPUM 9488; a) apertural side, b) abapertural side, c) top view.

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

Fig. 11 - *Tanea diluviiyoni korenzi* (Sacco, 1891). Rio Tonseno. 
MPUM 9487; apertural side.

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

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

Fig. 14 - *Tectonasca attestis* (Sacco, 1890). Benestare. Topo-
type, MPUM 9491; a) apertural side, b) abapertural side.
Dimensions (mm):

<table>
<thead>
<tr>
<th>DHW</th>
<th>PD</th>
<th>H</th>
<th>D</th>
<th>SH</th>
<th>AH</th>
<th>AW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.23-0.27</td>
<td>0.59-0.63</td>
<td>6.54-23.82</td>
<td>7.79-22.19</td>
<td>1.12-4.20</td>
<td>6.38-2007</td>
<td>3.97-11.37</td>
</tr>
<tr>
<td>0.25</td>
<td>0.61</td>
<td>16.20</td>
<td>14.99</td>
<td>2.66</td>
<td>13.54</td>
<td>7.67</td>
</tr>
<tr>
<td>UW</td>
<td>WLC</td>
<td>WAD</td>
<td>WAB</td>
<td>IS</td>
<td>SA</td>
<td></td>
</tr>
<tr>
<td>1.14-7.06</td>
<td>0.87-1.91</td>
<td>0.00-4.33</td>
<td>0.02-1.34</td>
<td>12°-32&quot;</td>
<td>101°-141&quot;</td>
<td></td>
</tr>
<tr>
<td>4.10</td>
<td>1.39</td>
<td>2.03</td>
<td>0.68</td>
<td>22°</td>
<td>121°</td>
<td></td>
</tr>
</tbody>
</table>

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

Genus *Tanea* Marwick, 1931

*Tanea dillywyni* koeneni (Sacco, 1891) stat. rev., comb. n.
Pl. 1, figs. 9-11; Pl. 2, fig. 16; Pl. 3, figs. 8, 14

1882 *Natica platycentra* - von Koeneni, p. 228, pl. 5, figs. 6, 7, not fig. 9 (operculum of *Natica platycentra* Bronn, 1831).
1891 *Natica (Natica) epiglobo* var. *koeneni* Sacco, p. 63.
1925 *Natica koeneni* - Kautsky, p. 6, fig. 18.
1956 *Polymeris (Polymeris) 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 Koeneni, 1882).

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

Material examined. Savona: 12 spms. referred to as *Natica dillywyni var. platycentra* Bronn by Sacco (1891), MGPT BS.029.01.043/02; Zimola: 7 spms. referred to as *Natica dillywyni var. platycentra* Bronn by Sacco (1891), MGPT BS.029.01.043/03; Cassine: 1 spm. (MPUM 9486); Rio Torero: 1 spm. (MPUM 9487); Badesaco: 3 spms. (private collection), 1 spm. (MGC Bagatti collection); Castell Arguato: 2 spms. (MGC Bagatti collection); Lugagnano: 1 spm. (MGC 877), 1 spm. (private collection); Monsindoli: 1 spm. (MPUM 9488), 9 spms. (MPUM 9489), 3 spms. (NP 9566), 5 spms. (private collection); Lullinghen, 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, subtrunal 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 fascicle; anterior lobe absent.

