



# Polyplacophora from the Early Pliocene of Estepona (Málaga, southwest Spain)

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## ABSTRACT

This paper discusses the chiton fauna (Mollusca, Polyplacophora) from early Pliocene (Zanclean and early Piacenzian) deposits of Estepona (Málaga, southwest Spain). The study material consists of more than 400 valves from five distinct localities: Velerín, Velerín Antena, Velerín Carretera, Parque Antena and Rio del Padrón. This is the first comprehensive account of fossil chitons from the Neogene of Spain. We identified 18 species, two of them described as new. The taxa are: *Lepidopleurus cajetanus*, *Lepidopleurus (Leptochiton) algésirensis*, *Lepidopleurus (Leptochiton) tavianii* sp.nov., *Lepidopleurus (Parachiton) aff. africanus*, *Hanleya hanleyi*, *Hanleya* sp., *Ischnochiton ulivii*, *Ischnochiton martinelli* sp. nov., *Ischnochiton rissoei*, *Ischnochiton (Stenosomus) aff. vanbellei*, *Callochiton septemvalvis*, *Lepidochitonina cinerea*, *Lepidochitonina canariensis*, *Chiton miocenicus*, *Chiton corallinus*, *Acanthochitonina fascicularis*, *Acanthochitonina crinita*, *Craspedochiton altavillensis*. Twelve species are still living in the Mediterranean and nine occur off the Atlantic coasts of Europe. The new species described here and *Hanleya* sp. are at present only known from Pliocene deposits, whereas *Ischnochiton ulivii* and *Craspedochiton altavillensis* apparently did not survive the Early Pleistocene.

## RIASSUNTO

Oltre 400 piastre fossili di poliplacofori sono state raccolte nel Pliocene (Zancleano e Piacenziano) di Estepona (Málaga, Spagna occidentale) in 5 diverse località: Rio del Padrón, Velerín, Velerín Antena, Velerín Carretera e Parque Antena. Queste località, abbastanza vicine tra di loro, hanno prodotto una ricca fauna di molluschi appartenenti ad ambienti e profondità molto diversificati. Sono state identificate 18 specie di poliplacofori, due delle quali descritte come nuove: *Lepidopleurus cajetanus*, *Lepidopleurus (Leptochiton) algésirensis*, *Lepidopleurus (Leptochiton) tavianii* sp.nov., *Lepidopleurus (Parachiton) aff. africanus*, *Hanleya hanleyi*, *Hanleya* sp., *Ischnochiton ulivii*, *Ischnochiton martinelli* sp.nov., *Ischnochiton rissoei*, *Ischnochiton (Stenosomus) aff. vanbellei*, *Callochiton septemvalvis*, *Lepidochitonina cinerea*, *Lepidochitonina canariensis*, *Chiton miocenicus*, *Chiton corallinus*, *Acanthochitonina fascicularis*, *Acanthochitonina crinita*, *Craspedochiton altavillensis*. Questa è la prima documentazione di poliplacofori fossili per il Neogene spagnolo. 12 specie sono note viventi in Mediterraneo, mentre 9 vivono lungo le coste atlantiche europee. Tre specie (le due nuove ed *Hanleya* sp.) risultano al momento solo plioceniche, mentre *Ischnochiton ulivii* e *Craspedochiton altavillensis* non superano il Pleistocene, e 9 specie hanno una distribuzione dal Miocene all'attuale.

**KEY WORDS:** Mollusca, Polyplacophora, Pliocene, Zanclean, Spain, new species.

## INTRODUCTION

The Early Pliocene (Zanclean to early Piacenzian) of the Málaga region (Andalusia, Spain) crops out in a narrow coastal strip between Estepona and San Pedro de Alcántara (Fig. 1), unconformably on older deposits, and forms the main body of the Cordillera Bética Mountains. The general geology of the area is described in detail by Guerra-Merchan (1997) and Guerra-Merchan *et al.* (2002). The Pliocene deposits consist of different lithologies whose macropaleontological richness is variable but generally high. Mollusca are one of the dominant benthic groups and their detailed systematic study is in progress (e.g., Vera-Pelaez *et al.*, 1995; La Perna *et al.*, 2002; Fehse & Landau, 2002, 2003; Landau *et al.*, 2003 a & b).

The present paper is the first account of the polyplacophoran fauna from these Pliocene beds, and is a contribution to the virtually unknown Cenozoic chiton fauna of the Iberian region as a whole. Indeed, chitons have never been mentioned from this region of biogeographic importance, by virtue of its geographic position between the Atlantic Ocean and the Mediterranean basin.

## MATERIALS & METHODS

The material originated from the following localities near Estepona: Rio del Padrón, Velerín Carretera, Velerín Antena,

Velerín conglomerates (hereafter indicated as Velerín) and Parque Antena (Fig. 1).

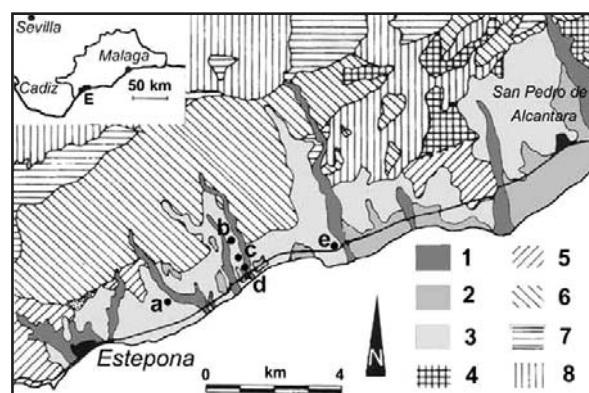


Fig. 1 – Location map and geological context after Vera-Pelaez *et al.* (1995, p. 95, fig. 1).

Fig. 1. Mappa della località e contesto geologico, da Vera-Pelaez *et al.* (1995, p. 95, fig. 1).

- |                                    |   |
|------------------------------------|---|
| 1 Recent alluvial                  | 5 |
| 2 Quaternary alluvial              | 6 |
| 3 Pliocene                         | 7 |
| 4 San Pedro de Alcantara Formation | 8 |
| 5 Campo de Gibraltar Complex       |   |
| 6 Malaguide Complex                |   |
| 7 Alpujarride Complex              |   |
| 8 Other deposits                   |   |
- a Rio del Padrón
  - b Velerín conglomerates
  - c Velerín Antena
  - d Velerín Carretera
  - e Parque Antena



These sites were sampled for their fossil mollusc fauna by some of the authors (B.L., R.M.). Considerable amounts of bulk sediment were taken and sieved on a 1 mm mesh. From each, about 5 kg of the gravel to sandy fraction (1 to 5 mm) was then examined under a binocular microscope.

The Rio del Padrón exposure is along a riverbed, mostly dry in summer, with a total thickness of c. 15 m. The main sedimentary bed consists of clayey sand, with a sparse fauna, in which white coral is present. The chiton fauna was found in a level above that with this white coral, about 5 m below the upper margin of the section, containing sand with shells and occasional pockets of gravel. The shells are often eroded, and bivalves are mostly disarticulated and decalcified. Guerra-Merchan *et al.* (2002) considered this deposit Zanclean, Early Pliocene II unit (MPL-2).

Velerín Carretera is a small outcrop, consisting of a roadcut about 4 m high. The sedimentary sequence consists of greyish sandy clay to clayey sand, containing predominantly superbly preserved small molluscs.

Velerín Antena is a dismissed quarry, displaying the same lithologic succession and richness in small mollusc shells. Bivalves, many still articulated, pertain mainly to Yoldiidae, Nuculanidae and Semelidae (Lozano-Francisco, 1998), and point to a basically in-situ deeper water community (infralittoral to possibly bathyal).

The Velerín conglomerates occur very close to Velerín Antena, in a steep valley cut by a seasonal creek. The lithology consists of conglomerates, with more or less indurated brown sands and pockets of yellowish-brown sand. Conglomerates and sands yield a rich fossiliferous fauna. Molluscs are abundant and dominated by gastropods, even of large size, with some bivalves occasionally still articulated. The conglomerates seem to represent a shingle beach, deposited by storm action in very short period and containing a mixture of faunal elements of different depths and environments. This is dated as early Piacenzian, "middle Pliocene" unit (Guerra Merchán *et al.*, 2002).

Parque Antena is a building site, in which clays very similar to those of Velerín Carretera and Velerín Antena are exposed, but hardened in the upper part. The samples analysed were taken at a depth of about 5 m below the highest point. All these localities are dated early Piacenzian, "middle Pliocene" unit (Guerra Merchán *et al.*, 2002).

## ABBREVIATIONS

The following abbreviations are used to identify the repositories of material:

IRScNB Institut Royal des Sciences Naturelles de Belgique, Brussels (Belgium);

MME Museo Municipal de Estepona (Spain);

MZB Zoological Museum of Bologna University (Italy);

BDA B.Dell'Angelo Colln, Prato (Italy);

RM R.Marquet Colln, Antwerp (Belgium), shortly to be transferred to IRScNB.

Type material and figured specimens are deposited in the malacological collection of the Zoological Museum of Bologna University.

## SYSTEMATIC PALAEONTOLOGY

We report only essential synonymy and bibliography for each species.

Class POLYPLACOPHORA Gray, 1821

Order NEOLORICATA Bergenhayn, 1955

Suborder LEPIDOPLEURINA Thiele, 1910

Superfamily LEPIDOPLEUROIDEA Pilsbry, 1892

Family LEPIDOPLEURIDAE Pilsbry, 1892

Genus *Lepidopleurus* Risso, 1826

Subgenus *Lepidopleurus* s.s.

*Lepidopleurus (Lepidopleurus) cajetanus* (Poli, 1791)

(Pl.7 Figs 4,8)

*Chiton cajetanus* Poli, 1791: 10, pl.4, figs 1-2.

*Chiton decoratus* Reuss, 1860: 257, pl.8, fig.7

*Lepidopleurus cajetanus* – Pilsbry, 1892: 15, pl.2, figs 41-46f. – Maluquer, 1915: 224, pl.14, figs 1-2. – Laghi, 1977: 95, pl.1, figs 13-20. – Sabelli & Taviani, 1979: 161, pl.1, figs 1-3. – Gaglini, 1985: I, pl.2, fig.1; pl.8, fig.3. – Kaas & Van Belle, 1985a: 32, fig.12. – Dell'Angelo & Palazzi, 1986: figs 9-10, 38-40, 53, 57, 63. – Forli *et al.*, 1999: 111, pl.1, figs 1-3, 9.

*Lepidopleurus (Lepidopleurus) cajetanus* – Dell'Angelo & Palazzi, 1989: 45, pls.1-2. – Dell'Angelo *et al.*, 1998: 235, pl.1, fig.8. – Dell'Angelo *et al.*, 1999: 260, pl.1, figs 2,4-7. – Dell'Angelo & Smriglio, 1999: 38, figs 10-15, pls.6-7.

*Lepidopleurus (L.) cajetanus* – Malatesta, 1962: 146, figs 1-2. – Dell'Angelo & Forli, 1995a: 223, fig.18. – Dell'Angelo *et al.*, 2001: 145, figs 1,4.

**Material.** Rio del Padrón: 2 intermediate valves (maximum width 9.3 mm); Velerín: 3 valves, 1 head (width 6.6 mm) and 2 tail (maximum width 6.3 mm).

**Remarks.** The species is characterized by tegmentum sculptured with some strong, concentric, terraced ribs on head valve, lateral areas of intermediate valves and postmucronal area of tail valve, and with somewhat branching or anastomosing longitudinal chains of granules in central and antemucronal areas. Unlike fully-grown adults, juveniles of this species may show some morphological variability. The commonest living *Lepidopleurus* is uncommon as a fossil, despite the robustness of its valves.

**Distribution.** *L. cajetanus* occurs in the Mediterranean Sea and Atlantic Ocean, from the Iberian Peninsula to Morocco and the Canary Islands. It was reported from the Miocene of central-eastern Europe (under the name of *Chiton decoratus* Reuss, 1860) and Italy (Tortonian of Montegibbio, Modena prov.; Messinian of Borelli, Turin prov.). It is frequent in the Plio-Pleistocene of the Mediterranean basin.

