Rivista Italiana di Paleontologia e Stratigrafia	volume 121	no. 2	6 pls.	pp. 217-242	July 2015

POLYPLACOPHORA FROM THE MIOCENE OF NORTH ITALY. PART 1: LEPTOCHITONIDAE, HANLEYIDAE, ISCHNOCHITONIDAE AND CALLISTOPLACIDAE

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Received: January 16, 2015; accepted: May 22, 2015

Key words: Mollusca, Polyplacophora, Systematics, Miocene, North Italy.

Abstract. This study describes the chiton fauna (Mollusca, Polyplacophora) from deposits of the Miocene marine sequence of North Italy, located in Piedmont and Emilia Romagna regions. This first part of the work describes the chitons pertaining to four families: Leptochitonidae, Hanleyidae, Ischnochitonidae and Callistoplacidae. The studied fossils consist of 391 valves from 13 sites (Sciolze, Valle Ceppi, Rocco di Passerano, Albugnano, Monchio di Sarzano Casina, Villa Monti, Rio di Bocca d'Asino, Sant'Agata Fossili, Vargo, Vigoleno, Montegibbio, Borelli, and Moncucco Torinese) ranging from the early Miocene (Burdigalian) to the late Miocene (Messinian). We identified 16 species, 12 of which were already known, two are identified only at generic level (*Stenosemus* sp. A & sp. B), and two are described as new: *Parachiton statianus* sp. n., and *Callistochiton borellianus* sp. n. Some species found are particularly noteworthy; *Lepidopleurus benoisti* is the new name attributed to the species previously known as *Middendorffia subcajetana* or *Gymnoplax orbignyi*, based on the study of the type material; *Leptochiton salicensis*, previously known only from the early Pleistocene of Salice (Messina, Sicily); *Hanleya mediterranea* is reported for the first time from the Miocene of Italy; *Ischnochiton ligusticus*, previously known only from the early Pliocene of Western Liguria; the distribution of *Stenoplax paviai*, recently described from the late Miocene (Rio di Bocca d'Asino), is extended to the early Miocene (Langhian). A complete discussion on the chiton fauna from the North Italian Miocene, consisting of all the species treated in both parts, will be given in the second part of this work.

Introduction

The Miocene marine sequence of North Italy has been well known since the 19th century (Doderlein 1862; Bellardi & Sacco 1873-1904; Coppi 1881; Sacco 1889), and several contributions focused on molluscs from the Torino hills (Pavia 2000; Zunino 2007; Zunino & Pavia 2009a, 2009b), the Messinian of Borelli, Torino (Pavia & Robba 1979; Pavia 1991; Davoli 1995, 2003), and some Tortonian deposits in the neighbourhoods of Alessandria (Stazzano, S. Agata Fossili, Rio di Bocca d'Asino: Bongo 1914; Robba 1968; Caprotti 2011), Parma (Torrente Stirone: Marasti 1973) and Modena (Montegibbio: Montanaro 1935-1939; Davoli 1972, 1977, 1982, 2000). However, Polyplacophora (chitons) have received limited attention (Malatesta 1962; Laghi 1977; Dell'Angelo & Palazzi 1989; Dell'Angelo et al. 1999). Even Sacco (1897), in his monumental "I molluschi dei terreni terziarii del Piemonte e della Liguria", gives scant attention to chitons, with only five species/varieties recorded from the Torino hills, and from the Tortonian of Stazzano and Montegibbio. The present study is based on a large number of valves from thirteen localities of early Miocene (Burdigalian) to late Miocene (Messinian) age. In this first part, the species within the families Leptochitonidae, Hanleyidae, Ischnochitonidae and Callistoplacidae are considered, while the remaining species will be treated in a second, forthcoming part which is still in progress.

Material and Methods

Large amounts of bulk sediment were collected by the authors (Piero Giuntelli, Maurizio Sosso) between 1990 and 2014, especially in outcrops no longer accessible, and this material is the basis of the present work. Additional specimens were provided by other collectors

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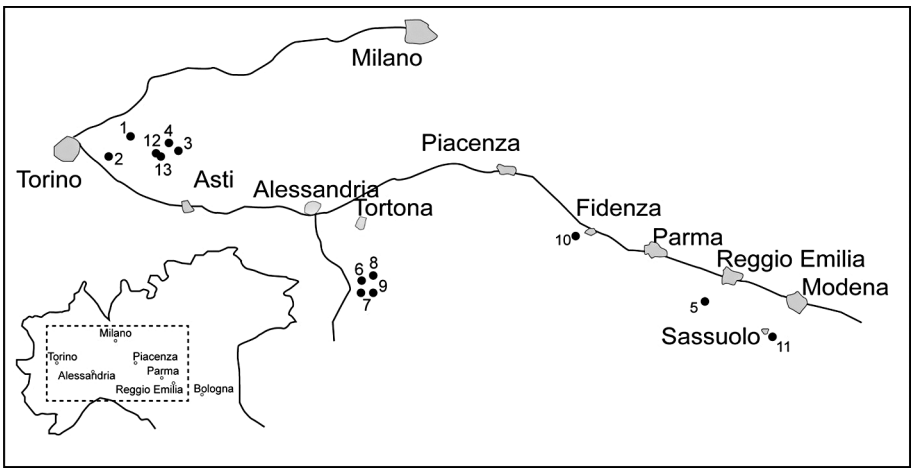


Fig. 1 - Study area and sites location. 1 - Sciolze; 2 - Valle Ceppi; 3 - Rocco di Passerano; 4 - Albugnano; 5 - Monchio di Sarzano Casina; 6 - Villa Monti; 7 - Rio di Bocca d'Asino; 8 - Sant'Agata Fossili; 9 - Vargo; 10 - Vigoleno; 11 - Montegibbio: 12 - Borelli; 13 - Moncucco Torinese.

(Luca Bertolaso, Reggio Emilia; Mauro Brunetti, Bologna; Massimo Rocca, Torino). The material housed at the Museo Regionale di Scienze Naturali di Torino (Bellardi & Sacco Collection) and at the Museo di Geologia e Paleontologia, Università di Torino (mainly collected by G. Pavia from Borelli) was examined. The bulk samples were washed in sieves (diameter 0.5, 1.0, 2.0 mm), and the material retained in the 1.0 mm and 2.0 mm fractions was then examined for chiton valves using a stereomicroscope. Taxonomic features of the recovered valves were studied and detected using a Cambridge S-360 scanning electron microscope (SEM) at the Dipartimento di Scienze della Terra dell'Università di Torino.

The maximum width (maximum right-left dimension perpendicular to the longitudinal body axis) of the valves (head, intermediate, and tail) of each species is given, also when the valves are incomplete, or when only small fragments are available. If the number of the valves of a species is small (< 10), we give also the maximum width of the valves for each locality.

All the figured material is at MZB (Zoological Museum of Bologna University, Bologna, Italy), where the Bruno Dell'Angelo collection will be housed too.

Abbreviations

BD B. Dell'Angelo Collection, Genova, Italy (to be housed in MZB).
BS Bellardi & Sacco Collection, Museo di Geologia e Paleontologia, Università di Torino (now stored at the Museo Regionale di Scienze Naturali di Torino), Italy.
IRSN Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium.
MGPT Museo di Geologia e Paleontologia, Università di Torino, Italy.
MHNBx Muséum d'Histoire naturelle de Bordeaux, France.
MNHN Muséum National d'Histoire Naturelle, Paris, France.
MSNG Museo Civico di Storia Naturale "Giacomo Doria", Genova, Italy.
MZB Zoological Museum of Bologna University, Bologna, Italy.
NHMW Natural History Museum Wien, Austria.
NHRM Naturhistoriska Riksmuseet, Stokholm, Sweden.
PG P. Giuntelli Collection, Torino, Italy (to be housed in MGPT).
RMNH Naturalis Biodiversity Center, Leiden, The Netherlands (formerly Rijksmuseum van Natuurlijke Historie).
USNM U.S. National Museum of Natural History, Washington (D. C.), USA.
WEM Wood End Museum of Natural History, Scarborough, England.
ZISP Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia.