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**PLATE 2**

Fig. 1 - *Tectonatica astenisi* (Sacco, 1892). Pradalbino II. MPUM 9497; apertural side.
Fig. 2 - *Tectonatica astenisi* (Sacco, 1892). Montegibbio. MPUM 9496; apertural side.
Fig. 3 - *Tectonatica pietro* (Hidalgo, 1873). Lectotype (designated by Templado et al., 1993). Isla del Aire, Menorca. MNCCM 15.05/758; a) apertural side, b) abapertural side.
Fig. 4 - *Tectonatica pietro* (Hidalgo, 1873). Paralectotype. Isla del Aire, Menorca. MNCCM 15.05/5173; apertural side.
Fig. 5 - *Tectonatica pietro* (Hidalgo, 1873). Bibbiano. MPUM 9506; a) apertural side, b) abapertural side.
Fig. 6 - *Tectonatica pietro* (Hidalgo, 1873). Montaione. MPUM 9510; apertural side.
Fig. 7 - *Tectonatica tectula* (Sacco, 1890). Lectotype (here designated). Villahermia. 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 vitta* (Philippi, 1844). Malaga, Spain. Private collection; apertural side.
Fig. 13 - *Tectonatica adansonii* (Blainville, 1825). Senegal. MPUM 9530; apertural side.
Fig. 14 - *Cochlis epigloboamalata* (Sacco, 1890). Oriono Piana. MPUM 9480; umbilicus.
Fig. 15 - *Cochlis frediani* sp. n. Ponte a Elsa; umbilicus of paratype in Pl. 1, fig. 9.
Fig. 16 - *Tanea dillywyni koeneni* (Sacco, 1891). Monsindoli; umbilicus of specimen in Pl. 1, fig. 10.
Fig. 17 - *Tectonatica astenisi* (Sacco, 1892). Pradalbino II; umbilicus of specimen in Pl. 2, fig. 1.
Fig. 18 - *Tectonatica pietro* (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 epigloboamalata* (Sacco, 1890). Oriono Piana; operculum of specimen in Pl. 1, fig. 3.
Fig. 22 - *Cochlis epigloboamalata* (Sacco, 1890). Benevagienna; operculum of specimen in Pl. 1, fig. 2.
Fig. 23 - *Cochlis frediani* sp. n. Ponte a Elsa; operculum of specimen in Pl. 1, fig. 8.
**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, semi-circular in outline, located at the middle of the colurnell 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 proscline growth lines that are slightly bent and change into broad, low wrinkles adapically; the wrinkles extend to the adapical 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):**

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**Remarks:** von Koenen (1882) described and figured a shell under the name *Natica plicatula* 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 *plicatula*. From von Koenen text, it appears that the name *plicatula* 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 plicatula*. Thus, the name *plicatula* 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 dalliwnyi* (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 dalliwnyi*.

The present subspecies superficially resembles *Cobitis plicatula* (Bronn, 1831), but differs in having coarser axial wrinkles extending to the adapical suture on the spire whorls and occupying the adapical one-third of 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 adapically 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. dalliwnyi koeneni* are from the Hemnorran (Late Burdigalian/Early Langhian) of Northwestern Europe; the species was also recovered from Langenfeldian (Late Serravallian/Early Tortonian), Sytian and Gramian (Late Tortonian) of the same area. Pliocene occurrences in Italy are from Zanclean deposits of Piedmont, Liguria, Emilia and Tuscany. *T. dalliwnyi 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

1890 *Natica minor* Seguenza, p. 111.

1892 *Natica (Natica) plicatula var. astensis* Sacco, p. 31.

1891 *Natica (Natica) plicatula 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).

1982 *Tectonatica astensis* - Pavia, p. 259 (pars), pl. 7, figs 10-11 (not lectotype Sacco, 1890).

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


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

1996 *Tectonatica (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.

2002 *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.


**Tectonica astensis** - Montefamiglio et al., 1982; p. 189, 196; - Pavia, 1982; p. 257 (pars); text-fig. 2C; - Aimareti & Ferrero Mortara, 1983; p. 186; - Aimone & Ferrero Mortara, 1985; p. 29; - Tropeano et al., 1984; p. 58; - Bernasconi, 1989; p. 58, 74; - Pavia et al., 1987; p. 544, 567, 568; - Barbabino & Scaccini, 1992; p. 412; - Basilicati et al., 1997, p. 43.

**Type material.** The lectotype of *Natica pulchella var. astensis* Sacco (designated by Pavia, 1976); the shell figured by Sacco (1891, pl. 2, fig. 50), MGPST B529.02.034 (Colli Astesi); 2 paralexotypes, MGPST B529.02.034/01 (Colli Astesi); 7 paralexatypes, MGPST B529.02.034/03 (Zinola); 2 paralexotypes, MGPST B529.02.034/05 (Colli Asteni).