Subgenus *Leptochiton* Gray, 1847

*Lepidopleurus (Leptochiton) algésirensis* (Capellini, 1859)

(Pl.2 Fig.3)

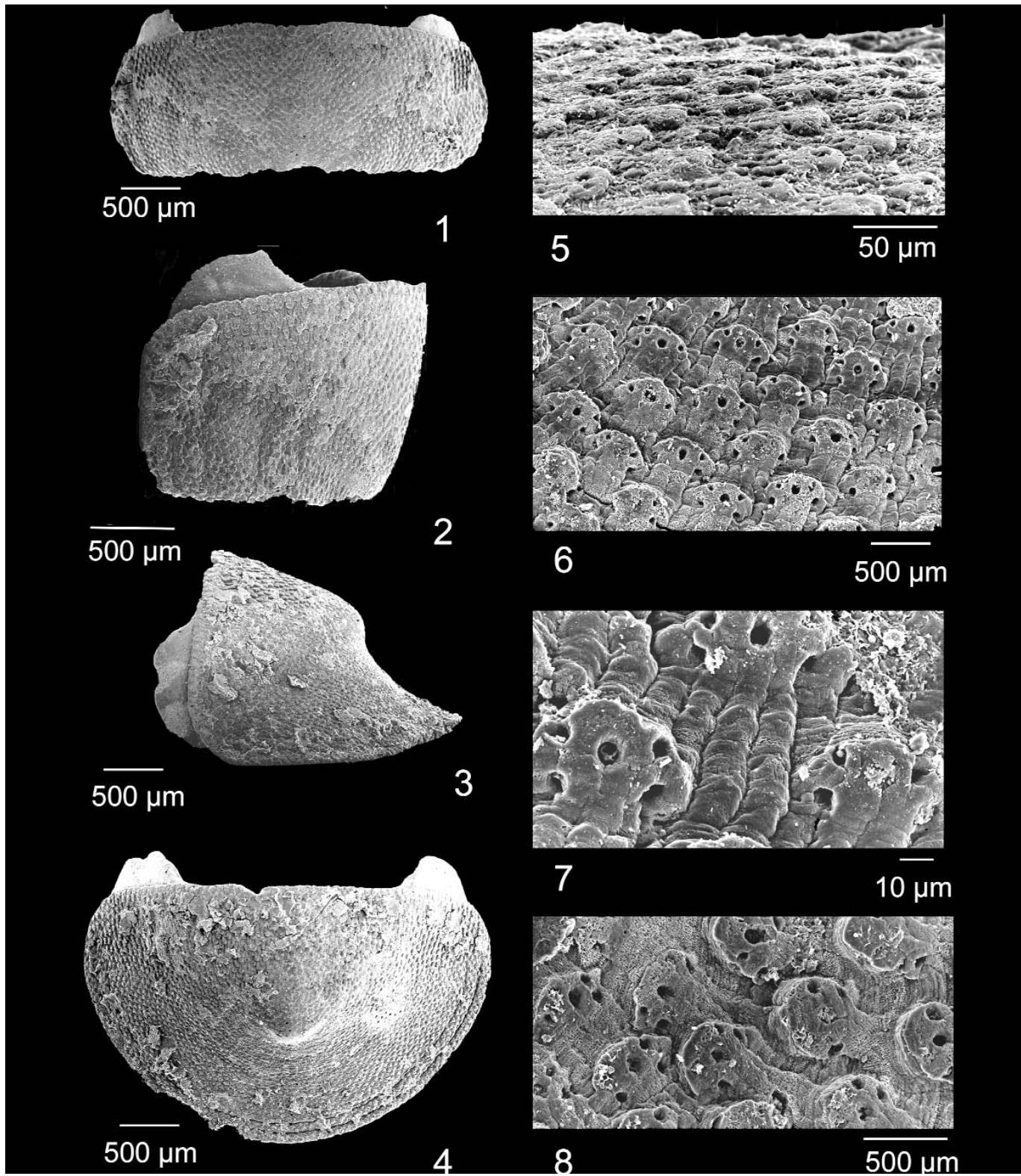
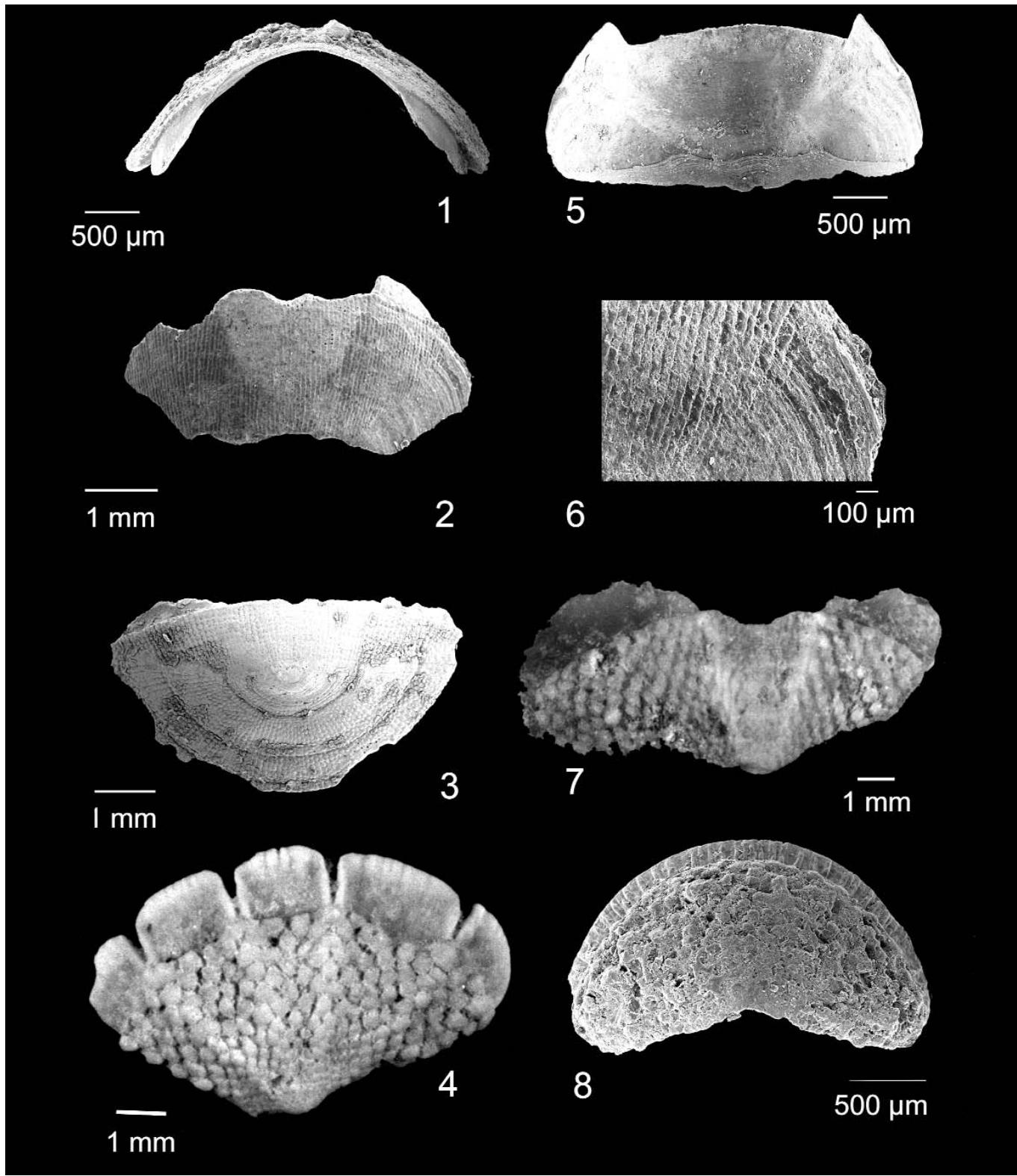


Plate 1

Figs 1-8: *Lepidopleurus tavianii* n.sp., Velerín Carretera: Figs 1-2, 5-7 holotype: Figs 1-2 intermediate valve, Fig. 5 ornamentation of central area, Figs 6-7 ornamentation of lateral area; Figs 3-4, 8 paratype MZB: Figs 3-4 tail valve, Fig. 8 ornamentation of postmucronal area.

Tav. 1

Figg. 1-8: *Lepidopleurus tavianii* n.sp., Velerín Carretera: Figg. 1-2, 5-7 olotipo: Figg. 1-2 piastra intermedia, Fig. 5 ornamentazione dell'area centrale, Figg. 6-7 ornamentazione dell'area laterale; Figg. 3-4, 8 paratipo MZB: Figg. 3-4 piastra posteriore, Fig. 8 ornamentazione dell'area postmucronale.



## Plate 2

Figs 1, 5: *Lepidopleurus tavianii* n.sp., Velerín Carretera: Fig. 1 intermediate valve, outline, paratype BDA, Fig. 5 intermediate valve, ventral view, paratype MZB; Figs 2, 6 *Lepidopleurus* aff. *africanus*, intermediate valve, Velerín Antena; Fig. 3 *Lepidopleurus algésirensis*, tail valve, Rio del Padrón; Figs 4, 7: *Craspedochiton altavillensis*, Velerín: Fig. 4 head valve, Fig. 7 intermediate valve; Fig. 8 *Hanleya hanleyi*, head valve, Velerín Antena.

## Tav. 2

Figg. 1, 5: *Lepidopleurus tavianii* n.sp., Velerín Carretera: Fig. 1 piastra intermedia, profilo, paratipo BDA, Fig. 5 piastra intermedia, vista ventrale, paratipo MZB; Figg. 2, 6 *Lepidopleurus* aff. *africanus*, piastra intermedia, Velerín Antena; Fig. 3 *Lepidopleurus algésirensis*, piastra posteriore, Rio del Padrón; Figg. 4, 7: *Craspedochiton altavillensis*, Velerín: Fig. 4 piastra anteriore, Fig. 7 piastra intermedia; Fig. 8 *Hanleya hanleyi*, piastra anteriore, Velerín Antena.



*Chiton algesirensis* Capellini, 1859: 327, pl.12, figs 3a-c.

*Lepidopleurus maguntiacus* de Rochebrune, 1883: 58

*Lepidopleurus algesirensis* – Pilsbry, 1893: 62, pl.14, figs 20,21. – Maluquer, 1915: 226, pl.14, fig.7. – Gaglini, 1985: II, pl.2, fig.2; pl.8, figs 1-2. – Bellomo & Sabelli, 1995: 201.

*Lepidopleurus (L.) algesirensis* – Malatesta, 1962: 151, figs 7-8.

*Lepidopleurus (Leptochiton) algesirensis* – Dell'Angelo & Palazzi, 1989: 61, pls.8-13. – Dell'Angelo & Smriglio, 1999: 53, figs 20-23, pls.12-13. – Dell'Angelo *et al.*, 2001: 145, fig.2.

*Leptochiton (L.) algesirensis* – Kaas & Van Belle, 1985a: 44, fig.17.

*Lepidopleurus maguntiacus* – Janssen, 1978: 219, pl.14, figs 11-15; pl.15, figs 16-17.

*Lepidopleurus maguntiacus* – Janssen, 1978: 219, pl.14, figs 11-15; pl.15, figs 16-17.

**Material.** Rio del Padrón: 3 valves, 1 intermediate (width 9 mm) and 2 tail (width 4.2 and 5 mm).

**Remarks.** The species is characterized by evenly sculptured tegmentum with small rounded granules arranged in radiating rows on head valve (100 or more), lateral areas of intermediate valves (14-16) and postmucronal area of tail valve, in longitudinal series in central (65-70) and antemucronal areas. Fossil findings are rare. Old records are doubtful and in need of critical revision. Dell'Angelo & Palazzi (1989) consider *Lepidopleurus maguntiacus* de Rochebrune, 1883, a species from the Oligocene of western Germany, to be a synonym of *L. algesirensis*. For a discussion see Janssen (1978) and Dell'Angelo & Palazzi (1989).

**Distribution.** *L. algesirensis* occurs in the western Mediterranean (more frequent in Sicily and along Spanish coasts) and Atlantic Ocean (Bretagne, Spain, Portugal, Canary and Madeira Islands, Senegal). It has been reported from the Oligocene of W.Germany (under the name of *L. maguntiacus*) and from some Italian Pliocene localities, e.g. Campore (Parma prov.), Altavilla (Palermo prov.) and Messina. It has also been reported from some southern Italian Pleistocene localities, e.g. Ficarazzi (Palermo prov.), Musala' and Pezzo (Reggio Calabria prov.).