Localities

All the localities considered in the present paper are listed below (Fig. 1). For each locality, as far as known, the geographical position (coordinates), the stratigraphy with important literature references and possible further details are given.

Recovery sites

1 Sciolze (Torino). This outcrop (45°05'46.5" N, 7°52'06.9" E) was located near the village of Sciolze, in the Torino province, and is no longer visible. This locality, as for Valle Ceppi, pertains to the Torino Hill, a structural domain of the Tertiary Piedmont Basin (Polino et al. 1991). The specimens here analyzed come from sandy-clayey beds intercalating with coarser deposits of Termofourà Formation, late Burdigalian in age (Giuntelli 2004).

2 Valle Ceppi (Torino). Valle Ceppi (45°03'47.1" N, 7°47'43.9" E) is a valley located at about 11 km from Torino, near the little town of Pino Torinese. As a matter of fact, the valley cuts through all of the Miocene lithosomes of the southern slope of the Torino Hill, from the Aquitanian to the Langhian; the upper Burdigalian middle-upper part of the succession shows numerous fossiliferous outcrops. This part pertains to the Termofourà Formation and is made up of silt-clay beds intercalated with coarse serpentine sandstones and lenses of resedimented conglomerate (for further stratigrafic and paleontologic data see Zunino & Pavia 2009a, 2009b).

3 Rocco di Passerano (Asti). This site (45°04'34.0" N, 8°01'44.2" E) is located near Passerano Marmorito and pertains to the Western Monferrato structural domain (Polino et al. 1992) and in particular to the Areniti di Tonengo Fm., Langhian in age. The specimens come from sandy levels with a rich association of planctonic foraminifera (*Praeorbulina* gr., *Globigerinoides* gr.) (Dela Pierre et al. 2003)

4 Albugnano (Asti). The outcrop of Albugnano (45°04'09.7" N, 7°59'02.6" E), referred to the upper Langhian, is composed of a fossiliferous sandstone-conglomerate horizon and corresponds to the Baldissero Formation, which is made up of marls and arenites with planctonic foraminifera and intensely bioturbated arenites with thin sandstone intercalations (Dela Pierre et al. 2003).

5 Monchio di Sarzano Casina (Reggio Emilia). The outcrop of Monchio di Sarzano Casina (44°31'42.37" N, 10°29'39.49" E) is referable to the Cigarello Formation and presumably dating to Serravalian. This formation is composed of epibathyal silts and marls with molluscs. Locally, sandy beds and rare resedimented horizons are present (Papani et al. 1987).

6 Villa Monti (Alessandria), 7 Rio di Bocca d'Asino (Alessandria), 8 Sant'Agata Fossili (Alessandria), 9 Vargo (Alessandria). The Tortonian localities of Villa Monti (44°44' 01.7" N, 8°52'31.5" E), Rio di Bocca d'Asino (44°53'21" N, 8°53'14" E), Sant'Agata Fossili (44°47'02.7" N, 8°55'26.4" E) and Vargo (44°44'36.9" N, 8°54'07.2"

E) are located in the the south-eastern end of TPB (Ghibaudo et al. 1985). These fossiliferous localities belong to the S. Agata Fossili Formation (S. Agata Fossili Marls) of Tortonian age, which consists of marls and intercalating arenaceous-conglomeratic beds. In the surroundings of Stazzano, this formation consists of a lower, sandy facies with interbedded pelitic intervals and an upper, mainly clayey facies with interbedded conglomeratic beds (Dell'Angelo et al. 2014). For additional information, reference is made to Bongo (1914) and Ghibaudo et al. (1985).

10 Vigoleno (Piacenza). This is a well known locality (44°49'08.91" N, 9°54'13.75" E) composed of clayey sands and no longer accessible. The malacofauna of different levels, in addition to the Foraminifera assemblages (Borsetti 1963), suggests an early and middle Tortonian age (Venzo & Pelosio 1963).

11 Montegibbio (Modena). The locality comprises a gully on the right side of the stream named Rio delle Bagole and a small exposure at about 400 m south of Cà del Chierico (44°29'52.79"N 10°46'58.35"E), coinciding respectively with collecting sites c2 and c3 of Davoli (1972). The outcrops consists of gray clayey marls belonging to the "Formazione del Termina" (Termina Formation); the age is Tortonian.

12 Borelli (Asti). The famous fossil locality of Borelli or Tetti Borelli shows a succession of sandstone and conglomerate beds, which are at times graded and bounded at their base by an erosional surface. This locality (45°03' 52.8" N, 7°56'27.4" E) pertains to the Marne di S. Agata Fossili Formation and is early Tortonian-Messinian in age. These coarse levels have produced abundant mollusc remains, which have been the object of systematic studies (Pavia & Robba 1979; Pavia 1991; Dell'Angelo et al. 1999; Davoli 2003). This succession has been interpreted as torbiditic deposists sedimented in a bathyal environment (Pavia & Robba 1979).

13 Moncucco Torinese (Asti). This outcrop (45°03'57.2" N, 7°55'48.6" E) is located near the village of Moncucco Torinese and is referable to the topmost part of the Marne di S. Agata Formation, composed of hemipelagic marls and laminated mudstones, pre-evaporitic, early Messinian in age (Angelone et al. 2011).

Previous records of chitons from the Miocene of North Italy

The paleontological documentation of Polyplacophora ("chitons") from the Miocene of North Italy is quite scant; very few records were provided in nineteenth century by Doderlein (1862) and Coppi (1881) from Montegibbio (Modena); by Michelotti (1847) from the Torino hills and by Sacco (1897) from the Torino hills, Montegibbio and Stazzano, as summarized in Tab. 1. Sacco refered to "Stazzano", many localities included in the neighbourhoods of this area, i.e. Vargo, Rio di Bocca d'Asino, and others (see Bongo, 1914: 398).

Other information on the occurrence of chitons in the Miocene of North Italy has been given more recently (e.g. Malatesta 1962; Dell'Angelo & Palazzi 1989), but two papers have been specifically dedicated to the chiton fauna of the Neogene of the Northern Apennines (Laghi 1977) and of the Messinian of Borelli, Torino (Dell'Angelo et al. 1999). The species reported in these papers are discussed herein and in the second part of the work, which is still in progress.

Systematics

We follow the classification proposed by Sirenko (2006). Since many of the chiton species were already exhaustively described from other Mediterranean Neogene sites (e.g. Laghi 1977; Dell'Angelo et al. 1999, 2004, 2012, 2013; Garilli et al. 2005), only short synonymy related to fossil taxa, some comments and stratigraphic ranges are given below. For species already discussed by the senior author and collaborators in the work covering the Pliocene of W. Liguria (Dell'Angelo et al. 2013), the synonymy is updated with new references when necessary. The geographic range and habitat of extant species were described by Dell'Angelo & Smriglio (1999).

Class **Polyplacophora** Gray, 1821

Subclass **Loricata** Shumacher, 1817

Order **Lepidopleurida** Thiele, 1909

Family Leptochitonidae Dall, 1889

Genus *Lepidopleurus* Risso, 1826

Type species: *Chiton cajetanus* Poli, 1791, by subsequent designation (Herrmannsen, 1846). Non: *Lepidopleurus* (Carpenter MS) Dall, 1879 (= *Lepidozona* Pilsbry, 1892).