**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 Asteni: 5 shells previously referred to as *Natica (Tectonica) tectula* Sacco by Sacco (1892), MGPST B529.04.003/06; Cossato: 2 spms. (NP 9572); Villaverina: 1 spm. (PPPM 51782); Volpeolo: 2 spms. (NP 9584); Bussana Vecchia: 16 spms. (private collections); Carunchi: 14 spms. (private collection); Rio Tornero: 15 spms. (NP 9581), 104 spms. (private collection); Arda: 6 spms. (NP 9569); Bacedasco: 1 spm. (NP 9567); Badalagona: 7 spms. (NP 9566); Campore: 5 spms. (MPUM 9495), 30 spms. (NP 9570); Diolo: 5 spms. (NP 9573); Montegibbio: 1 spm. (MPUM 9496); Pradalbino I: 3 spms. (NP 9594); 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); Riso Rossello: 2 spms. (MPUM 9501), 3 spms. (NP 9582), 13 spms. (PPPM 51781-51795); San Lorenzo in Collina: 9 spms. (MPUM 9502), 41 spms. (NP 9582), 2 spms. (MGC 578); Torrettine Sterone: 3 spms. (NP 9583); Bihlino: 2 spms. (MPUM 51796-51797); Ciuscono: 4 spms. (MPUM 9503), 43 spms. (NP 9571); II Campino: 11 spms. (PPPM 51798-51828); Linari: 7 spms. (NP 9575); Monsindolo: 5 spms. (MPUM 9504), 27 spms. (NP 9576); Orciano Pisanino: 2 spms. (MPUM 9505), 12 spms. (NP 9577); Guindonia: 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, whors convex.
- **Suture:** linear, adpressed.
- **Body whorl:** inflated, somewhat depressed, moderately extended and slightly expanded toward the aperture; submarginal 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.
- **Fasciole:** broad and low, separated from the basal fasciole by a very narrow furrow.
- **Umbilical callus:** large, rather thick, located at the mid apical 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 substural 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, or less deep.**

**Dimensions (mm):**

<table>
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<th>DHW</th>
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<td>1.93-10.17</td>
<td>0.11-2.59</td>
<td>1.65-1.83</td>
</tr>
</tbody>
</table>

**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 (Natica) 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 *Tectonica rizzae* (Philippi, 1844) is the most closely related species. It differs in having less sinuous outline of the umbilical callus and more widely open apical 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 settepassi* Gaglioti in Settepassi, 1985 is currently regarded as a synonym of *Tectonica rizzae*.

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

**Tectonica prietoi** (Hidalgo, 1873) comb. n.

Pl. 2, figs 5-6, 18; Pl. 3, figs 4-6, 18-21

1873 *Natica prietoi* Hidalgo, p. 322 (one specimen is illustrated in pl. 20 B, figs. 2, 3 of the atlas dated 1875; see remarks).
1980 Tectonatica aetheri - Pavia, p. 257 (pars), pl. 7, figs. 5-7 (not Sacco, 1890).
1991 Natica adansonii - Poppe & Goto, p. 121, pl. 17, fig. 11 (not Blainville, 1825).
1992 Natica (Tectonatica) testula - Cavallo & Repetto, text-fig. 126 (operculum), not the shell (= Tectonatica testula Sacco, 1890).
1996 Natica (Tectonatica) aetheri - Pedriali, p. 7 (pars), pl. 2, fig. 10 (not Sacco, 1890).
1997 Natica (Natica) adansonii - Giannuzzi-Savelli et al., figs 748, 810 (not Blainville, 1825).
1997 Natica (Natica) prietoi - Giannuzzi-Savelli et al., figs. 794.
1998 Natica prietoi - Gubbidi & Nofroni, p. 21, text-figs 1, 2.
1999 Tectonatica attis - Forli et al., p. 115, 116, pl. 2, fig. 4 (not Sacco, 1890).

Uncertain references

Lunatia easteri - 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 figured herein (pl. 2, fig. 5), MNCNM 19.55/758 (Isla del Aire, Menorca); 1 paralectotype, MNCNM 19.05/5171 (Isla del Aire, Menorca) also figured herein (pl. 2, fig. 4).