#### *Lepidopleurus (Leptochiton) tavianii* sp.nov.

(Pl.1 Figs 1-8; Pl.2 Figs 1,5)

**Diagnosis.** Intermediate valves broadly rectangular, moderately elevated (dorsal elevation 0.39 – 0.55), back evenly rounded, lateral areas slightly raised; tail valve more than semicircular, mucro subcentral. Tegmentum uniformly sculptured with neatly separated fungiform granules, arranged in bee's nest structure, with aesthetes situated on body of tubercles and neck of each tubercle shaped by 5 nodulose ribs. Articulamentum without insertion laminae and with small triangular apophyses.

**Description.** Head valve not available.

Intermediate valves broadly rectangular, back evenly rounded, moderately elevated, front margin slightly convex, side margins

rounded, hind margin straight, apices inconspicuous, lateral areas slightly or not raised.

Tail valve more than semicircular in shape, head margin almost straight, mucro prominent, subcentral, postmucronal slope concave. Tegmentum uniformly sculptured with well raised, neatly separated, fungiform section granules.

Granules arranged in bee's nest structure, i.e. six granules at corners of hexagon and one in the center, suggesting longitudinal or radial, mutually staggered striae, or a trellis-work structure, of diagonal, intersect striae.

Aesthetes situated on body of fungiform tubercle (width 54-65 µm), generally 5 of equal width, one of which lies in axial plane of prominence with the other four situated two by two at its sides. Tubercles consisting of two parts: a superior one (i.e. expanded upper part, body) and an inferior one (neck), which has 5 nodulose ribs, about 48-58 µm in length. Body of each tubercle partially covering neck of next tubercle.

Articulamentum without insertion laminae. On ventral side of intermediate valves, posterior area having evident expanded central zone, with bisinuate superior margin. Apophyses small, sharply triangular, widely separated by large jugal sinus.

**Material.** Velerín Antena: 3 intermediate valves, maximum width 4.6 mm; Velerín Carretera: 24 valves, 19 intermediate (maximum width 4 mm) and 5 tail (maximum width 3.5 mm).

**Type material.** Holotype: MZB 25049 (1 intermediate valve, Velerín Carretera). Paratypes: MZB 25050 (1 intermediate and 1 tail valve, Velerín Carretera); MME (1 intermediate and 1 tail valve, Velerín Carretera); IRSN IST 6449 (1 intermediate and 1 tail valve, Velerín Carretera); BDA 4566 (2 intermediate valves, Velerín Carretera); RM (2 intermediate valves, Velerín Carretera).

**Etymology.** The species is named after Marco Taviani, marine geologist and paleontologist, for his contribution and support in the study of Cenozoic mollusc paleontology.

**Type locality.** Velerín Carretera, near Estepona (Málaga, Spain).

**Type stage.** Early Piacenzian (Pliocene).

**Remarks.** No head valves of this distinctive taxon have yet been found. The species is well characterized by its tegmentum sculpture which differs from that of other known living and fossil Mediterranean and Atlantic *Lepidopleurus (Leptochiton)* species by virtue of granules with fungiform section arranged in beehive structure.

#### Subgenus *Parachiton* Thiele, 1909

##### *Lepidopleurus (Parachiton) aff. africanus* Nierstrasz, 1906 (Pl.2 Figs 2,6)

*Lepidopleurus africanus* Nierstrasz, 1906a: 155, figs 1-9.



*Lepidopleurus (Parachiton) thielei* Sulc, 1934: 6, pl.1, figs 4-5.

*Leptochiton (Parachiton) africanus* – Kaas, 1977: 81, figs 1-5. – Kaas & Van Belle, 1985a: 163, fig.75. – Cesari, 1987: 12, pl.9, figs 1-6; pl.10, figs 1-5.

*Lepidopleurus africanus* – Baluk, 1984: 286, pl.1, figs 1-2.

*Lepidopleurus (Parachiton) africanus* – Laghi, Russo & Dell'Angelo, 1981: 1, pl.1, figs 3-9. – Dell'Angelo & Palazzi, 1989: 80, pls.23-24. – Dell'Angelo *et al.*, 1998: 242, pl.1, figs 2-4,6-7. – Dell'Angelo & Smriglio, 1999: 80, figs 30-33, pls.23-24.

*Lepidopleurus thielei* – Baluk, 1971: 454, pl.1, fig.8.

*Lepidopleurus (Parachiton) thielei* – Laghi, Russo & Dell'Angelo, 1981: 1, pl.1, figs 1-2.

**Material.** Velerín Antena: 3 intermediate valves, incomplete, maximum width 4.8 mm.

**Remarks.** *Lepidopleurus (Parachiton) africanus* is a rare species, originally described from a single specimen from Oran (Algeria), stored in the collection of the Zoological Museum of Utrecht. This record remained unique for almost 70 years, until Kaas (1977) validated the species and confirmed its presence in the Mediterranean on the basis of new records.

Our material consists of 3 incomplete intermediate valves. Tegumentum sculpture is sufficient to identify the species: the granules are arranged in longitudinal series in the central area, forming fine, irregular but not conspicuous quincuncial lirae on the lateral areas, which give the shell a smooth appearance. The only difference with respect to the original description is the number of lirae in the central area, 36-40 in typical specimens (see Dell'Angelo & Smriglio, 1999, pl.23, fig.D) and 70-80 in the material studied here. Whether this character is sufficient to warrant a specific distinction between our fossil material and typical *Lepidopleurus (Parachiton) africanus* is not clear at present.

**Distribution.** *L. africanus* inhabits the Mediterranean, but is a rare species. It has been reported from the Miocene of Austria and Poland (as *Lepidopleurus thielei*), Pliocene of some Italian localities, e.g. Valle Andona (Asti prov.) and Castell'Arquato (Piacenza prov.), and Pleistocene of various sites in the province of Reggio Calabria (Arangea, Archi and Terreti).

Family HANLEYIDAE Bergenhayn, 1955  
Genus *Hanleya* Gray, 1857

*Hanleya hanleyi* (Bean in Thorpe, 1844)  
(Pl.2 Fig.8)

*Chiton hanleyi* Bean in Thorpe, 1844: 263, fig.57.

*Chiton multigranosus* Reuss, 1860: 259, pl.8, figs 8a-b.

*Hanleya hanleyi* – Pilsbry, 1892: 17, pl.3, figs 71-79. – Malquer, 1915: 233, pl.14, fig.10. – Malatesta, 1962: 153, figs 9-10. – Laghi, 1977: 99, pl.3, figs 5-9. – Marquet, 1984, p. 336, pl. 1, fig. 3. – Kaas & Van Belle, 1985a: 193, fig.91. – Gaglini,

1985: IV, pl.3, fig.2. – Dell'Angelo & Giusti, 1997: 51, fig.2. – Dell'Angelo *et al.*, 1998: 244, pl.2, figs 1-2. – Dell'Angelo *et al.*, 1999: 262, pl.1, figs 1,3. – Dell'Angelo & Smriglio, 1999: 85, figs 34-36, pls.25-26. – Dell'Angelo *et al.*, 2001: 147, fig.8. *Hanleya multigranosa* – Sabelli & Taviani, 1979: 158, pl.1, fig.4. – Baluk, 1984: 287, pl.5, figs 1a-b.

*Chiton strigillatum* – Wood, 1848: pl. 20, fig. 10.

**Material.** Parque Antena: 1 intermediate valve, width 4 mm; Velerín Antena: 2 valves, 1 head (width 2.1 mm) and 1 intermediate (width 3 mm).

**Remarks.** The species is characterized by tegmentum uniformly sculptured with roundish granules, arranged without special order on head valve, lateral areas of intermediate valves and postmucronal area of tail valve, in longitudinal rows, fine and close set on jugum, increasing in size and converging posteriorly towards side margins in pleural areas and antemucronal area of tail valve.

*Hanleya multigranosa* (Reuss, 1860), found in the Miocene (Badenian) of the Vienna basin and of Korytnica (Poland), in the Miocene of Miste (The Netherlands, North Sea basin) and recently reported from the Pleistocene of “Torrente Stirone” (prov. Parma, Italy) (Sabelli & Taviani, 1979) is considered conspecific to the present species.

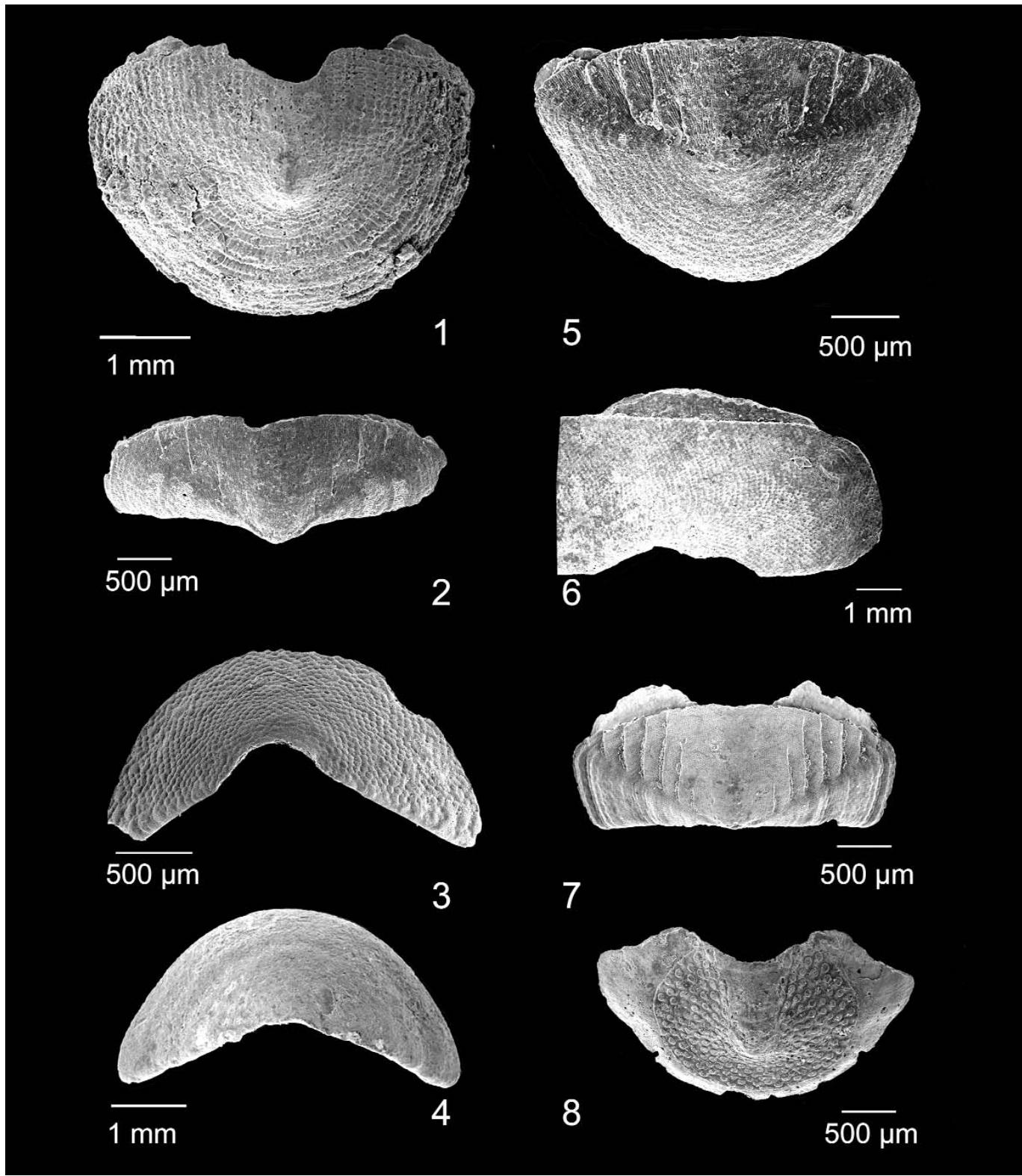
**Distribution.** *H. hanleyi* occurs in the Atlantic Ocean from the Barents Sea to the Canary Islands, off the East coast of N. America, and in the Mediterranean Sea. It was reported from the Middle Miocene (Badenian) of the central European basins, Tortonian of Montegibbio (Modena), the Hemmoor Stufe of Miste and Messinian of Borelli (Turin). There are a few records from the Pliocene of Great Britain, Belgium and Italy and from the Pleistocene of Norway and Italy. In the North Sea basin it is found in the Early Pliocene Kattendijk Fm. of Belgium, characterized by deep and rather cold water (*Petaloconchus* reef), without any hard substrates unless the *Petaloconchus* tubes and other shells. The British records are from the Coralline Crag.