Tab. 1 - Current status of the chiton records provided in 19th century.

works / species reported	locality	current status
MICHELOTTI, 1847		
Chiton miocenicus Michelotti n. sp.	Torino hills	*Chiton miocenicus* Michelotti, 1847
DODERLEIN, 1862		
Chiton zibinicus Doderlein n. sp.	Montegibbio	*Chiton olivaceus* Spengler, 1797
COPPI, 1881		
Acanthochites fascicularis Linnaeus	Montegibbio	*Acanthochitona fascicularis* (Linnaeus, 1767)
Lepidopleura cajetana Poli	Montegibbio	*Lepidopleurus cajetanus* (Poli, 1791)
Clathropleura sulcatula Risso an. *sicula* Gray	Montegibbio	*Chiton olivaceus* Spengler, 1797
SACCO, 1891		
Chiton miocenicus Michelotti	Torino hills, Sciolze	*Chiton miocenicus* Michelotti, 1847
Middendorffia subcajetana (D'Orbigny)	Torino hills, Sciolze	*Lepidopleurus benoisti* (de Rochebrune, 1883)
Lepidopleurus marginatus (Pennant)	Stazzano	*Lepidochitona cinerea* (Linnaeus, 1767)
Acantochiton costatus (Rov.) Sacco n. sp.	Torino hills, Sciolze	*Craspedochiton mutinocrassus* (Sacco, 1897) *Craspedochiton* ? sp.
Acantochiton costatus var. *mutinocrassa* Sacco n. var.	Montegibbio	*Craspedochiton mutinocrassus* (Sacco, 1897)

Remarks. The genus is known from the Eocene to the Recent. Three species attributed with certainty to the genus *Lepidopleurus* are present in Europe: *L. cajetanus* (Miocene – Recent), *L. benoisti* (Miocene, see below) and *L. virgifer* (Sandberger, 1859) from the Oligocene of Germany, while the generic attribution to *Lepidopleurus* or *Leptochiton* of other species (Eocene – Oligocene) of France, Germany and Ukraine is more uncertain.

Lepidopleurus cajetanus (Poli, 1791)

Pl. 1

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

Additions to the bibliography in Dell'Angelo et al. (2013: 68):

2013 *Lepidopleurus cajetanus* (Poli) – Dell'Angelo et al., p. 68, pl. 1, figs A-M.

Type material: Probably lost. Lectotype designated by Dell'Angelo & Palazzi (1989), specimen figured by Poli (1791: pl. 4, fig. 1).

Type locality: Gaeta (Latina), Tyrrhenian Sea (41°12'53"N, 13°34'35"E).

Material examined: Villa Monti: 79 valves (16 head, 32 intermediate, and 31 tail) (BD, MZB 32005, PG); Rio di Bocca d'Asino: 61 valves (19 head, 19 intermediate, and 23 tail) (BD, MZB 32001-32002, PG); Vigoleno: 1 head valve (BD, MZB 32044); Montegibbio: 22 valves (6 head, 8 intermediate, and 8 tail) (BD, MZB 32004, MZB 32006); Borelli: 40 valves (9 head, 22 intermediate, and 9 tail) (BD, MGPT PU 135037, MZB 32003, MZB 32007, PG). Maximum width of the valves: 8.3 / 10 / 7.5 mm.

Remarks. The species is characterized by a tegmentum sculptured with strong, concentric, terraced ribs on the head valve, lateral areas of intermediate valves and postmucronal area of the tail valve. Additionally there are branching or anastomosing longitudinal chains of granules in the central area of intermediate valves and antemucronal area of the tail valve. Detailed descriptions of this species are in Dell'Angelo & Smriglio (1999) and Dulai (2005).

Tail valves of juvenile specimens show remarkable variations [mucro is almost central in juvenile specimens but moves posterior (even to the end of the valve) as individuals grew older, due to the bulging of the posterior area on the ventral side (Pl. 1, figs 9-12)] and has well described and illustrated by Laghi (1977: fig. 3a-b), by Dulai (2005: pl. 2, figs 1, 3-4) in valves from Middle Miocene (Badenian) of Hungary, and by Dell'Angelo et al. (2013: pl. 1, figs F-G) in valves from Pliocene of Liguria, Italy.

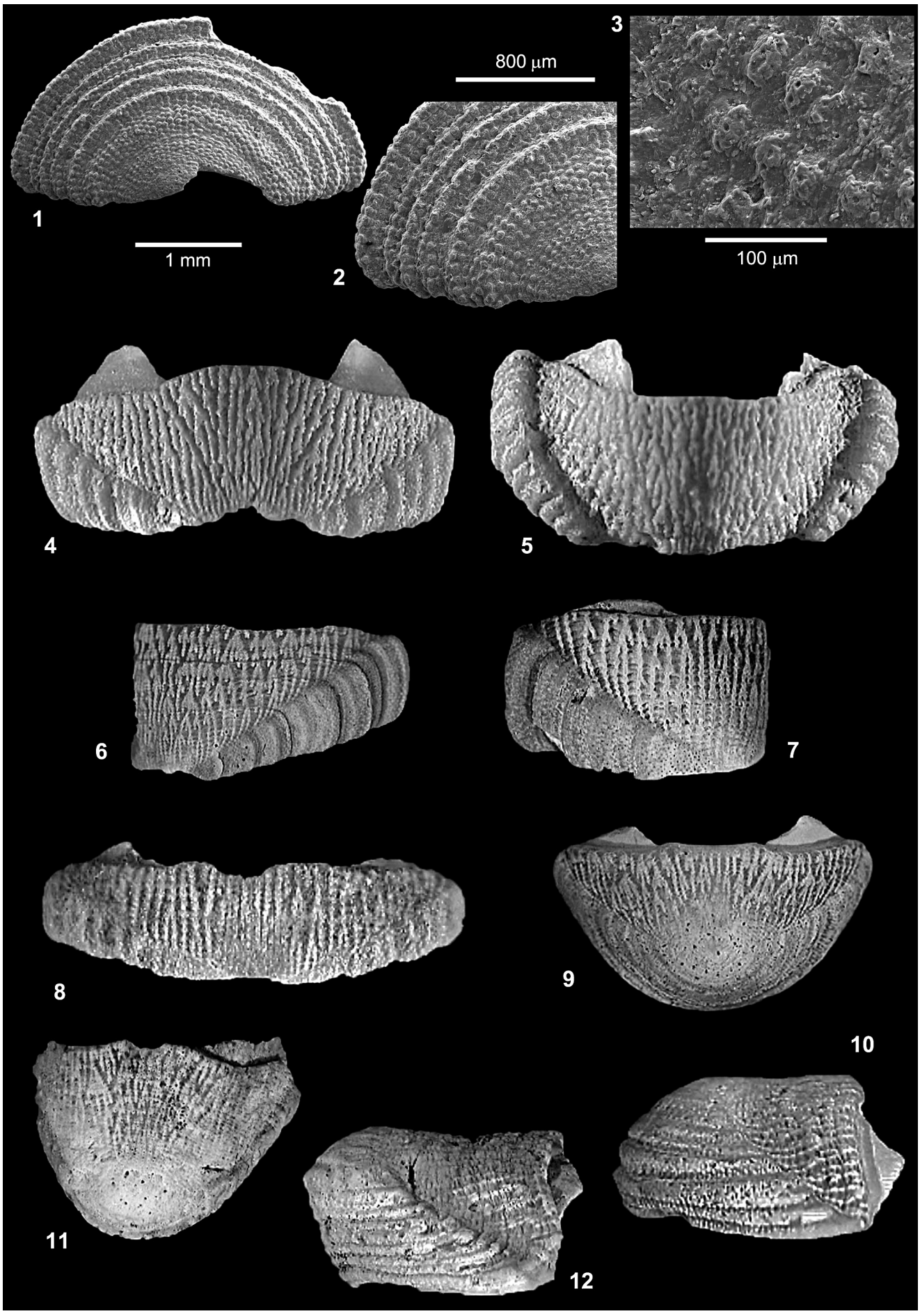
Another remarkable example of variation in the sculpture of the tegmentum can be evidenced in the central area of intermediate valves and antemucronal area of the tail valve, normally with longitudinal chains of granules, somewhat branching or anastomosing, transversally intersected by thinner cords that give a pitted appearance. The longitudinal chains may be irregularly directed towards the sides in some cases, but the sculpture of "parallel" chains is always well evident. This type of sculpture is prevalent in Recent specimens (see Dell'Angelo & Smriglio, 1999: pl. 6 fig. E, pl. 7 figs K, L), but also in valves from Pleistocene and Pliocene (see Garilli et al. 2005: pl. 1, fig. 1 from the Pleistocene of Kyllini, Greece; Dell'Angelo et al. 2013: pl. 1, fig. B from the Pliocene of Liguria). In the Miocene valves the prevalent sculpture is more irregular and rough, shaped by groups of granules branching longitudinally many times, and giving an appearance without evidence of longitudinal chains (Pl. 1, figs 6-7, 9). Also the intersections by thinner cords are not present. The variability is very large, in some valves the multiple branching seem present only in a part of the central areas (Pl. 1, fig. 4). This more irregular sculpture is also present (less frequently) in Recent specimens (see Dell'Angelo & Palazzi 1989: pl. 2, fig. 1) and in Pleistocene and Pliocene valves (see Sabelli & Taviani 1979: pl. 1, fig. 3 from the Pleistocene of Torrente Stirone; Dell'Angelo et al. 2013: pl. 1, fig. F from the Pliocene of Liguria).