Material examined. Villalvemia: 16 shells previously referred to as Natica (Natica) pulchella var aetheri by Sacco (1890), MGPT BS.029.02.034/04; Villalvemia: 1 spm. (NP 9599); Bussana Vecchia: 3 spms. (private collection); Arosa: 2 spms. (NP 9588); Badagiano: 1 spm. (NP 9585); Arda II: 1 spm. (NP 9623); Torrette Stirone: 1 spm. (NP 9598); Barca: 1 spm. (NP 9586); Bibbiano: 1 spm. (MPUM 9506), 1 spm. (MPUM 9527), 1 spm. (MPUM 9508), 5 spms. (MPUM 9509), 34 spms. (NP 9587), 2 spms. (MGC 579); Giuncano: 1 spm. (NP 9592); il Campione: 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); Spiccchio: 8 spms. (NP 9589); Bovetto: 1 spm. (MPUM 9514), 2 spms. (NP 9597); Ravagnino: 6 spms. (private collection); Mesina 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: globular, rather thick.
Spira: conical, moderately elevated, whorls convex.
Suture: linear, adpressed.
Body whorl: inflated, somewhat depressed, moderately extended and very slightly expanded toward the aperture; subbasal shell obscure or lacking.
Aperture: D-shaped, height about 1.7 times the width.
Pariet al callus: subrectangular, moderately wide and rather thin, ending at the level of the basal fascicle; anterior lobe absent.
Umblilicus: similar to that of Tectonatica aetheri (Sacco, 1890), but more widely open.
Fusicle: broad and low, separated from the basal fascicle by a narrow furrow.
Umbrilcal 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 fascicle: nearly indistinct.
Surface: with protoconch growth lines; a faint spiral striation occurs on the body whorl.

PLATE 3

Fig. 1 - Tectonatica aetheri (Sacco, 1890). Pradalbino II; operculum of specimen in Pl. 2, fig. 1.
Fig. 2 - Tectonatica aetheri (Sacco, 1890). Benestare. MPUM 9592; operculum.
Fig. 3 - Tectonatica ruriae (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 korenii (Sacco, 1891). Cassine. MPUM 9486; operculum.
Fig. 9 - Tectonatica testula (Sacco, 1890). Massariano. 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 epiglona (Sacco, 1890). Oreizano Piazza. MPUM 9481; protoconch.
Fig. 13 - Cochlis frediani sp. n. Ponte a Elsa. MPUM 9484; protoconch.
Fig. 14 - Tanea dillwyni korenii (Sacco, 1891). Rio Torsero; protoconch of specimen in Pl. 1, fig. 12.
Fig. 15 - Tectonatica aetheri (Sacco, 1890). Pradalbino II. MPUM 9549; protoconch.
Fig. 16 - Tectonatica aetheri (Sacco, 1890). Pradalbino II. MPUM 9499; protoconch.
Fig. 17 - Tectonatica aetheri (Sacco, 1890). Benestare. MPUM 9493; protoconch.
Fig. 18 - Tectonatica prietoi (Hidalgo, 1873). Ponte a Elsa. MPUM 9515; 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 testula (Sacco, 1890). Bibbiano. MPUM 9526; protoconch.
Fig. 23 - Tectonatica testula (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 ruriae (Philippi, 1844). Malaga, Spain; MPUM 9534; protoconch.
Fig. 27 - Tectonatica adansonii (Blainville, 1825). Senegal protoconch of specimen in Pl. 2, fig. 13.
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):

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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 adamsoni Blainville, 1825 (cf. Giannuzzi-Savelli et al. 1997, p. 19, footnote 3). We concur with Gubbioli & Norfoni (1998) in considering Hidalgo's species and that of Blainville as distinct. Actually, Natica adamsoni (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 slimmer 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 Gelasion of the Torrente Strione Section. Examination of the literature shows that the species was never quoted from Quaternary deposits. Our recoveries from Arda II, Bovetto and Ravagnone (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

1892 Natica (Tectonatica) tectula Sacco, p. 33.
1891 Natica (Tectonatica) tectula - Sacco, p. 31, pl. 2, fig. 53.
1936 Natica tectula - Moroni, p. 106, pl. 9, fig. 55.
1958 Natica (Natica) tectula - Sorgenfrei, p. 190, pl. 38, fig. 122.
1979 Tectonatica tectula - Marinelli, p. 136, pl. 4, figs 6-8.
1979 Tectonatica tectula - Pavia & Robba, p. 594.
1982 Tectonatica tectula - Pavia & Robba (pars, pl. 7, figs 9, 13; not pl. 7, figs 10-11 (= Natica (Natica) pulchella var. astensis Sacco, 1892).
1984 Tectonatica tectula - Ferrero Mortara et al., p. 35.
1992 Natica (Tectonatica) tectula - Cavallol & Repetto, text fig. 126, not the operculum (= Natica prietoi Hidalgo, 1873).
1992 Natica (Tectonatica) tectula - Pedriani, p. 8, pl. 2, figs 11-13; pl. 3, fig. 1.
1997 Tectonatica tectula - Lacroce, p. 27, pl. 2, fig. 6.
1999 Tectonatica tectula - Forlì et al., p. 115, pl. 2, fig. 5.