*Hanleya* sp.  
(Pl.3 Fig.1)

**Material.** Velerín Antena: 1 tail valve, width 4.3 mm.

**Remarks.** We recovered a single tail valve belonging to the genus *Hanleya* Gray, 1857, but differing from the typical taxon *H. hanleyi*. In particular, the tegmental sculpture is remarkable, consisting of longitudinal series of granules in the antemucronal area and radial series in the postmucronal area. The shape of the valve of typical *H. hanleyi* also differs, being slightly less than semicircular, whereas our valve is nearly transversely elliptical.

So far, three species of *Hanleya* are known to occur in the European Cenozoic: *H. glimmerodensis* Janssen, 1978, only known from the Oligocene of central Europe, *H. hanleyi* (Bean in Thorpe, 1844), and *H. nagelfar* (Lovén, 1864). Our valve is very similar to *H. nagelfar* (see fig. 92/6 in Kaas & Van Belle, 1985a).



## Plate 3

Fig. 1 *Hanleya* sp., tail valve, Velerín Antena; Figs 2, 5: *Callochiton septemvalvis*, Velerín Antena: Fig. 2 intermediate valve, Fig. 5 tail valve; Fig. 3 *Lepidochiton canariensis*, head valve, Velerín Carretera; Figs 4, 7: *Chiton corallinus*: Fig. 4 head valve, Velerín, Fig. 7 intermediate valve, Rio del Padrón; Fig. 6 *Lepidochitonina cinerea*, intermediate valve, Parque Antena; Fig. 8 *Acanthochiton fascicularis*, tail valve, Rio del Padrón.

## Tav. 3

Fig. 1 *Hanleya* sp., piastra posteriore, Velerín Antena; Figg. 2, 5: *Callochiton septemvalvis*, Velerín Antena: Fig. 2 piastra intermedia, Fig. 5 piastra posteriore; Fig. 3 *Lepidochitonina canariensis*, piastra anteriore, Velerín Carretera; Figg. 4, 7: *Chiton corallinus*: Fig. 4 piastra anteriore, Velerín, Fig. 7 piastra intermedia, Rio del Padrón; Fig. 6 *Lepidochitonina cinerea*, piastra intermedia, Parque Antena; Fig. 8 *Acanthochiton fascicularis*, piastra posteriore, Rio del Padrón.

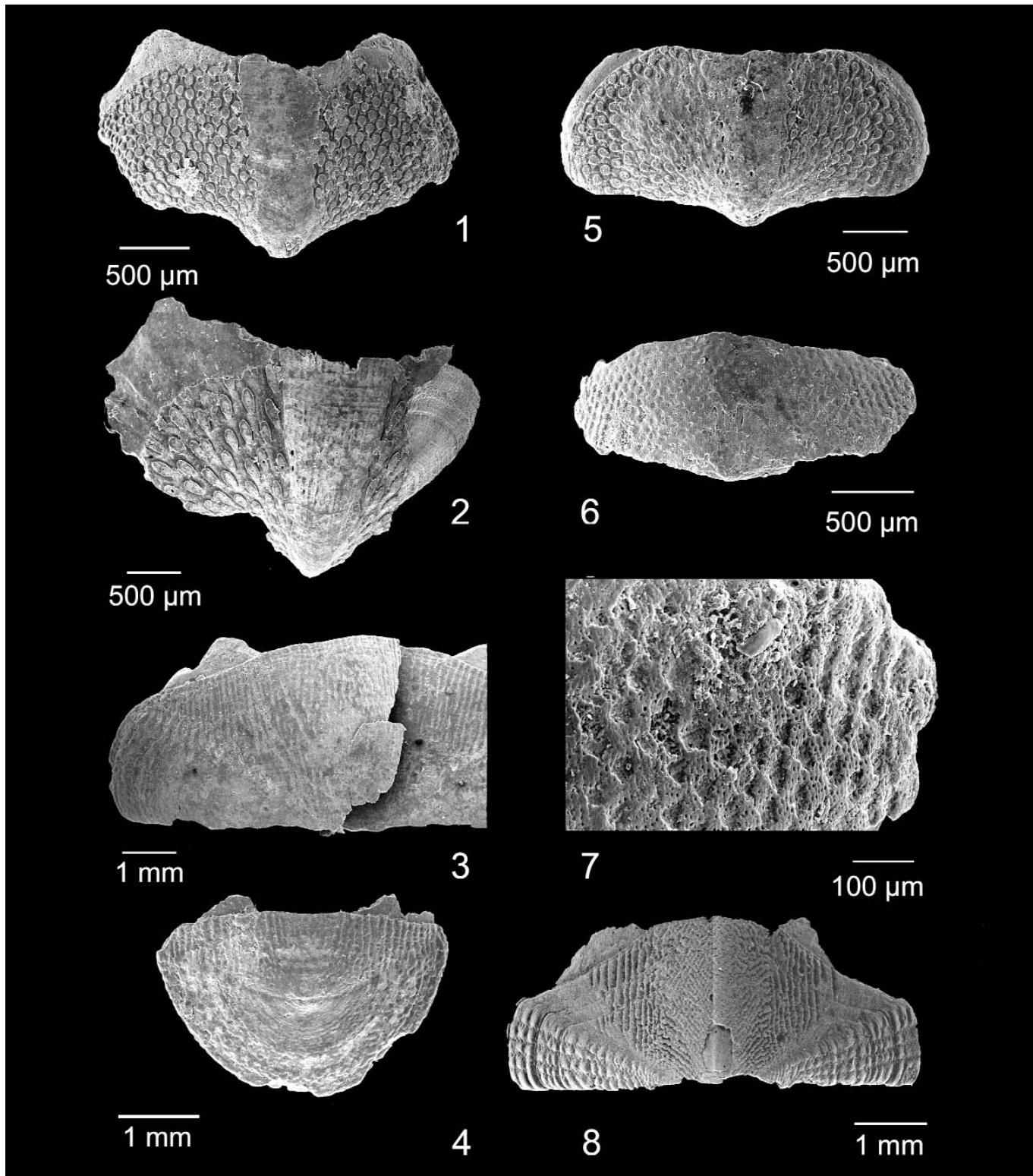


Plate 4

Fig. 1 *Acanthochitona fascicularis*, intermediate valve, Velerín Carretera; Figs 2, 5: *Acanthochitona crinita*: Fig. 2 f. *oblonga*, intermediate valve, Parque Antena, Fig. 5 intermediate valve, Velerín Carretera; Figs 3-4 *Ischnochiton rissoii*: Fig. 3 intermediate valve, Velerín Carretera, Fig. 4 tail valve, Rio del Padrón; Figs 6-7 *Ischnochiton ulivii*, intermediate valve, Parque Antena; Fig. 8 *Ischnochiton martinelli* n.sp., intermediate valve, holotype, Velerín Carretera.

Tav. 4

Fig. 1 *Acanthochitona fascicularis*, piastra intermedia, Velerín Carretera; Figg. 2, 5: *Acanthochitona crinita*: Fig. 2 f. *oblonga*, piastra intermedia, Parque Antena, Fig. 5 piastra intermedia, Velerín Carretera; Figg. 3-4 *Ischnochiton rissoii*: Fig. 3 piastra intermedia, Velerín Carretera, Fig. 4 piastra posteriore, Rio del Padrón; Figg. 6-7 *Ischnochiton ulivii*, piastra intermedia, Parque Antena; Fig. 8 *Ischnochiton martinelli* n.sp., piastra intermedia, olotipo, Velerín Carretera.



This taxon now lives in the NE Atlantic, associated with sponges of deep-sea coral banks. *H. nagelfar* is known from the Mediterranean Pleistocene (Bellomo & Sabelli, 1995: 16 valves from "Contrada Case Alte", Reggio Calabria; Dell'Angelo *et al.*, 1998: 2 valves from submerged taphocoenoses, cruise CS96, Strait of Sicily, st.32 –328/704 m) and considered a "Celtic-boreal guest" (Malatesta & Zarlenga, 1986). Because of the scarcity of material from the Pliocene of Malaga (one valve) and the ecological requirements of *H. nagelfar*, we prefer to leave our nomenclature open.

Suborder ISCHNOCHITONINA Bergenhayn, 1930  
 Family ISCHNOCHITONIDAE Dall, 1889  
 Subfamily ISCHNOCHITONINAE Dall, 1889  
 Genus *Ischnochiton* Gray, 1847

***Ischnochiton ulivii* Dell'Angelo & Forli, 1996**  
 (Pl.4 Figs 6-7)

*Ischnochiton ulivii* Dell'Angelo & Forli, 1996: 46, figs 16-26.

*Ischnochiton ulivii* – Dell'Angelo *et al.*, 2001: 150, fig.21.

**Material.** Parque Antena: 1 intermediate valve, width 2.1 mm.

**Remarks.** The species is characterized by small, neat but irregularly arranged depressions in the central area and minute irregularly arranged tubercles in the lateral areas. The only valve found agrees well the characteristics of the species.

**Distribution.** *I. ulivii* is a rare species previously known only from the Pliocene (Tuscany: Pietrafitta and Orciano Pisano) and Pleistocene (Tuscany: Riparbella) of Italy. The present finding considerably extends its geographic distribution.

***Ischnochiton martinelli* sp.nov.**

(Pl.4 Fig.8; Pl.5 Figs 1-4,6-8; Pl.6 Figs 1-8; Pl.7 Fig.1 )

**Diagnosis.** Head valve semicircular, notched in the middle; intermediate valves broadly rectangular, moderately elevated (dorsal elevation 0.36-0.54), carinated; tail valve semicircular, mucro subcentral. Head valve, lateral areas of intermediate valves and postmucronal area of tail valve sculptured with radial nodulose riblets, central area with vermicular ribs obliquely intersecting in the jugal area, tending to form longitudinal striae in the pleural areas, and a smooth zone near the margin of the lateral areas. Slit formula 9-11/1/11.

**Description.** Head valve semicircular, front slope straight to slightly concave, posterior margin widely V-shaped, notched in middle; tegmentum sculptured with about 26-30 radiating nodulose riblets, becoming indistinct toward apex, nodules squarish, being formed by many concentric grooves crossing riblets. Intermediate valves broadly rectangular, carinated, moderately elevated, anterior border consisting of three segments, the two

lateral ones concave and the one between the apophyses convex, posterior border nearly straight, not beaked, side margins slightly convex. Lateral areas moderately elevated, sculptured like head valve, with 4-5 radial nodulose riblets crossed by many concentric grooves.

Jugal area with reticulate sculpture consisting of obliquely intersecting vermicular ribs, with granules that tend to separate, whereas in pleural area these vermicular ribs tend to form about ten real longitudinal striae, often somewhat eroded. An almost smooth area, with some macroaesthetes arranged in parallel rows (Pl.5, Fig.4), is present in extreme part of pleural areas, towards margin of lateral areas.

Tail valve semicircular, with anterior border similar to that of intermediate valves, mucro subcentral, hind slope slightly concave behind mucro; antemucronal area sculptured like central area of intermediate valves, postmucronal area sculptured like head valve.

Articulamentum whitish, apophyses wide; slit formula 9-11/1/11, slits inequidistant.

**Material.** Parque Antena: 4 valves, 2 head (maximum width 3 mm) and 2 intermediate, incomplete; Velerín Antena: 8 valves, 1 head (width 3.6 mm), 6 intermediate (maximum width 4.3 mm) and 1 tail, width 4.1 mm; Velerín Carretera: 30 valves, 3 head (maximum width 4.8 mm) and 27 intermediate (maximum width 6.5 mm).