At a first look, the two extreme forms of this range of variability (i.e. Pl. 1, figs 6 and 8) seem to pertain to two different species, but the study of a great number of Miocene to Recent valves permit us to see a large set of variations. The only other work we know of that has addressed the extent of similar observed variation is by Fischer & Renner (1979: fig. 3), who show evidence of the surface structure of a tail valve of a living *L. cajetanus* (from Rovinj, Croatia) with longitudinal chains of granules, and no irregularity.

Distribution. *Middle Miocene*: Paratethys (Langhian-Serravallian): Austria, Czech Republic, Poland,

PLATE 1

Figs 1-12 - *Lepidopleurus cajetanus* (Poli, 1791).
1-3) Villa Monti, head valve, MZB 32000, width 3.3 mm. 1-2, dorsal views. 3 - detail of the sculpture. 4) Rio di Bocca d'Asino, intermediate valve, MZB 32001, width 8 mm, dorsal view. 5) Rio di Bocca d'Asino, intermediate valve, MZB 32002, width 8.2 mm, dorsal view, valve with the starting point of concentric ribs in lateral areas not near the apex, as in the valve of figure 4. 6) Borelli, half right intermediate valve, MZB 32003, width 5.2 mm, dorsal view, showing a more irregular and rough sculpture, shaped by groups of granules branching longitudinally many times. 7) Montegibbio, half left intermediate valve, MZB 32004, width 5 mm, dorsal view, sculpture as in valve of fig. 6. 8) Villa Monti, intermediate valve, MZB 32005, width 4 mm, dorsal view. 9-10) Montegibbio, tail valve, MZB 32006, width 7.5 mm, dorsal and ventral views, second ontogenetic postlarval stage. 11-12) Borelli, tail valve, MZB 32007, width 6.3 mm, dorsal and ventral views, final ontogenetic postlarval stage.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1 mm
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Romania, Hungary, Ukraine (Dulai 2005; Dell'Angelo et al. 2007; Studencka & Dulai 2010). *Late Miocene:* Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Villa Monti, Rio di Bocca d'Asino, Vigoleno, Montegibbio, Borelli (Laghi 1977; Dell'Angelo et al. 1999; this paper). *Pliocene*: western Mediterranean, Estepona Basin, Spain (Dell'Angelo et al. 2004); central Mediterranean, Italy (Laghi 1977; Dell'Angelo et al. 2001, 2013; Chirli 2004). *Pleistocene*: central Mediterranean, Italy (Sabelli & Taviani 1979), Greece and Cyprus (Garilli et al. 2005; Koskeridou et al. 2009). *Recent*: Atlantic Ocean, from Spain and Portugal south to Morocco and Canary Islands; Mediterranean (Dell'Angelo & Smriglio 1999).

Lepidopleurus benoisti (de Rochebrune, 1883)

Pl. 2, figs 1-13, 18-20

1824 *Chiton cinereus* f. Poli (*non* Linnaeus) – Bonelli, n° 2648 (*fide* Sacco, 1897).

1842 *Chiton cinereus* (*non* Linnaeus) – Sismonda, p. 24 (*fide* Sacco, 1897).

1847 *Chiton cajetanus* (*non* Poli) – Sismonda, p. 25 (*fide* Sacco, 1897).

1852 *Chiton miocaenicus* (*non* Michelotti) – d'Orbigny, p. 94 (*fide* Cossmann & Peyrot, 1919).

1852 *Chiton subcajetanus* d'Orbigny, p. 94, n° 1746.

1882 *Callochiton benoisti* Rochebrune – Benoist, p. xxix (*nomen nudum*).

1883 *Gymnoplax benoisti* de Rochebrune, p. 64, pl. 1, fig. 8.

1883 *Gymnoplax orbignyi* de Rochebrune, p. 65, pl. 1, fig. 7.

1883 *Chiton subcajetanus* Poli – de Rochebrune, 1883, p. 65 (in synonymy of *Gymnoplax orbignyi*)

1883 *Chiton cinereus* (*non* Lin.) – de Rochebrune, p. 70.

1894 *Chiton benoisti* (de Roch.) – Degrange-Touzin, p. 407.

1897 *Middendorffia subcajetana* (D'Orb.) – Sacco, p. 90, pl. 7, figs 21-25.

1919 *Chiton miocaenicus* (*non* Michelotti) – Cossmann & Peyrot, p. 32, pl. 2, figs 21-22 (*fide* Laghi 1977).

1919 *Chiton benoisti* (de Rochebrune) – Cossmann & Peyrot, p. 33, pl. 2, figs 23-27.

1934 *Lepidopleurus* (*Lepidopleurus*) *decoratus* Reuss – Šulc, p. 3 (*partim*).

1977 *Lepidopleurus subcajetanus* (d'Orbigny) – Laghi, p. 99, pl. 1, fig. 21

1981 *Gymnoplax benoisti* de Rochebrune – Van Belle, p. 23 (gen. inquir.).

1981 *Gymnoplax orbignyi* de Rochebrune – Van Belle, p. 55 [in synonymy of *Lepidopleurus decoratus* Reuss)].

1981 *Chiton subcajetanus* Poli – Van Belle, p. 74 (in synonymy of *Lepidopleurus decoratus* Reuss).

1984 *Middendorffia subcajetana* Sacco – Ferrero Mortara et al., p. 299, pl. 55, fig. 6.

1984 *Lepidopleurus subcajetanus* d'Orbigny – Bałuk, p. 285.

? 2003 *Lepidopleurus subcajetanus* Sacco – Kroh, p. 132, pl. 2, fig. 1.

2005 *Lepidopleurus subcajetanus* d'Orbigny – Dulai, p. 31 (in synonymy of *L. cajetanus*).

2010 *Lepidopleurus subcajetanus* d'Orbigny – Studencka & Dulai, p. 263, fig. 3E (in synonymy of *L. cajetanus*).

Type material: *subcajetanus*: Lectotype designated by Dell'Angelo & Palazzi (1989), on the valve figured by Poli (pl. 4, fig. 1), the same valve as for *L. cajetanus* (Dell'Angelo & Palazzi 1989: 54). *benoisti*: Syntypes MHNBx 2009.TY.P.306.0, two tail valves from the Benoisti collection (width respectively 13.63 and 7.04 mm).

Type locality: *subcajetanus*: Sciolze, Torino hills (Miocene, Burdigalian). benoisti: Mérignac, near Bordeaux (Miocene, late Aquitanian/early Burdigalian).

Material examined: Torino hills: 3 tail valves, maximum width 14 mm, figured by Sacco (1897: pl. 7, figs 21-23), Laghi (1977: pl. 1, fig. 21) and Ferrero Mortara et al. (1984: pl. 55, fig. 6) (PMRSN BS.105.02.001-003); Valle Ceppi: 2 valves (1 head, width 6.2 mm, and 1 intermediate, width 5 mm) (BD, PG, MZB 32008-32009).