Uncertain references
Natica (Lumatia) tectula - Brugnone, 1882: p. 117.
Natica (Tectonatica) tectula mut. bernensis - Cossmann & Peyrot, 1919: p. 416, pl. 11, figs 43-44.
Type material. The lectotype of Natia (Tecontatica) teclula Sacco (here designated); the shell figured by Sacco (1891, pl. 2, fig. 53) and figured herein (pl. 2, fig. 7), MGPT BS.029.04.001 (Villaver- nia); 11 paratypes, MGPT BS.029.04.001/01 (Villaver- nia); 4 paratypes, MGPT BS.029.04.001/02 (Colli Torretini); 2 paratypes, MGPT BS.029.04.001/03 (Sanova Formaci); 64 paratypes, MGPT BS.029.04.001/04 (Massareno); 22 paratypes, MGPT BS.029.04.001/05 (unknown locality, Piacezian); 71 paratypes, MGPT BS.029.04.001/06 (Colli Astei).

Other material examined. Borelli: 6 spms. (NP 9619); Cassato: 5 spms. (NP 9605); Masserano: 1 spm. (MPUM 9516); Villavernia: 4 spms. (NP 9617), 160 spms. (PPMM 51021-51160); Volpedo: 10 spms. (MPUM 9517), 34 spms. (NP 9618); Busana Vecchia: 1 spm. (private collection); Rio Tossero: 4 spms. (private collection); Arda: 4 spms. (NP 9603); Bacedasco: 2 spms. (NP 9600); Badagnano: 1 spm. (NP 9601), 124 spms. (PPMM 51161-51248); Balzo del Muscio: 112 spms. (NP 9612); Montegibbio: 1 spm. (NP 9518), 5 spms. (NP 9620); Montezago: 21 spms. (NP 9612); Pradalibino I: 3 spms. (NP 9613); Pradal- bino II: 13 spms. (MPUM 9519), 47 spms. (NP 9614), 1 spm. (MGC 980); 1 spm. (private collection); Rio Rosello: 1 spm. (MPUM 9520), 5 spms. (MPUM 9521), 52 spms. (NP 9615), 162 spms. (PPMM 51285-51664); 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 9622); Casciule: 1 spm. (NP 9607); Criciano: 2 spms. (NP 9608); Il Campino: 5 spms. (MPUM 9527), 34 spms. (NP 9656), 130 spms. (PPMM 51647-51776); Lainari: 4 spms. (NP 9608); Marcella: 5 spms. (MPUM 51777-51781); Monto- taino: 20 spms. (NP 9609); Montenero: 1 spm. (NP 9611); Altavilla Milicia: 1 spm. (NP 9622), 2 spms. (private collection); Bonares, Huel- va, Spain: 4 spms. (NP 9623).

Material examined for comparison. Boveto: 16 spms. (MPUM 9535) of Natia filosa Philippi, 1845.

Dimensions (mm):

<table>
<thead>
<tr>
<th>DHW</th>
<th>PD</th>
<th>H</th>
<th>D</th>
<th>SH</th>
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<tr>
<td>0.08</td>
<td>0.12</td>
<td>1.10</td>
<td>1.46</td>
<td>3.37</td>
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<tr>
<td>0.10</td>
<td>1.28</td>
<td>6.87</td>
<td>6.67</td>
<td>1.53</td>
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</tbody>
</table>

AH
AW
UW = WUC
IS
SA

Remarks. The name teclula 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 teclula was just cited later on by Sismonda (1842, 1847), Bocca (1848) and d’Orbigny (1852). Sacco (1890) first published a concise diagnosis of teclula, thus making available the name, and is to be considered the author of the species.