**Type material.** Holotype: MZB 25051 (1 intermediate valve, Velerín Carretera). Paratypes: MZB 25052 (1 head, 1 intermediate and 1 tail valve, Velerín Antena); MME (1 head and 2 intermediate valves, Velerín Carretera); IRSN IST 6450 (1 head valve, Parque Antena, 1 intermediate valve, Velerín Antena, 1 tail valve, Velerín Carretera); BDA 4567 (1 head and 2 intermediate valves, Velerín Carretera); RM (1 head valve, Parque Antena, 1 head valve, Velerín Carretera, 1 intermediate valve, Velerín Antena).

**Etymology.** The species is named after Jordi Martinell, Barcelona, in recognition of his work on Iberian molluscan palaeontology.

**Type locality.** Velerín Carretera, near Estepona (Málaga, Spain).

**Type stage.** Early Piacenzian (Pliocene).

**Remarks.** This species is somewhat related to *Ischnochiton anserinus* Laghi, 1977, a rare taxon from the Lower Pliocene of N. Italy ("La Tagliata", Modena) and also reported from the Pliocene of Tuscany (Dell'Angelo *et al.*, 2001). *I. anserinus* differs from *I. martinelli* by having the lateral areas and anterior area sculptured with fine granules formed by a trellis-work of diagonal furrows, giving a smooth appearance in eroded material. Laghi established his new species on the basis of 9 intermediate valves (not well preserved, incomplete) and a small fragment of a head valve (Laghi, 1977: pl.1, fig.11). All subsequent



records of *I. anserinus* refer to intermediate valves. No tail valve is available, and only the head valve fragment. However, the lateral areas of all valves of *I. anserinus* examined by us appear smooth, with no trace of nodulose riblets. On the contrary the complete set of valves examined all have radiating nodulose riblets in lateral and terminal areas. We therefore consider our material a distinct new species.

Subgenus *Ischnochiton* s.str.

***Ischnochiton (Ischnochiton) rissoi* (Payraudeau, 1826)**  
(Pl.4 Figs 3-4)

*Chiton rissoi* Payraudeau, 1826: 87, pl.3, figs 4-5.  
*Chiton mediterraneus* Gray MS, Reeve, 1847: pl.23, fig.157.  
*Ischnochiton rudolticensis* Sulc, 1934: 23, pl.2, figs 41-43.

*Ischnochiton rissoi* – Pilsbry, 1892: 102, pl.20, figs 1-7. – Nierstrasz, 1906b: 163, figs 10,12. – Maluquer, 1915: 246, pl.14, figs 5-6,8-9. – Baluk, 1984: 287, pl.6, figs 2a-b. – Gaglini, 1985: V, pl.2, fig.5; pl.6, figs 3-4. – Forli *et al.*, 1999: 111. – Dell'Angelo *et al.*, 2001: 150, figs 20, 23.

*Ischnochiton (I.) rissoi* – Malatesta, 1962: 160, figs 16-17. – Dell'Angelo & Forli, 1995a: 230, fig.15. – Dell'Angelo *et al.*, 1998: 246, pl.3, fig.2.

*Ischnochiton (Ischnochiton) rissoi* – Dell'Angelo & Smriglio, 1999: 100, figs 40-48, pls.29-31.

*Ischnochiton (Simplischnochiton) rissoi* – Laghi, 1977: 104, pl.1, figs 4-9. – Dell'Angelo *et al.*, 1999: 265, pl.3, figs 3,5.

*Ischnochiton rudolticensis* – Baluk, 1971: 458, pl.3, figs 5-8.

**Material.** Parque Antena: 1 intermediate valve, width 4.3 mm; Velerín Antena: 2 intermediate valves, maximum width 4.5 mm; Rio del Padron: 5 valves, 1 head (fragment, width 3.5 mm), 2 intermediate (maximum width 5.2 mm) and 2 tail (maximum width 6.3 mm); Velerín: 4 tail valves, maximum width 6.8 mm; Velerín Carretera: 1 intermediate valve, width 7.3 mm.

**Remarks.** The species is characterized by tegmental sculpture consisting of concentric vermicular ribs, often intersected by fine radial furrows, on the anterior valve, the lateral areas of the intermediate valves and the postmucronal area of the tail valve. The ribs continue longitudinally on the central areas of the intermediate valves and on the antemucronal area of the tail valve. Our material matches the characteristics of this highly variable species. Taxonomic status is rather complex.

Laghi (1977) considered the Miocene (Badenian) valves from Korytnica (Poland) (identified by Baluk (1971) as *Ischnochiton rudolticensis* (Sulc, 1934)) to be conspecific with *I. rissoi*, a synonymy accepted by Baluk (1984) and subsequent authors.

**Distribution.** *I. rissoi* is currently only confirmed in the Mediterranean Sea. Some Atlantic records (Canary, Selvagens and Azores Islands) need confirmation. It has been reported

since the Middle Miocene (Badenian) of central eastern European basins, the Tortonian of northern Apennines, the Messinian of Borelli (Turin) and many Italian Plio-Pleistocene localities.

Subgenus *Stenosemus* Middendorff, 1847

***Ischnochiton (Stenosemus) aff. vanbellei* Kaas, 1985**  
(Pl.7 Figs 2,5-6)

*Ischnochiton (Stenosemus) vanbellei* Kaas, 1985b: 316, figs 55-68.

*Ischnochiton vanbellei* – Dell'Angelo & Giusti, 1997: 52, fig.3. – Dell'Angelo *et al.*, 2001: 150, fig.24.

Non *Ischnochiton vanbellei* – Smriglio, Mariottini & Gravina, 1989: 126, figs 3,4ab (= *Ischnochiton dolii*).

*Ischnochiton (Stenosemus) vanbellei* – Kaas & Van Belle, 1990: 71, fig.29. – Dell'Angelo *et al.*, 1998: 246, pl.2, figs 6,8.

**Material.** Rio del Padrón: 1 intermediate valve, width 4 mm; Velerín Carretera: 6 intermediate valves, maximum width 6.4 mm.

**Remarks.** The six intermediate valves found are characterized by a sculpture formed by 2-3 nodulose ribs on the lateral areas and 15-16 longitudinal riblets on the central area. Only a small part of jugal area is smooth, and 2-3 of innermost ribs do not reach superior margin. Nodulosity of ribs in lateral areas is very evident in two valves.

Shape of valves and sculpture of lateral areas are similar to those of *I. vanbellei*, which however have different sculpture of the central area, with 7-9 (or more) longitudinal sulci on either side, the three or four innermost ones not reaching the anterior margin, and a wider smooth jugal area. The sculpture of the central area is more similar to that of *I. dolii* Van Belle & Dell'Angelo, 1998, an uncommon deep species living in the Mediterranean Sea.

Our attribution is doubtful since the variability of *I. vanbellei* is not yet fully understood.

**Distribution.** *I. vanbellei* is currently known from the Tuscan Archipelago, Sicily Strait, Malta, Spain (Marbella) and Mauritania. It was reported from the submerged glacial Pleistocene of the southern Ligurian Sea, from a taphocenosis at 350 - 500 m dredged between Capraia Is. and Capo Corso.

Subfamily CALLOCHITONINAE Plate, 1901  
Genus *Callochiton* Gray, 1847

***Callochiton septemvalvis* (Montagu, 1803)**  
(Pl.3 Figs 2,5)

*Chiton septemvalvis* Montagu, 1803: 3.

*Chiton achatinus* Brown, 1823: 402.

*Chiton euplaeae* O.G.Costa, 1829: i,iv, pl.1, fig.3.

*Chiton doriae* Capellini, 1859: 325, pl.12, fig.2.

*Chiton rariplicatus* Reuss, 1860: 258, pl.8, figs 9-11.

*Callochiton laevis* – Laghi, 1977: 108, pl.2, figs 14-18. – Baluk,

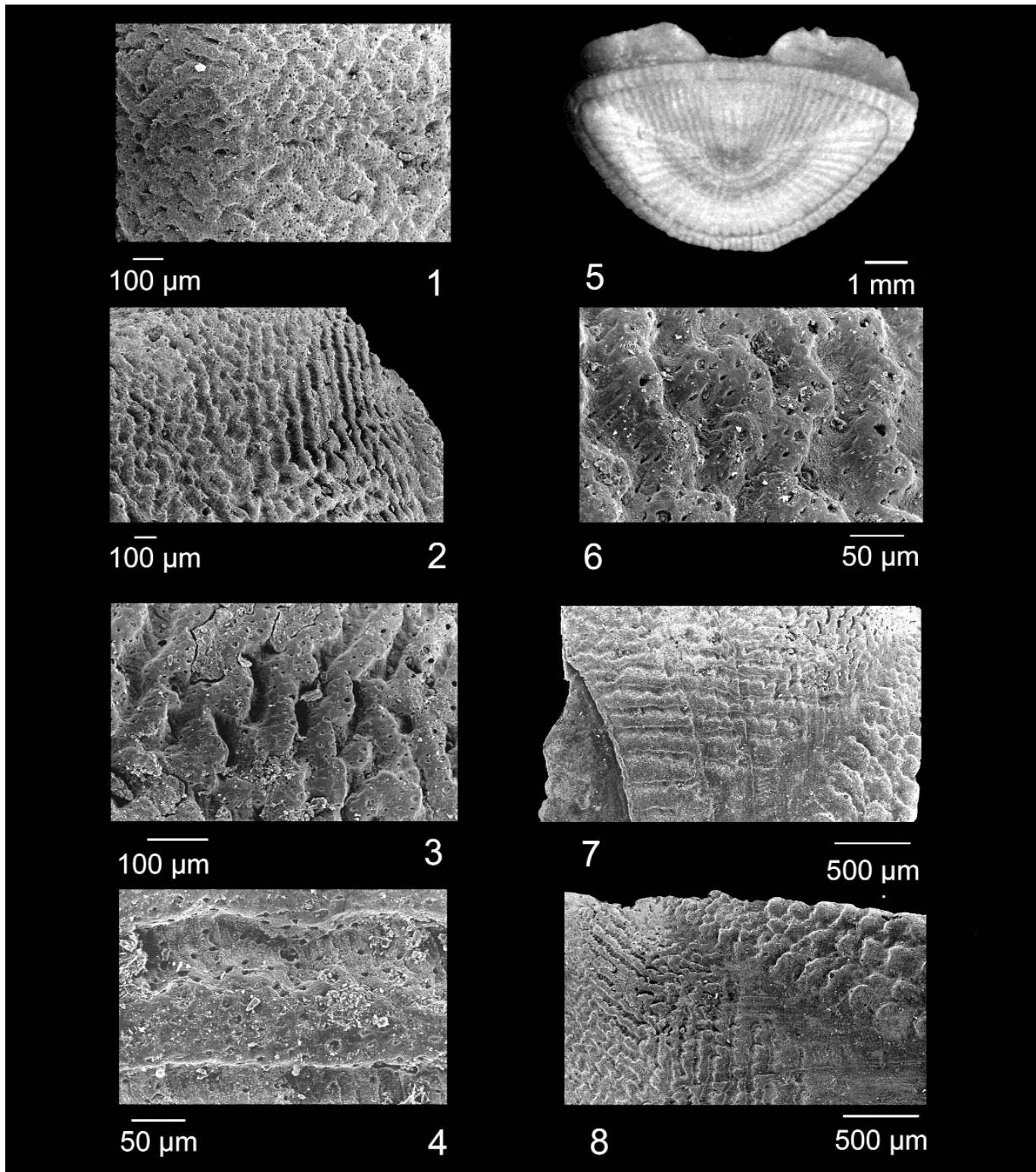


Plate 5

Figs 1-4, 6-8 *Ischnochiton martinelli* n.sp., intermediate valve, holotype, Velerín Carretera: Fig. 1 reticulate sculpture of jugal area, Figs 2-3 contact between jugal and pleural areas, Fig. 4 smooth area in extreme part of pleural area, Fig. 6 granules of jugal area, Fig. 7 longitudinal striae of pleural area, Fig. 8 lateral area; Fig. 5 *Chiton miocenicus*, tail valve, Velerín.

Tav. 5

Figg. 1-4, 6-8 *Ischnochiton martinelli* n.sp., piastra intermedia, olotipo, Velerín Carretera: Fig. 1 scultura reticolata dell'area jugale, Figg. 2-3 contatto tra le aree jugale e pleurale, Fig. 4 zona liscia nella parte estrema dell'area pleurale, Fig. 6 granuli dell'area jugale, Fig. 7 strie longitudinali dell'area pleurale, Fig. 8 area laterale; Fig. 5 *Chiton miocenicus*, piastra posteriore, Velerín.