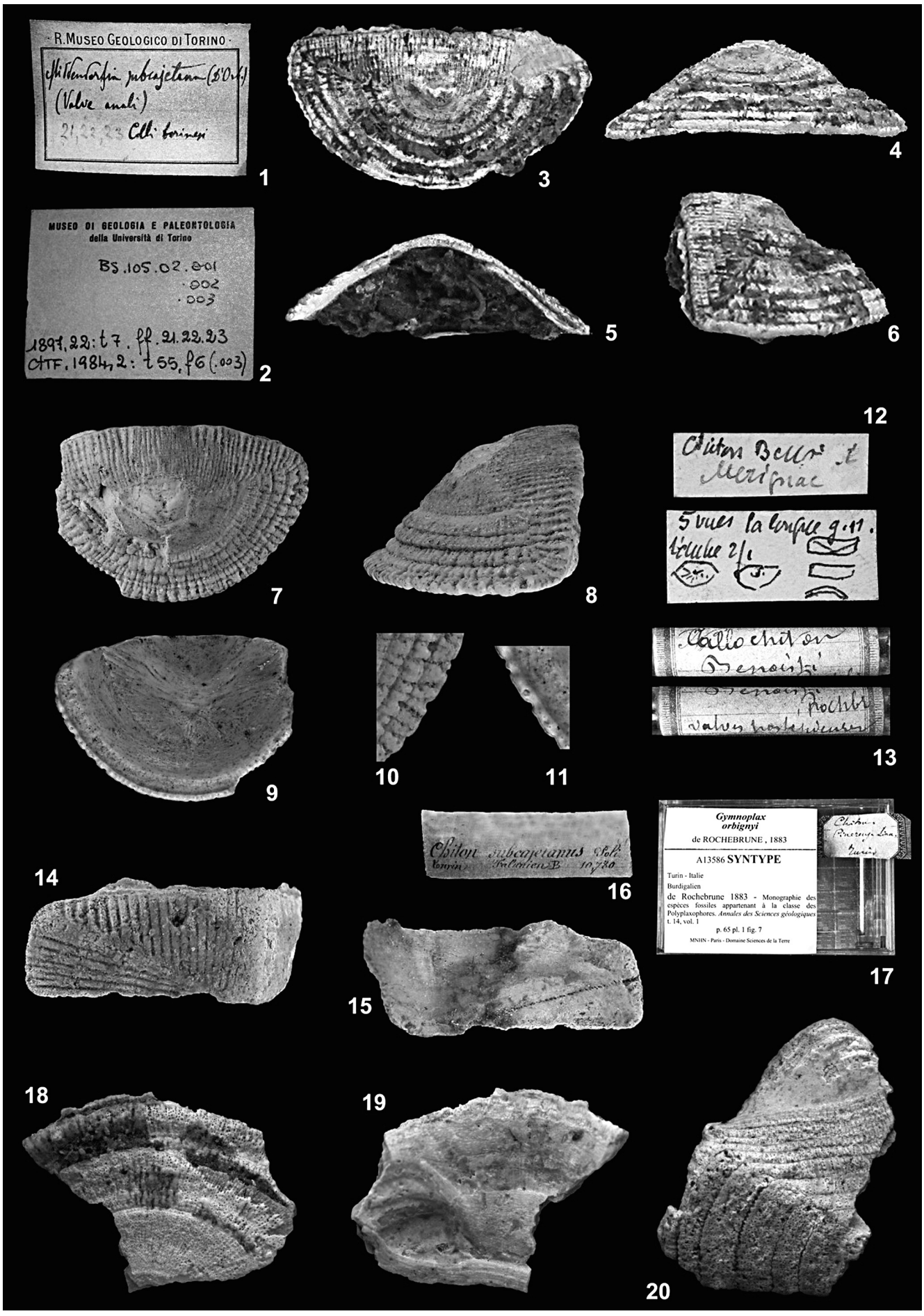
Description. Tail valve elongate, large, elevate, width almost two times the length (W/L = 0.52-0.54) for the valves described by Sacco from the Torino hills), mucro flat, in anterior position, anterior slope almost straight or slightly convex, posterior slope slightly concave. Antemucronal area with somewhat branching or anastomosing coarse longitudinal granulated ribs; postmucronal area with coarse radial ribs, consisting of fused granulae, crossed by concentric terraced ribs. Articulamentum without insertion laminae, apophyses not preserved.

Taxonomic/nomenclatural history. This species has already been largely discussed by Dell'Angelo & Palazzi (1989), but the problems relating to the taxon "*subcajetanus*", and the new information available after the examination of the types of *Gymnoplax benoisti* and

PLATE 2

Figs 1-13, 18-20 - *Lepidopleurus benoisti* (de Rochebrune, 1883). 1-6) Torino hills, tail valve figured as *Middendorffia subcajetana* (d'Orbigny, 1852), by Sacco (1897: pl. 7, fig. 23), Laghi (1977: pl. 1, fig. 21) and Ferrero Mortara *et al.* (1984: pl. 55, fig. 6) (PMRSN, Syntype BS.105.02.003), width 13.6 mm. 1-2 - original labels. 3-6 - dorsal, posterior, frontal and lateral views.
7-13) Mérignac (Miocene, late Aquitanian/early Burdigalian), tail valve from the Benoist's collection (syntype 2, MHNBx 2009.TY.P.306.0), originally determined as *Gymnoplax benoisti* de Rochebrune, 1883, width 7.04 mm. 7-9 - dorsal, lateral and ventral views. 10-11 - detail of the posterior margin, dorsal and ventral views. 12-13 - original labels.
18-20) Valle Ceppi. 18-19 - head valve, MZB 32008, width 6.2 mm, dorsal and ventral views. 20 - a fragment of an intermediate valve, MZB 32009, width 5 mm.

Fig. 14-17 - *Gymnoplax orbignyi* de Rochebrune, 1883, Torino hills, intermediate valve (MNHN, Syntype n° F.A13586, collection d'Orbigny n° 10780), width 8 mm. 14-15 - dorsal and ventral views. 16-17 - original labels.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Gymnoplax
orbignyi
de ROCHEBRUNE, 1883
A13586 SYNTYPE
Turin - Italie
Burdigalien
de Rochebrune 1883 - Monographie des espèces fossiles appartenant à la classe des Polyplaxophores. Annales des Sciences géologiques t. 14, vol. 1
p. 65 pl. 1 fig. 7
MNHN - Paris - Domaine Sciences de la Terre
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G. orbignyi, allow some considerations on its taxonomic/nomenclatural history, as listed below:

1791 – Poli describes and figures the new species *Chiton cajetanus*.

1822 – Lamarck describes briefly, with no figure, the same species.

1824 – Bonelli reports, with no figure, *Chiton cinereus* in the handwritten catalogue of fossils from the Torino Museum.

1842 – Sismonda reports the Bonelli's (1824) citation in a list of fossil species from Piedmont.

1847 – Sismonda reissues his 1842 list, but using the Poli's (1791) name: "*Chiton Cajetanus* Poli. Lam. *An. s. vert*. 7. p. 495. – Pol. *Test*. t. 4. f. 1. – *C. cinereus* Linn. sec. Bon. t E. Sism.".

1852 – d'Orbigny introduces the taxon *Chiton subcajetanus*, but without a description, only with bibliographical references: "*subcajetanus*, Poli, Lam., *An. s. vert*., 7, p. 495; Poli, *Test*., pl. 4. fig. 1. *C. cinereus*, Linn. sec. bon. et sism. Turin".

1882 – Benoist quotes the *nomen nudum* "*Callochiton benoisti* de Rochebrune".

1883 – de Rochebrune, considering that Poli (1791) never described *subcajetanus*, and that the valves he had available ("Hab. *Faluns de Turin*. – Mus. Paris.") have different characteristics from *cajetanus*, suggests the new taxon *Gymnoplax orbignyi*, in honour of the first author who refered to *subcajetanus*. He describes moreover a new species (*Gymnoplax benoisti*) on valves from the Miocene of Mérignac, France.