Natia 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 teclula on the basis of the moderately thick operculum that lacks the marginal groove (Pl. 3, figs. 10, 11) and is characteristic of the genus Cryptonautica Dall, 1892. The Recent Natia affinis Gmelin, 1791 and Natia 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. teclula is a rather long-ranging and widely distributed taxon. Reliable Miocene records were from Hemmoorlan (Late Burdi- galian/Early Langhian) of Denmark (Arunn Formation), Middle Miocene of Piedmont, Late Miocene of Spain and Italy. The species occurs commonly in Zanclean and Piacezian deposits of Italy and Spain, whereas its presence in the Gelasion is very scanty. The rare quotations from the Pleistocene need to be confirmed; these could actually refer to Cryptonautica filosa (Philippi, 1845).

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APPENDIX (Locality data)

Piedmont

1. Boreli, Moncucco Toninse (Torino Province). A small 
outcrop, approximately 150 m northeast of the hamlet named Boreli (for-
merly Tetti Boreli), exposes medium to coarse sand of late Early Mes-
inian 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 50 connecting Alessandria to Acqui Terme. Gray, un-
bedded silty clay belonging to the Argille di Lugagnano (Lugagnano 
Clay) of Zaneclan age. For additional information, reference to Robba 

3. Coniato (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 Pleistocene age. For additional information, reference to Aimone 

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 Pleistocene 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 Villal-
vernia. 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 ex-
posed on the left side of the stream Rio Limbione, between La Casci-
etta 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 Lug-
gnano and the Sabbie di Asti (Asti Sand); this section was assigned a 
general Pleistocene age. For additional information, reference to Benigni 
& Cornelli (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 ex-
poses a 14 m thick section of gray, unbedded clayey silt belonging to 
the Argille di Otterovo (Otterovo Clay); the age is late Zaneclan to 
early Piacenzian.

8. Caraschi, Albenga (Savona Province). The outcrop, pre-
cently hindered by a slide, is located on the right side of the stream 
Río Torsero, along a road that about 0.6 km west of Casa Bruno. Gray 
clayey silt belonging to the Argille di Otterovo; the age is MPL 4, i.e. 

9. Rio Torsero, Albenga (Savona Province). The Pliocene de-
posits 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 8.65 m of light gray, very sandy clayey 
silt forming the uppermost part of the Argille di Otterovo. The clayey 
silt yielded planktonic foraminiferal assemblages pointing toward a 
MPL3 to MPL4, i.e. a late Zaneclan 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 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).


13. Bagadano (Piacenza Province). Gully named Rio dei Carbonari, on the right side of Torrente Chero, about 0.5 km southeast of the village of Bagadano. Gray sandy clay belonging to the Formation of Castell'Arquato (Castell'Arquato Formation); the age is 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 Buscaci (1896).


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


19. Montegibbio, Sansepolcro (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 C2 and C3 of Dovoli (1972). Gray clayey marl belonging to the Formazione del Termini (Termini Formation); the age is Torrinian.


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 Bongioni (1963).

23. Rio Rosello, near Sarano (Piacenza Province). Right bank of Rio Rosello, about 280 m southwest 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. Torrette Strione (Parma Province). A Pli-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 Nicomedes, 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).


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). Outcrop (Pietrafitta, Fosso di Libbiano, Podere Molagorni, Poggio alla Staffa) around the village of Bibbiano, 4 km northwest of Poggibonsi. Yellowish medium sand, locally gray sandy clay reported to be of Middle Pliocene age (Bogi et al. 2002).

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

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

31. Il Campino, Rapaleno 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 Leghi (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'Elia (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).


36. Montaione (Firenze Province). Deep plowings in front of the country-house Villa Filipaca, 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 & Scapin (2001).

37. Montenero, Castel del Piano (Grosetto 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 Pisan (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 Eba**, San Miniato (Pisa Province). Quarry west of Ponte a Eba 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).


**Latium**


**Calabria**

42. **Benestare** (Reggio di Calabria Province). Outcrops north-west of Benestare, on the northern slope of Poggio Frandina, along a right tributary stream of Torrente Baracali. Bluish-gray clay and yellowish 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 Tyrrenian. For further information, reference to Bonfiglio (1992).

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 Tyrrenian. For further information, reference to Bonfiglio (1992).

**Sicily**

45. **Alta Villa Milicia** (Palermo Province). Cliff on the right bank of Milicia River, close to the northwestern end of Alta Villa Mili- cia, corresponding to collecting site 5 of Moroni & Paonita (1964). Section, over 40 m thick, of yellow sand ("Alta Villa 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).