1984: 290.

*Callochiton doriae* – Maluquer, 1915: 241, pl.14, fig.14; pl.15, fig.22.

*Callochiton (C.) achatinus* – Malatesta, 1962: 158, fig.15.

*Callochiton septemvalvis* – Kaas & Van Belle, 1985b: 11, fig.2. – Dell'Angelo & Forli, 1995a: 226, figs 10,17. – Dell'Angelo & Smriglio, 1999: 125, figs 55-63, pls.40-41. – Dell'Angelo *et al.*, 2001: 147, fig.10.

*Callochiton euplaeae* – Gaglini, 1985: XI, pl.4, fig.4; pl.8, figs 5-6; pl.9, figs 1-2.

*Callochiton rariplacatus* – Baluk, 1971: 461, pl.5, figs 1-5.

**Material.** Velerín Antena: 6 valves, 4 intermediate (maximum width 3.7 mm) and 2 tail (maximum width 2.6 mm); Rio del Padrón: 5 valves, 3 intermediate (maximum width 2.7 mm) and 2 tail (maximum width 2.3 mm); Velerín Carretera: 2 intermediate valves, maximum width 2.2 mm.

**Remarks.** This species has long been known under the names of *C. laevis* (Montagu, 1803, non Pennant, 1777), *C. achatinus* (Brown, 1823), and *C. doriae* (Capellini, 1859). Kaas (1978) proposed the name *Callochiton septemvalvis* (Montagu, 1803) for this taxon, and separation of the typical Atlantic form, *C. septemvalvis septemvalvis*, from the Mediterranean one, *C. septemvalvis euplaeae* (O.G.Costa, 1829), at subspecific level. The latter taxon is characterized by its smaller size and by the presence of 3-5 longitudinal scars on the pleural areas. Dell'Angelo & Palazzi (1994) suggested adopting the taxon *Callochiton septemvalvis* to designate this species as a whole, since *Chiton euplaeae* was clearly described by O.G. Costa (1829) as having a smooth surface, without any trace of scars.

Our valves have the same tegmental sculpture as living specimens, i.e. a dense and uniform set of cords, barely visible with the naked eye, with 3-4 longitudinal grooves in the pleural area, these are however more elongate and finer than those on living and fossil valves from Italian sites. Only in two intermediate valves are longitudinal grooves absent.

Laghi (1977) considered the Miocene (Badenian) specimens from Korytnica (Poland), identified by Baluk (1971) as *Callochiton rariplacatus* (Reuss, 1860), as well as those from the Miocene of the Vienna Basin illustrated by Reuss (1860) and Sulc (1934), to be conspecific with *Callochiton septemvalvis*, a synonymy accepted by Baluk (1984) and subsequent authors.

**Distribution.** *Callochiton septemvalvis* is widely distributed in the northeastern Atlantic Ocean, from Norway to the Canary Islands and the Mediterranean Sea. It has been reported from the Miocene of central-eastern Europe (under the name of *Chiton rariplacatus* Reuss, 1860) and the Miocene of Montegibbio (Modena, N.Italy). *Callochiton septemvalvis* is common in the Italian Plio-Pleistocene, and is recorded from the Portuguese Pliocene.

Subfamily LEPIDOCHITONINAE Iredale, 1914

Genus *Lepidochitona* Gray, 1821

Subgenus *Lepidochitona* s.str.

*Lepidochitona (L.) cinerea* (Linnaeus, 1767)

(Pl.3 Fig.6)

*Chiton cinereus* Linnaeus, 1767: 1107.

*Chiton marginatus* Pennant, 1777: 71, pl.36, fig.2.

*Chiton cinereus* – Dodge, 1952: 23.

*Lepidochitona cinerea* – Laghi, 1977: 105, pl.3, figs 1-4. – Gaglini, 1985: vii, pl.3, fig.1; pl.7, figs 1-2. – Forli *et al.*, 1999: 111, pl.1, fig.7. – Dell'Angelo *et al.*, 2001: 148, figs 12,15.

*Lepidochitona (L.) cinerea* – Malatesta, 1962: 155, figs 11-12.

*Lepidochitona (L.) cinerea* – Kaas & Van Belle, 1981: 9, figs 2-17,128/1. – Kaas & Van Belle, 1985b: 84, fig.39. – Dell'Angelo & Forli, 1995a: 227, fig.14. – Dell'Angelo *et al.*, 1999: 264, pl.2, figs 1-3. – Dell'Angelo & Smriglio, 1999: 138, pls.44-45, figs 67-72.

*Ischnochiton marginatus* – Maluquer, 1915: 244, pl.15, figs 18-21.

**Material.** Parque Antena: 1 intermediate valve, incomplete, width 7.3 mm; Velerín Antena: 1 intermediate valve, width 10 mm; Velerín: 2 intermediate valves, maximum width 15.58 mm.

**Remarks.** This species had a complicated taxonomical history. Early authors mistook *Lepidopleurus (Leptochiton) asellus* (Gmelin, 1791) for *Chiton cinereus* Linnaeus, 1767, adopting the younger name *Ch. marginatus* Pennant, 1777. The species is characterized by tegmentum sculptured all over with fine diamond-shaped granules, arranged in a somewhat irregular quincunx pattern.

A similar species, *L. subgranosa* Baluk, 1971 was recorded from the Miocene (Badenian) of Poland, and considered by Laghi (1977) a junior synonym of *L. cinerea*. This synonymy was not accepted by Baluk (1984), who regards the ornamentation of *L. subgranosa* as more similar to that of *L. canariensis* (Thiele, 1909) than to that of *L. cinerea*.

**Distribution.** Today, *Lepidochitona (L.) cinerea* is widely distributed along the European Atlantic coasts, from Norway in the north to the Iberian Peninsula, and into the Mediterranean and Black Sea; it also occurs along the northwestern Atlantic coast of Morocco. This species was probably reported from the Badenian of Poland, Tortonian of Montegibbio (Modena) and Messinian of Borelli (Turin), with a few records from some Italian and Portuguese Pliocene localities and the Pleistocene of Italy and Norway.

*Lepidochitona (L.) canariensis* Thiele, 1909

(Pl.3 Fig.3)

*Trachydermon canariensis* Thiele, 1909: 15, pl.2, figs 14-25.

*Lepidochitona canariensis* – Dell'Angelo & Tringali, 2000: 51, fig.1.

*Lepidochitona (L.) canariensis* – Kaas & Van Belle, 1985b: 95, fig.44.

*Lepidochitona (Lepidochitona) canariensis* – Dell'Angelo & Smriglio, 1999: 154, fig.78, pl.51.

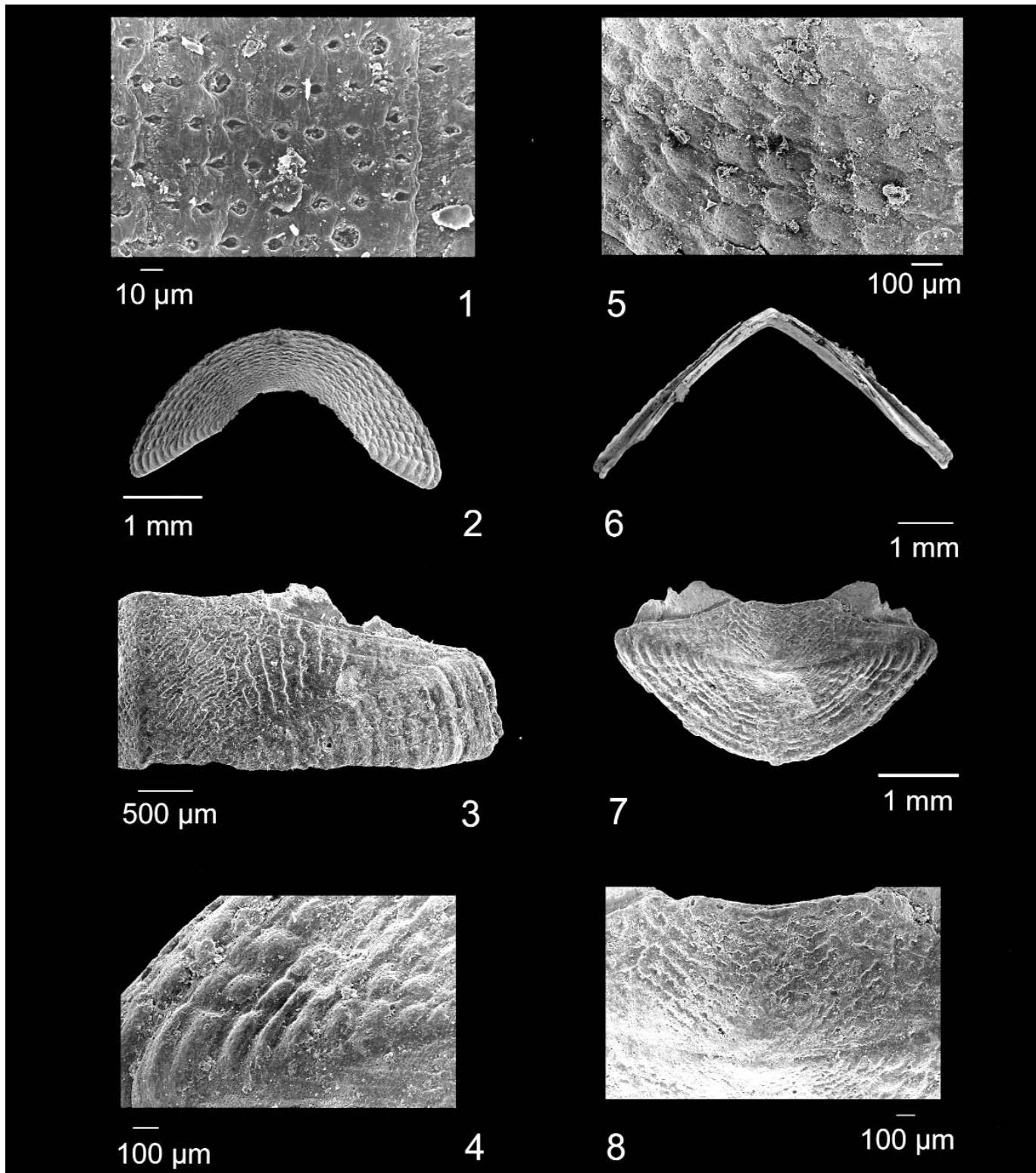


Plate 6

Figs 1-8 *Ischnochiton martinelli* n.sp.: Fig. 1 holotype, Velerín Carretera, macroaesthetes arranged in parallel rows in smooth area in extreme part of pleural area, Figs 2, 5 head valve, paratype MME, Velerín Carretera, Fig. 3 intermediate valve, Velerín Antena, Figs 4, 7, 8 tail valve, paratype MZB, Velerín Antena, Fig. 6 intermediate valve, outline, paratype BDA, Velerín Carretera.

Tav. 6

Figg. 1-8 *Ischnochiton martinelli* n.sp.: Fig. 1 olotipo, Velerín Carretera, macroesteti disposti in strie parallele nella zona liscia nella parte estrema dell'area pleurale, Figg. 2, 5 piastra anteriore, paratipo MME, Velerín Carretera, Fig. 3 piastra intermedia, Velerín Antena, Figg. 4, 7, 8 piastra posteriore, paratipo MZB, Velerín Antena, Fig. 6 piastra intermedia, profilo, paratipo BDA, Velerín Carretera.