1897 – Sacco describes *Middendorffia subcajetana* (d'Orbigny, 1852), validating the attribution of valves reported by Bonelli (1824 as *Chiton cinereus*), Sismonda (1842 as *Chiton cinereus*), and Sismonda (1847 as *Chiton cajetanus*) to this species, as already indicated by d'Orbigny (1852). This must be considered as a valid description of this species, with a diagnosis in Latin.

1934 – Šulc considers a tail valve (width 18 mm) from the Middle Miocene of Pötzleinsdorf, Austria, and the valves illustrated by Sacco (1897) as a very large form of *Lepidopleurus decoratus*; he regards the name *Chiton subcajetanus* d'Orbigny, 1852 as a *nomen nudum* but was apparently unaware of Sacco's (1897) later validation of the name. In the opinion of Šulc (1934), large specimens are known from sandy facies at Pötzleinsdorf in Austria, as well as in the north Italian localities. Šulc regards *Lepidopleurus virgifer*, *L. decoratus and L.cajetanus* as different, albeit closely allied, species.

1977 – Laghi, studying the still available part of the Sacco's material (BS collection), considers *Lepidopleurus subcajetanus* (d'Orbigny, 1852) a valid species.

1984 – Bałuk cites *Lepidopleurus subcajetanus* in the discussion of *L. cajetanus* from Middle Miocene of Poland, and considers that some of the valves reported by Šulc may belong to the latter species, being reasonably larger (a maximum width of 18 mm) than the known valves of *L. cajetanus*.

1989 – Dell'Angelo & Palazzi publish an in-depth study of the above cited taxa, and consider *Middendorffia subcajetanus*, *Gymnoplax benoisti*, and *Gymnoplax orbignyi* synonyms of *Lepidopleurus virgifer* (Sandberger, 1859). They also designated lectotypes of *Lepidopleurus cajetanus*, *L. subcajetanus, and Gymnoplax benoisti*.

2003 – Kroh illustrates a single tail valve, heavily abraded and incomplete, identified as *Lepidopleurus subcajetanus*, from the Langhian of the Molasse zone (Niederleis, Austria).

2010 – Studencka & Dulai illustrate four valves of *Lepidopleurus cajetanus* from the Middle Miocene of Ukraine, and carefully discuss the differences from *L. virgifer* and the "status" of *L. subcajetanus*.

Comparisons. Dell'Angelo & Palazzi (1989) designated lectotypes of *Chiton cajetanus* and *C. subcajetanus* as the same specimen, one figured by Poli (1791: pl. 1, fig. 4). Therefore *C. subcajetanus* is a junior synonym of *C. cajetanus*, and this taxon cannot be used for this species.

Gymnoplax orbigny de Rochebrune, 1883 was originally proposed as "*nomen substitutivum*" for *Chiton subcajetanus*, based on the chiton valves from the Torino hills. The diagnosis of de Rochebrune (1883: 65) refers to an intermediate valve: "Testa?... valvis intermediis carinatis; areis centralibus longitudinaliter sulcatis, sulcis angustis rectis, areis lateralibus radiatim sulcatis, sulcis ad marginem furcatis. Long. 0,010. Lat. 0,003. Hab. *Faluns de Turin*. – Mus. Paris.". A syntype of *Gymnoplax orbignyi* is preserved at MNHN (A13586, an intermediate valve), and the photographs made by Andreas Kroh (NHMW) during a visit at MNHN (Pl. 2, figs 14-17) leave no doubt on the attribution of this valve to *Chiton miocenicus* Michelotti, 1847, thus the name *Gymnoplax orbignyi* cannot be used for the species described by Sacco on the valves from the Torino hills. The diagnosis of de Rochebrune, and the intermediate valve he figured (pl. 1, fig. 7) agree with the attribution of this species to *Chiton miocenicus*.

Gymnoplax benoisti was described by de Rochebrune (1883) on the basis of intermediate and tail valves from the Miocene (late Aquitanian/early Burdigalian) of France (Mérignac, near Bordeaux), and reported by Cossmann & Peyrot (1919) also from other French Miocene localities (Léognan and Saucats). Dell'Angelo & Palazzi (1989) selected as lectotype of this species one of the valves figured by Cossmann & Peyrot, but thanks to the courtesy of Charles Laurent (MHNBx) two tail valves from the Benoist's collection (MHNBx 2009.TY.P.306.0) have been regarded here as

Tab. 2 - Maximum valve widths noted for *Lepidopleurus cajetanus* and *L. benoisti*.

Species	Maximum valves' width (mm)	References
Lepidopleurus cajetanus	8.3 – 10 – 8	Dell'Angelo et al. 2013; this paper
Lepidopleurus benoisti	12.5 – 15 – 18	Sacco 1897; Cossmann & Peyrot 1919; Šulc 1934; Studencka & Dulai 2010

syntypes (width 13.63 and 7.04 mm). The here-illustrated syntype 2 (Pl. 2, figs 7-10), confirms the identity of these valves with the tail valves described by Sacco from the Torino hills as *Chiton subcajetanus* (pl. 2, figs 1-6), and therefore *Gymnoplax benoisti* is the current name to be used for the species previously known as *Middendorffia subcajetanus* (non *Gymnoplax orbignyi*).

Šulc considered a tail valve (width 18 mm) from the Middle Miocene of Pötzleinsdorf, Austria and the valves illustrated by Sacco (as *Middendorffia subcajetana*) as a very large form of *Lepidopleurus decoratus*. In the Šulc collection there are no large tail valves like those he discussed (the valves of *L. decoratus* housed at NHMW are under study by Dell'Angelo & Kroh), and we agree with Laghi (1977), Bałuk (1984) and other authors in considering *L. decoratus* conspecific with *L. cajetanus*.

Remarks. The given description agree with the diagnosis of Sacco (1897: 90) of *Chiton subcajetanus*, referring to the tail valves from Torino hills: "Valva caudalis crassa, convexa, striolis radiantibus minutis et confertissimis, cingulis concentricis (limbo paralleis) scalaratis, sat crassis, munita; regio apicalis perelata, sublaevis vel tantum striolis irradiantibus ornate; 5-15 Millim. lata.". The lacking of insertion laminae and the similarity of this species to other *Lepidopleurus* species, is sufficient to attribute the species to the genus *Lepidopleurus*.

We therefore consider tail valves of *Lepidopleurus benoisti* similar to those of *L. cajetanus* at the second stage of growth (Laghi 1977; Dell'Angelo et al. 2013), but with larger dimensions, larger than those reached by *L. cajetanus* at the last stage of growth, the mucro in anterior position, and less evident concentric terraced ribs in the postmucronal area (real concentric folds in *L. cajetanus*).

The maximum width of valves (respectively for head, intermediate, and tail valves) of *Lepidopleurus cajetanus* known from the literature are reported in Tab. 2.

The maximum widths of tail valves attributable to *Lepidopleurus benoisti* known from the literature are: 15 mm (Sacco 1897, as *Middendorffia subcajetana*); 18 mm (Šulc 1934, as *L. decoratus*); 17 mm (Cossmann & Peyrot 1919, as *Chiton benoisti*); 12 mm (Cossmann & Peyrot 1919, as *Chiton miocaenicus*); 13.6 mm (Syntypes of *Gymnoplax benoisti*); 6.1 mm (Kroh, 2003).

The only record of intermediate valves of this species is that reported by Cossmann & Peyrot (1919, as *Chiton benoisti*, 15 mm), but the figures are very poor, and the description does not give useful indications. The problem is that, while the tail valves of *L. benoisti* are clearly identified and separated from *L. cajetanus*, the head and intermediate ones do not show specific morphological characters useful to separate them by *L. cajetanus*, apart from the larger dimensions of the valves. In this sense, the largest head valve of *L. cajetanus* figured by Studencka & Dulai (2010: fig. 3E, width 12.5 mm) from the Badenian of Szuszkowce, Ukraine, could be interpreted as a head valve of *L. benoisti*, but there are not visible differences with the other head valves of *L. cajetanus* figured by Studencka & Dulai (2010: fig. 3A-D, width 3.7- 5.4 mm).

The maximum valve widths indicated for the taxa considered are summarized in Tab. 2.

Dell'Angelo & Palazzi (1989) also considered the present species (= *Chiton subcajetanus*) synonyms of *Lepidopleurus virgifer*. The status of *L. virgifer* is under study by Kroh & Dell'Angelo, on the basis of type material of the latter species found at NHMW, and this study should provide an opportunity for a better assessment of the relationships between *L. benoisti* and *L. virgifer*.

We tentatively attribute two valves to this species from the Burdigalian of Valle Ceppi: a small fragment of an intermediate valve (pl. 2, fig. 20), and an incomplete head valve (pl. 2, figs 18-19). Both seem quite different from the valves of *L. cajetanus*: the head valve is flattened and the concentric terraced ribs are only somewhat prominent, not as strong as in typical *L. cajetanus* species; the longitudinal granulated ribs of the central area of the intermediate valve seem more regular, not shaped by groups of granules branching longitudinally many times as in typical *L. cajetanus* from the Miocene of Italy. Notwithstanding their incompletness, these two valves could have a width compatible with those of *L. benoisti*, and the distribution of *L. cajetanus* does not extend to as early as the middle Miocene (Badenian of Central Paratethys).

Distribution. *Early Miocene:* northeastern Atlantic (late Aquitanian/early Burdigalian): Aquitaine Basin, France (Cossmann & Peyrot 1919); Proto-Mediterranean Sea (Burdigalian): North Italy, Torino Hills (Sacco 1897; this paper). *Middle Miocene:* Paratethys (Lan-

ghian-Serravallian): Austria, Ukraine (Šulc 1934; Studencka & Dulai 2010).

Genus *Leptochiton* Gray, 1847

Type species: *Chiton cinereus* Montagu, 1803, non Linnaeus, 1767 (= *Chiton asellus* Gmelin, 1791), by subsequent designation (Gray 1847b)

Remarks. The genus is known from the Mississippian to the Recent.

Leptochiton cancellatus (Sowerby, 1840)

Pl. 3, figs 1-6

1840 *Chiton cancellatus* Sowerby II, figs 104, 104a-b, 105.
Additions to the bibliography in Dell'Angelo et al. (2013: 70):
2013 *Leptochiton cancellatus* (Sowerby) – Dell'Angelo et al., p. 70, pl. 1, figs N-T.

Type material: Unknown, probably lost (*fide* Kaas & Van Belle 1985: 43).

Type locality: possibly the coast of Great Britain, probably Oban, Scotland (56°24'46"N, 5°28'24"W) (*fide* Kaas & Van Belle 1985: 43).

Material examined: Villa Monti: 1 tail valve (PG, MZB 32045); Rio di Bocca d'Asino: 8 valves, 1 head, and 7 intermediate (BD, MZB 32010-32011, PG); Montegibbio: 2 intermediate valves (BD, MZB 32046). Maximum width of the valves: 2.3 / 3 / 2.5 mm.

Remarks. The species is characterized by the rounded intermediate valves, and the tegmentum sculptured with very dense granules arranged in radial series on the head valve, the lateral areas of intermediate valves, and the postmucronal area of the tail valve, in longitudinal series in the central area of the intermediate valves and the antemucronal area of the tail valve, with reduced intercostal spaces. Detailed descriptions of this species are in Kaas & Van Belle (1985) and Dell'Angelo & Smriglio (1999).

Leptochiton sulci (Bałuk, 1971) is a very similar species described from the Middle Miocene (early Badenian) of the Paratethys (Poland: Korytnica). It was considered conspecific with *L. cancellatus* by Laghi (1977), Dell'Angelo & Palazzi (1989), Dell'Angelo & Smriglio (1999) and Dell'Angelo & Silva (2003). However the two taxa show marked differences, as reported by Dell'Angelo et al. (2013: 71), so we prefer considering the two nominal taxa as different species, following Bałuk (1971, 1984) and Studencka & Dulai (2010).

The valves of members of *Leptochiton* are small, fragile and very difficult to find, so additional material will be required to better understand the relationships among the European Miocene *Leptochiton*.

Distribution. *Middle Miocene:* Paratethys (Langhian-Serravallian): Austria (Šulc 1934), Ukraine (Studencka & Dulai 2010). *Late Miocene:* Proto-Mediterranean Sea (Tortonian): Po Basin, North Italy: Villa Monti, Rio di Bocca d'Asino, Montegibbio (Dell'Angelo & Palazzi 1989; this paper). *Pliocene:* northeastern Atlantic, Mondego Basin, Portugal (Dell'Angelo & Silva 2003); central Mediterranean, Italy (Dell'Angelo & Palazzi 1989; Dell'Angelo et al. 2001); North Sea Basin, Belgium (Marquet 2002). *Pleistocene:* North Atlantic: Sweden and Norway (Dell'Angelo & Palazzi 1989; Dell'Angelo & Smriglio 1999), not recorded from Mediterranean area. *Recent:* Atlantic Ocean, Britain and Ireland and the coast of France, Spain and Portugal; Mediterranean (Dell'Angelo & Smriglio 1999).

Leptochiton scabridus (Jeffreys, 1880)

Pl. 3, figs 7-11

1880 *Chiton scabridus* Jeffreys, p. 33.
Additions to the bibliography in Dell'Angelo et al. (2013: 71):
2013 *Leptochiton scabridus* (Jeffreys) – Dell'Angelo et al., p. 71, pl. 1, figs E-G.

Type material: Syntypes: 1 specimen, Goodrington, Torbay (USNM 177391); 15 specimens, Jersey (USNM 177392) (*fide* Warén 1980).

Type locality: Goodrington, Torbay, Jersey (Great Britain), 50°24'59"N, 3°33'14"W.

Material examined: Rio di Bocca d'Asino: 3 intermediate valves, maximum width 1.7 mm (BD, MZB 32012); Montegibbio: 1 intermediate valve, width 1.5 mm (BD, MZB 32013).