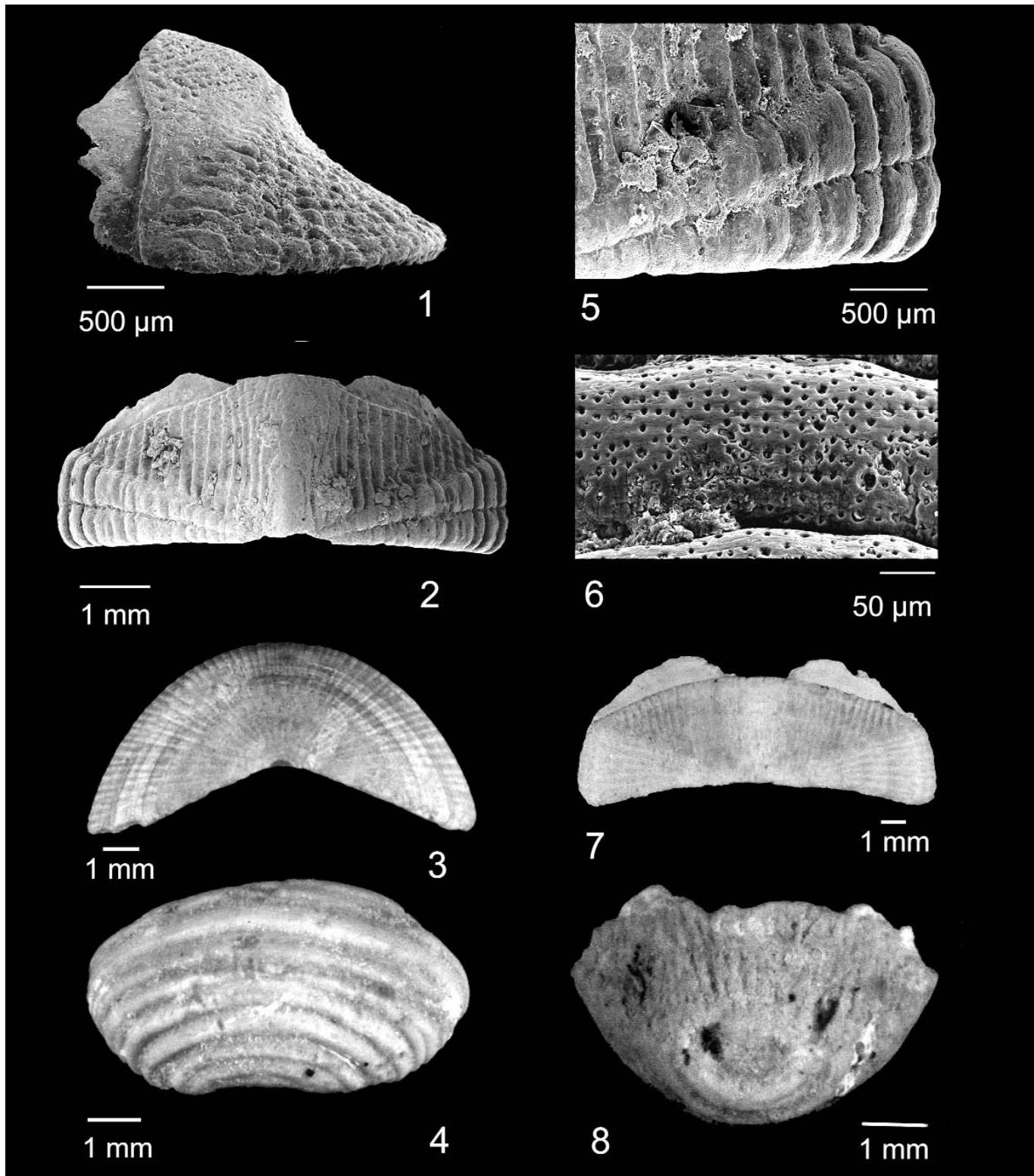


Plate 7

Fig. 1 *Ischnochiton martinelli* n.sp., tail valve, lateral view, paratype MZB, Velerín Antena; Figs 2, 5-6 *Ischnochiton* aff. *vanbellei*, intermediate valve, Velerín Carretera: Fig. 2 intermediate valve, Fig. 5 lateral area, Fig. 6 aesthetes on nodulose ribs in lateral area; Figs 3, 7 *Chiton miocenicus*, Velerín: Fig. 3 head valve, Fig. 7 intermediate valve; Figs 4, 8 *Lepidopleurus cajetanus*, Velerín: Fig. 4 head valve, Fig. 8 tail valve.

Tav. 7

Fig. 1 *Ischnochiton martinelli* n.sp., piastra posteriore, vista laterale, paratipo MZB, Velerín Antena; Figg. 2, 5-6 *Ischnochiton* aff. *vanbellei*, piastra intermedia, Velerín Carretera: Fig. 2 piastra intermedia, Fig. 5 area laterale, Fig. 6 esteti sulle strie nodulose nell'area laterale; Figg. 3, 7 *Chiton miocenicus*, Velerín: Fig. 3 piastra anteriore, Fig. 7 piastra intermedia; Figg. 4, 8 *Lepidopleurus cajetanus*, Velerín: Fig. 4 piastra anteriore, Fig. 8 piastra posteriore.



**Material.** Velerín Carretera: 2 head valves, maximum width 2.3 mm.

**Remarks.** The two head valves found are characterized by tegmentum sculptured with fine roundish granules, arranged in a somewhat irregular quincunx pattern. It is difficult to determine the species on the basis of head valves alone, but it is certainly not conspecific with *Lepidochitona cinerea* (Linnaeus, 1767), which has wider head valves and characteristic diamond-shaped granules. Our valves lack the more or less obsolete radiating ribs, typical of other *Lepidochitona* species, i.e. *L. caprearum* (Scacchi, 1836) and *L. monterosatoi* Kaas & Van Belle, 1981. We attribute the valves to *L. canariensis*, a species now found in the Mediterranean Sea, though with some doubt, until more study material is available.

Our valves are also similar to those of *Lepidochitona subgranosa* Baluk, 1971, a species from the Miocene (Badenian) of Poland, which could be conspecific with *L. canariensis*.

**Distribution.** *L. canariensis* only now occurs in the Canary and Madeira Islands and was recently found in a Mediterranean (Morocco: Torres de Alcalà) locality. This is the first fossil record for the species.

Family CHITONIDAE Rafinesque, 1815  
Subfamily CHITONINAE Rafinesques, 1815  
Genus *Chiton* Linnaeus, 1758

*Chiton miocenicus* Michelotti, 1847  
(Pl.5 Fig.5; Pl.7 Figs 3,7)

*Chiton miocenicus* Michelotti, 1847: 132, pl.16, fig.7.

*Chiton miocenicus* – Sacco, 1897: 89, pl.7, figs 8-20. – Dell'Angelo *et al.*, 1999: 271, pl.4, figs 1,3,5-8. – Forli *et al.*, 1999: 113, pl.1, figs 4-6. – Dell'Angelo *et al.*, 2001: 152, fig.27.

**Material.** Parque Antena: 5 valves, 4 intermediate (maximum width 15 mm) and 1 tail, width 8.5 mm; Velerín Antena: 13 valves, 12 intermediate (maximum width 19.5 mm) and 1 tail, width 5 mm; Rio del Padrón: 15 valves, 2 head (maximum width 7.3 mm), 8 intermediate (maximum width 13 mm) and 5 tail (maximum width 4.5 mm); Velerín: 92 valves, 19 head (maximum width 14.5 mm), 38 intermediate (maximum width 19.5 mm) and 35 tail (maximum width 12.2 mm); Velerín Carretera: 4 intermediate valves, maximum width 12 mm.

**Remarks.** The species is characterized by a sculpture of radial grooves on the head valve, lateral areas of the intermediate valves, and postmucronal area of the tail valve, and of longitudinal grooves on the pleural areas, about 20-25 on each side. *Chiton miocenicus* has been described from the Miocene of the Turin hills, and recently from the Tuscan Pliocene (Forli *et al.*, 1999). The species is similar to *C. olivaceus* Spengler, 1797, considered conspecific with *C. miocenicus* by many authors, which however has fewer radial and longitudinal grooves. It is also similar to

*C. saeniensis* Laghi, 1984, that has the same valve shape as *C. miocenicus*, but the tegmentum is smooth or the grooves are only faint.

Fossil species belonging to the genus *Chiton* are in great need of critical study.

**Distribution.** species is known from the Miocene (Burdigalian) of Turin hills, Messinian of Borelli (Turin) and some Italian Pliocene localities.

Subgenus *Rhyssoplax* Thiele, 1893

*Chiton (Rhyssoplax) corallinus* (Risso, 1826)  
(Pl.3 Figs 4,7)

*Lepidopleurus corallinus* Risso, 1826: 268.  
*Chiton pulchellus* Philippi, 1844: 83, pl.19, fig.14 (*non* Gray, 1828).  
*Chiton denudatus* Reuss, 1860: 259, pl.8, figs 14-15.  
*Chiton philippii* Issel, 1870: 5 (nom.nov.*pro* *Chiton pulchellus* Philippi, 1844).

*Chiton corallinus* – Maluquer, 1915: 259, pl.16, figs 30-31. – Laghi, 1977: 109, pl.2, figs 9-12. – Baluk, 1984: 290. – Gaglini, 1985: XIV, pl.5, fig.2; pl.6, figs 1-2. – Dell'Angelo & Giusti, 1997: 55, figs 14,16. – Dell'Angelo *et al.*, 2001: 152, fig.25.  
*Chiton (Chiton) corallinus* – Malatesta, 1962: 163, figs 20-21.  
*Chiton (Rhyssoplax) corallinus* – Dell'Angelo & Smriglio, 1999: 174, pls.58-59, figs 97-107.  
*Chiton denudatus* – Baluk, 1971: 462, pl.5, figs 9-11.

**Material.** Parque Antena: 8 valves, 5 intermediate (maximum width 7 mm) and 3 tail (maximum width 3 mm); Velerín Antena: 5 valves, 3 intermediate (maximum width 7 mm) and 2 tail (maximum width 3.2 mm); Rio del Padrón: 23 valves, 17 intermediate (maximum width 6 mm) and 6 tail (maximum width 4.6 mm); Velerín: 19 valves, 2 head (maximum width 6.7 mm), 11 intermediate (maximum width 9.5 mm) and 6 tail (maximum width 6.5 mm); Velerín Carretera: 33 valves, 2 head (maximum width 3.1 mm), 27 intermediate (maximum width 7.6 mm) and 4 tail (maximum width 5.3 mm)

**Remarks.** The species is characterized by smooth head valve, lateral areas of intermediate valves and postmucronal area of tail valve. The pleural areas have 7-10 longitudinal grooves on each side that are actually small outward-leaning folds of the tegmentum. Our material matches the characteristics of the species well.

Laghi (1977) considered *Chiton denudatus* Reuss, 1860, a species from the Miocene of Steinabrunn (Vienna Basin), Rudoltice (Bohemia) and Korytnica (Central Poland), to be a junior synonym of *Chiton corallinus*, a synonymy accepted by Baluk (1984) and subsequent authors.

**Distribution.** Today, *Chiton corallinus* occurs only in the Mediterranean Sea. It has been reported from the Miocene of



central-eastern Europe (under the name of *Chiton denudatus* Reuss, 1860) and from the Tortonian of Montegibbio (Modena prov.). It is more common in Italian Pliocene (locally very frequent) and Pleistocene deposits, and is also reported from the Pliocene of Portugal.

Suborder ACANTHOCHITONINA Bergenhayn, 1930  
Family ACANTHOCHITONIDAE Simroth, 1894  
Subfamily ACANTHOCHITONINAE Simroth, 1894  
Genus *Acanthochitona* Gray, 1821

***Acanthochitona fascicularis* (Linnaeus, 1767)**  
(Pl.3 Fig.8 ; Pl.4 Fig.1)

*Chiton fascicularis* Linnaeus, 1767: n.1106.

*Acanthochites communis* Risso, 1826: 268.

*Acanthochites faluniensis* de Rochebrune, 1883: 60.

*Acanthochitona fascicularis* – Kaas, 1985: 585, figs 1-6. – Dell'Angelo & Forli, 1995a: 235, figs 8,11. – Dell'Angelo & Giusti, 1997: 56, figs 11,17,18. – Dell'Angelo et al., 1998: 249, pl.3, figs 8-9. – Forli et al., 1999: 113, pl.1, fig.10. – Dell'Angelo et al., 1999: 273, pl.5, figs 1,3-5; pl.6, figs 3,4,6. – Dell'Angelo & Smriglio, 1999: 192, figs 113-123, pls.64-65. – Dell'Angelo et al., 2001: 153, figs 30,33.  
*Acanthochitona communis* – Malatesta, 1962: 166, figs 24-25. – Laghi, 1977: 110, pl.3, figs 13-19.  
*Acanthochitona faluniensis* – Sulc, 1934: 17, pl.1, fig.29; pl.2, figs 30-32. – Baluk, 1984: 291, pl.8, figs 1-5.

**Material.** Parque Antena: 7 valves, 1 head (width 3.2 mm), 5 intermediate (maximum width 4 mm) and 1 tail (width 2.5 mm); Velerín Antena: 18 valves, 1 head (width 2 mm), 16 intermediate (maximum width 3.2 mm) and 1 tail (width 2.2 mm); Rio del Padrón: 1 tail valve, width 2.7 mm; Velerín: 3 intermediate valves, maximum width 6.8 mm; Velerín Carretera: 11 intermediate valves, maximum width 3.5 mm.

**Remarks.** *A.fascicularis* is an extremely variable species with very complicated synonymy, characterized by tegmentum uniformly covered with small roundish granules arranged along orderly arched lines on the valves, except for the jugal area, and by its flat or slightly concave surface.

A similar species, *A.faluniensis* de Rochebrune, 1883, which differs substantially from *A.fascicularis* in the shape of the lateral margins of the tegmentum and finer granulation, consisting of slightly larger roundish granules, was recorded from the Miocene of central-eastern Europe, and considered a junior synonym of *A.fascicularis* by Laghi (1977). This synonymy was not accepted by Baluk (1984).

Our valves have larger granules than living Mediterranean specimens, so they are more similar to those of *A.faluniensis*.

**Distribution.** *A.fascicularis* occurs throughout the Mediterranean and in the Atlantic, from the British Channel and Bretagne to the Azores and the Canary Islands. It has been reported

from the Miocene (Badenian) of central-eastern Europe, Tortonian of Montegibbio (Modena) and Messinian of Borelli (Turin). It is recorded from many Italian Plio-Pleistocene localities, being locally very frequent.

***Acanthochitona crinita* (Pennant, 1777)**  
(Pl.4 Figs 2,5)

*Chiton crinitus* Pennant, 1777: 71, pl.36, figs 1,A1.

*Acanthochitona lacrimulifera* Baluk, 1971: 464, pl.2, figs 6-9.

*Acanthochitona oblongus* Leloup, 1981: 1, figs 1a-d, pl.1.

*Chiton crinitus* – Dodge, 1952: 21.

*Acanthochitona crinita* – Kaas, 1985: 588, figs 7-50. – Dell'Angelo & Forli, 1995a: 236, fig.13. – Dell'Angelo et al., 1999: 275, pl.5, figs 2,6. – Dell'Angelo & Smriglio, 1999: 198, figs 124-130, pls.66-68. – Dell'Angelo et al., 2001: 153, fig.32.

*Acanthochitona crinita* f. *oblonga* – Dell'Angelo & Forli, 1995a: 237, fig.6.

*Acanthochitona fascicularis* – Malatesta, 1962: 164, figs 22-23. – Laghi, 1977: 111, pl.3, figs 20-21. – Baluk, 1984: 291, pl.9, fig.2. – Gaglini, 1985: XVI, pl.4, fig.1; pl.9, figs 3-6.

**Material.** Parque Antena: 2 intermediate valves (maximum width 3.5 mm); Rio del Padrón: 1 intermediate valve, width 3.2 mm; Velerín Carretera: 8 valves, 1 head (width 2.2 mm) and 7 intermediate (maximum width 3 mm).

**Remarks.** *A.crinita* also presents a high degree of variability in its specific characters and extremely complicated synonymy. It differs from *A.fascicularis* in characteristics of the girdle, in the more ellipsoidal shape of the intermediate valves and in the shape of granules of the tegmentum, which are oval to more or less elongate.

Our material has granules more elliptical than those of *A.fascicularis*. They are more elongated, approaching those of the form *oblonga* Leloup, 1981 (Pl.4, Fig.2) in two valves, from Parque Antena.

**Distribution.** *A.crinita* occurs in the Mediterranean Sea (with a few records from the African coasts) and along the Atlantic coast of Europe (as far north as Norway) and North America, as well as Madeira, the Azores, Canary Islands and Cape Verde Islands. It has been reported from the Miocene (Badenian) of the Paratethys basins of central-eastern Europe, Tortonian of Montegibbio (Modena) and Messinian of Borelli (Turin). Found in various Italian Plio-Pleistocene localities, but less frequently than *A.fascicularis*. The form *oblonga* has been recorded from the Pleistocene of Riparbella (Pisa).

Genus *Craspedochiton* Shuttleworth, 1853

***Craspedochiton altavillensis* (Seguenza, 1876)**  
(Pl.2 Figs 4,7)

*Chiton altavillensis* Seguenza, 1876: 264.



*Gymnoplax deslongchampsi* de Rochebrune, 1883: 69, pl.3, fig.6.  
*Acanthochites profascicularis* Boettger, 1905: 208.

*Cryptoconchus (Craspedoplax) profascicularis* – Sulc, 1934: 13.  
*Craspedochiton profascicularis* – Baluk, 1984: 292, pl.12, figs 1-2.  
*Craspedochiton schafferi* – Baluk, 1971: 465, pl.4, figs 13-14.  
*Craspedochiton deslongchampsi* – Laghi, 1977: 112, pl.4, figs 4-8.  
– Sabelli & Taviani, 1979: 158, pl.1, fig.16.  
*Craspedochiton altavillensis* – Dell'Angelo & Palazzi, 1988: 174,  
fig.1. – Dell'Angelo *et al.*, 1999: 276, pl.6, figs 1,2,5. – Dell'  
l'Angelo *et al.*, 2001: 153, fig.31.

**Material.** Velerín Antena: 1 intermediate valve (width 13.5 mm); Rio del Padrón: 5 valves, 1 head and 4 intermediate (maximum width 8.7 mm); Velerín: 8 valves, 2 head, 5 inter-

mediate and 1 tail (maximum width 15.6 mm); Velerín Carretera: 3 intermediate valves (maximum width 11 mm).

**Remarks.** The species is characterized by tegmentum covered with large elevated granules of irregular shape, except on the jugal area. The shape of the granules is highly variable, from single granules, regularly ellipsoidal, to coalescing granules fused to form irregular cords, as the elevation and density of granules on the tegmentum is also variable. Another characteristic is the large raised rib that separates the lateral and pleural areas in intermediate valves. A study of this species and related synonyms is reported by Dell'Angelo *et al.*(1999).

Our material matches the characteristics of the species well. The synonymy between *altavillensis* and *deslongchampsi* has been discussed by Dell'Angelo & Palazzi (1988), who also designated

**Table 1** – Number of valves found by locality/species

**Tab. 1** – Numero di piastre rinvenute per località/specie

Species	Parque Antena	Velerín Antena	Rio del Padron	Velerín	Velerín Carretera	total
<i>Lepidopleurus cajetanus</i>			2	3		5
<i>Lepidopleurus algesirensis</i>			3			3
<i>Lepidopleurus tavianii</i> sp.nov.		3			24	27
<i>Lepidopleurus</i> aff. <i>africanus</i>		3				3
<i>Hanleya hanleyi</i>	1	2				3
<i>Hanleya</i> sp.		1				1
<i>Ischnochiton ulivii</i>	1					1
<i>Ischnochiton martinelli</i> sp.nov.	4	8			30	42
<i>Ischnochiton rissoi</i>	1	2	5	4	1	13
<i>Ischnochiton</i> aff. <i>vanbellei</i>			1		6	7
<i>Callochiton septemvalvis</i>		6	5		2	13
<i>Lepidochitona cinerea</i>	1	1		2		4
<i>Lepidochitona canariensis</i>					2	2
<i>Chiton miocenicus</i>	5	13	15	92	4	129
<i>Chiton corallinus</i>	8	5	23	19	33	88
<i>Acanthochitona fascicularis</i>	7	18	1	3	11	40
<i>Acanthochitona crinita</i>	2		1		8	11
<i>Craspedochiton altavillensis</i>		1	5	8	3	17
<b>Total</b>	<b>30</b>	<b>63</b>	<b>61</b>	<b>131</b>	<b>124</b>	<b>409</b>

neotypes after verifying the lack of type material of Seguenza and de Rochebrune.

**Distribution.** The species has been reported from the Burdigalian of Turin hills, Badenian of central-eastern Europe, Tortonian of Montegibbio and Messinian of Borelli. There are a few records from some Italian Pliocene localities and a single report from the Lower Pleistocene (Torrente Stirone, Parma prov., N.Italy).

## DISCUSSION

This paper is the first comprehensive and illustrated account of fossil

chitons from the Neogene of Spain.

Chitons sourced from the five Pliocene localities of Estepona (Málaga) include 18 species represented by 409 valves (Table 1). Half of the specimens (53%) belong to two species: *Chiton miocenicus* (129 valves) and *Chiton corallinus* (88 valves). *Lepidopleurus tavianii* sp.nov., *Ischnochiton martinelli* sp.nov., *I.rissoi*, *Callochiton septemvalvis*, *Acanthochitona fascicularis*, *A.crinita* and *Craspedochiton altavillensis* are represented by a fair number of valves. The remaining species (*Lepidopleurus cajetanus*, *L.algesirensis*, *L.(Parachiton)* aff. *africanus*, *Hanleya hanleyi*, *Hanleya* sp., *Ischnochiton ulivii*, *I. aff. vanbellei*, *Lepidochitona cinerea* and *L.canariensis*) are represented by seven or fewer valves.



Table 2 – Chronostratigraphic distribution of species.  
Tab. 2 – Distribuzione cronostratigrafica delle specie.

Species	Pliocene	Miocene			Pliocene	Pleistocene	Living	
	this study	Badenian	Tortonian	Messinian			Medit.	Atlantic
<i>Lepidopleurus cajetanus</i>	x	x	x	x	x	x	x	x
<i>Lepidopleurus algesirensis</i>	x				x	x	x	x
<i>Lepidopleurus tavianii</i> sp.nov.	x							
<i>Lepidopleurus</i> aff. <i>africanus</i>	x	x			x	x	x	
<i>Hanleya hanleyi</i>	x	x	x	x	x	x	x	x
<i>Hanleya</i> sp.	x							
<i>Ischnochiton ulivii</i>	x				x	x		
<i>Ischnochiton martinelli</i> sp.nov.	x							
<i>Ischnochiton rissoii</i>	x	x	x	x	x	x	x	
<i>Ischnochiton</i> aff. <i>vanbellei</i>	x					x	x	x
<i>Callochiton septemvalvis</i>	x	x	x		x	x	x	x
<i>Lepidochitonina cinerea</i>	x	?	x	x	x	x	x	x
<i>Lepidochitonina canariensis</i>	x						x	x
<i>Chiton miocenicus</i>	x			x	x			
<i>Chiton corallinus</i>	x	x	x		x	x	x	
<i>Acanthochitonina fascicularis</i>	x	x	x	x	x	x	x	x
<i>Acanthochitonina crinita</i>	x	x	x	x	x	x	x	x
<i>Craspedochiton altavillensis</i>	x	x	x	x	x	x		
Total	18	9	9	8	13	13	12	9

The Estepona chitons include European species distributed from Miocene to present (Table 2).

The fauna of Estepona is the most diverse polyplacophoran fauna ever reported from a single European Pliocene area; for comparison, 16 species have been recorded from the early Pliocene of Pietrafitta (Siena prov., Italy) and 14 species from Orciano Pisano (Pisa prov., Italy) discussed by Dell'Angelo *et al.* (2001).

New taxa introduced here (*Lepidopleurus* (*Leptochiton*) *tavianii* and *Ischnochiton martinelli*) and *Hanleya* sp. are currently only known from the Early Pliocene, whereas *Ischnochiton ulivii* and *Craspedochiton altavillensis* do not go beyond the Lower Pleistocene. Nine species are recorded from Miocene to present (Mediterranean Sea) (Table 2). Twelve species still live in the Mediterranean and nine occur only on the Atlantic coasts of Europe.

Of the 12 living Mediterranean species, four (*Lepidopleurus cajetanus*, *L.algesirensis*, *Lepidochitonina cinerea* and *L.canariensis*) are typical infralitoral species, five (*Ischnochiton rissoii*, *Callochiton septemvalvis*, *Chiton corallinus*, *Acanthochitonina fascicularis* and *A.crinita*) have a widespread vertical distribution, from 0 to 100 m or deeper, and only three (*Lepidopleurus* (*Parachiton*) aff. *africanus*, *Hanleya hanleyi* and *Ischnochiton* aff. *vanbellei*) may be regarded as deep water taxa.

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