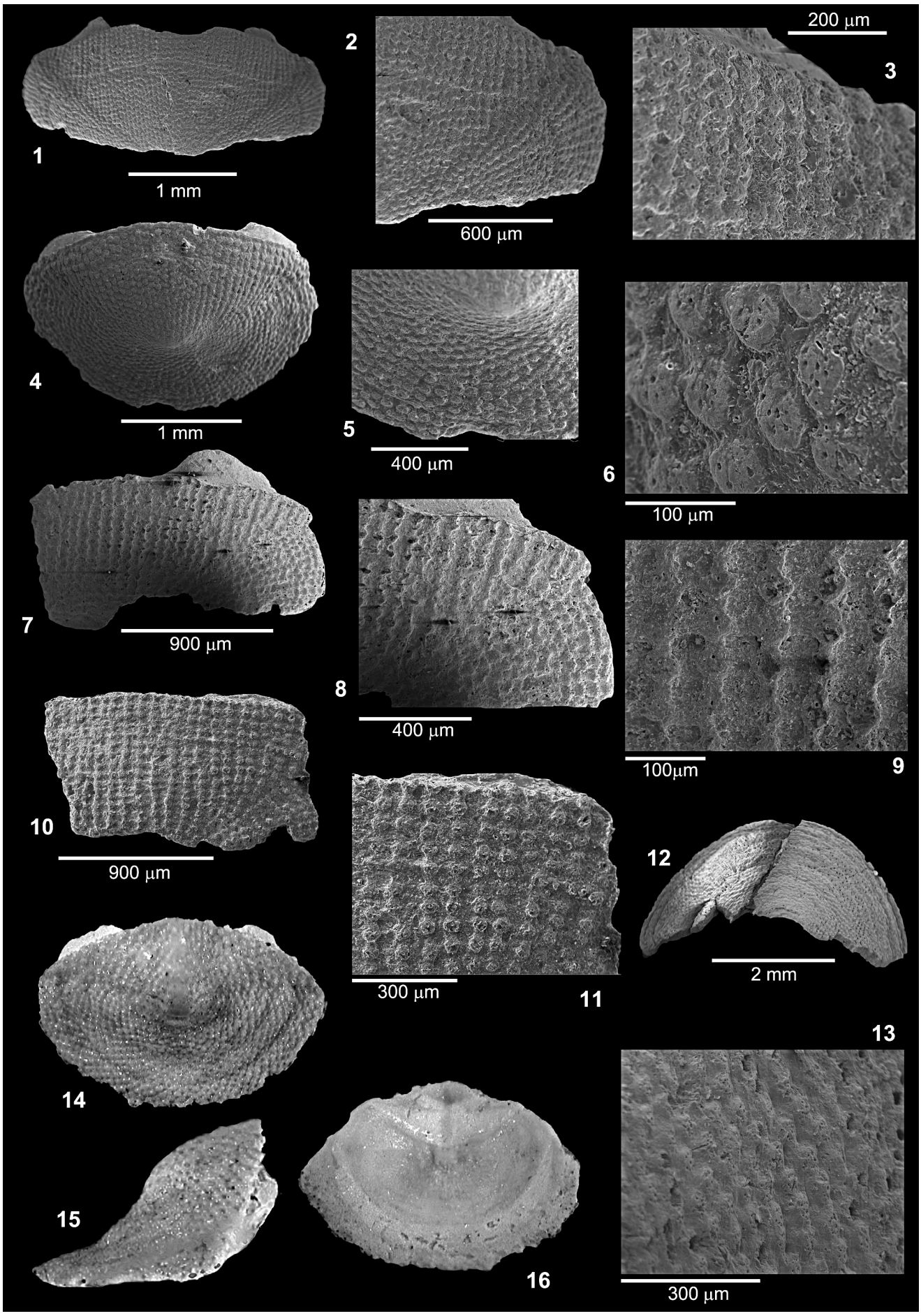
Remarks. The species is characterized by rather irregular granules sculpturing the tegmentum, of subquadrangular/subrhomboidal shape and well separated from each other, arranged in radial series on the head valve, the lateral areas of intermediate valves and the postmucronal area of the tail valve; these granules are in longitudinal series in the central area of the intermediate valves and the antemucronal area of the tail valve, where they look like a square mesh. The tegmentum has a rough surface, on which the granules are ex-

PLATE 3

Figs 1-6 - *Leptochiton cancellatus* (Sowerby, 1840), Rio di Bocca d'Asino.
1-3) intermediate valve, MZB 32010. 1 - dorsal view. 2-3 - details of the sculpture. 4-6) tail valve, MZB 32011. 4 - dorsal view. 5-6 - detail of the sculpture of the postmucronal area.

Figs 7-11 - *Leptochiton scabridus* (Jeffreys, 1880).
7-9) Rio di Bocca d'Asino, intermediate valve, MZB 32012. 7 - dorsal view. 8-9 - details of the sculpture. 10-11) Montegibbio, intermediate valve, MZB 32013. 10 - dorsal view. 11 - detail of the sculpture.

Figs 12-16 - *Leptochiton salicensis* (Dell'Angelo & Bonfitto, 2005).
12-13) Rocco di Passerano, head valve, MZB 32014. 12 - dorsal view. 13 - detail of the sculpture. 14-16) Borelli, tail valve, MZB 32015, width 2.1 mm, dorsal, lateral and ventral views.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tended into a body usually formed by two or three longitudinal varices that become unified or merge together along the external margin of the valve. Detailed descriptions of this species are in Kaas & Van Belle (1985) and Dell'Angelo & Smriglio (1999).

All the studied material is incomplete and poorly preserved. The fossil records are very scarce, possibly also due to misleading determination as the similar species *Leptochiton cancellatus* (see Dell'Angelo & Palazzi, 1989: 61).

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian): Po Basin, North Italy: Rio di Bocca d'Asino, Montegibbio (Dell'Angelo & Palazzi 1989; this paper). *Pliocene*: central Mediterranean, Italy, only two records: Sestri Ponente, Genova (Dell'Angelo et al. 2013) and «La Tagliata», Modena (Laghi 1977, as *L. cancellatus*, see Dell'Angelo & Palazzi 1989). *Pleistocene*: central Mediterranean, Greece: Kyllini (Garilli et al. 2005). *Recent*: Atlantic Ocean, S.W. U.K. and northern France (the British Channell), northern Spain, Canary Islands and Angola; Mediterranean Sea, Italy, Greece, and Malta (Dell'Angelo & Smriglio 1999).

Leptochiton salicensis (Dell'Angelo & Bonfitto, 2005)

Pl. 3, figs 12-16

2005 *Lepidopleurus* (*Leptochiton*) *salicensis* Dell'Angelo & Bonfitto, p. 1, figs 1-8.

2005 *Lepidopleurus* (*Leptochiton*) *salicensis* Dell'Angelo & Bonfitto - Schwabe, p. 102.

2013 *Leptochiton salicensis* Dell'Angelo & Bonfitto - Dell'Angelo et al., p. 71, 74, 76.

Type material: Holotype: MZB 31028 (1 intermediate valve). Paratypes: MZB 31029 (two valves); BD 4662 (four valves).

Type locality: Salice (Messina, Sicily, Italy); early Pleistocene.

Material examined: Rocco di Passerano: 1 head valve, width 4.3 mm (PG, MZB 32014); Borelli: 1 tail valve, width 2.1 mm (BD, MZB 32015).

Remarks. This species is characterized by the tegmentum sculpture, with pronounced, neatly separated roundish/polygonal granules, randomly arranged on the entire valve surface.

The two head and tail valves found are very similar in shape and in the structure of the granules to *Leptochiton salicensis* as described from the type locality. The only observed difference is the position of the mucro in the tail valve, subcentral in type material of this species and a bit more anterior in the examined valves, but, notwithstanding the scarcity of the material examined, we consider these valves within the variability of *L. salicensis*. These findings widely extend the distribution of the species to the Miocene.

Only two other known fossil species have the same kind of tegmentum sculpture, fully covered with randomly or quincuncially arranged granules: *Leptochiton alveolus* (M. Sars in Lovén, 1846) from the Recent North Atlantic and the Pliocene of Italy (Dell'Angelo et al. 2013), with oval granules of different shape; *Leptochiton tavianii* Dell'Angelo et al. 2004 from the Pliocene of Estepona (Spain). However, the latter species has granules characterized by a fungiform section and are arranged in a beehive structure.

Distribution. *Early Miocene*: Proto-Mediterranean Sea (Burdigalian): North Italy: Rocco di Passerano (this paper). *Late Miocene*: Proto-Mediterranean Sea (Messinian): Po Basin, North Italy: Borelli (this paper). *Early Pleistocene*: central Mediterranean: Italy: Salice (Dell'Angelo & Bonfitto 2005).

Genus *Parachiton* Thiele, 1909

Type species: *Lepidopleurus* (*Parachiton*) *acuminatus* Thiele, 1909 by original designation.

Remarks. *Parachiton* was originally established by Thiele (1909) as a subgenus of the genus *Lepidopleurus* on the basis of its disproportionately large tail valve with subterminal mucro, and overall similarities of the other valves with species of *Lepidopleurus*. It is now considered to be a distinct genus (Sirenko 2006), also due to differences in the radula (Saito 1996). To date there are 22 Recent species known, all from the Indo-Pacific except for *P. africanus* (Nierstrasz, 1906) from the Mediterranean Sea. This species is known also from the Pliocene-Pleistocene deposits in the Mediterranean area, and a single extinct species, *P. thielei* (Šulc, 1934),

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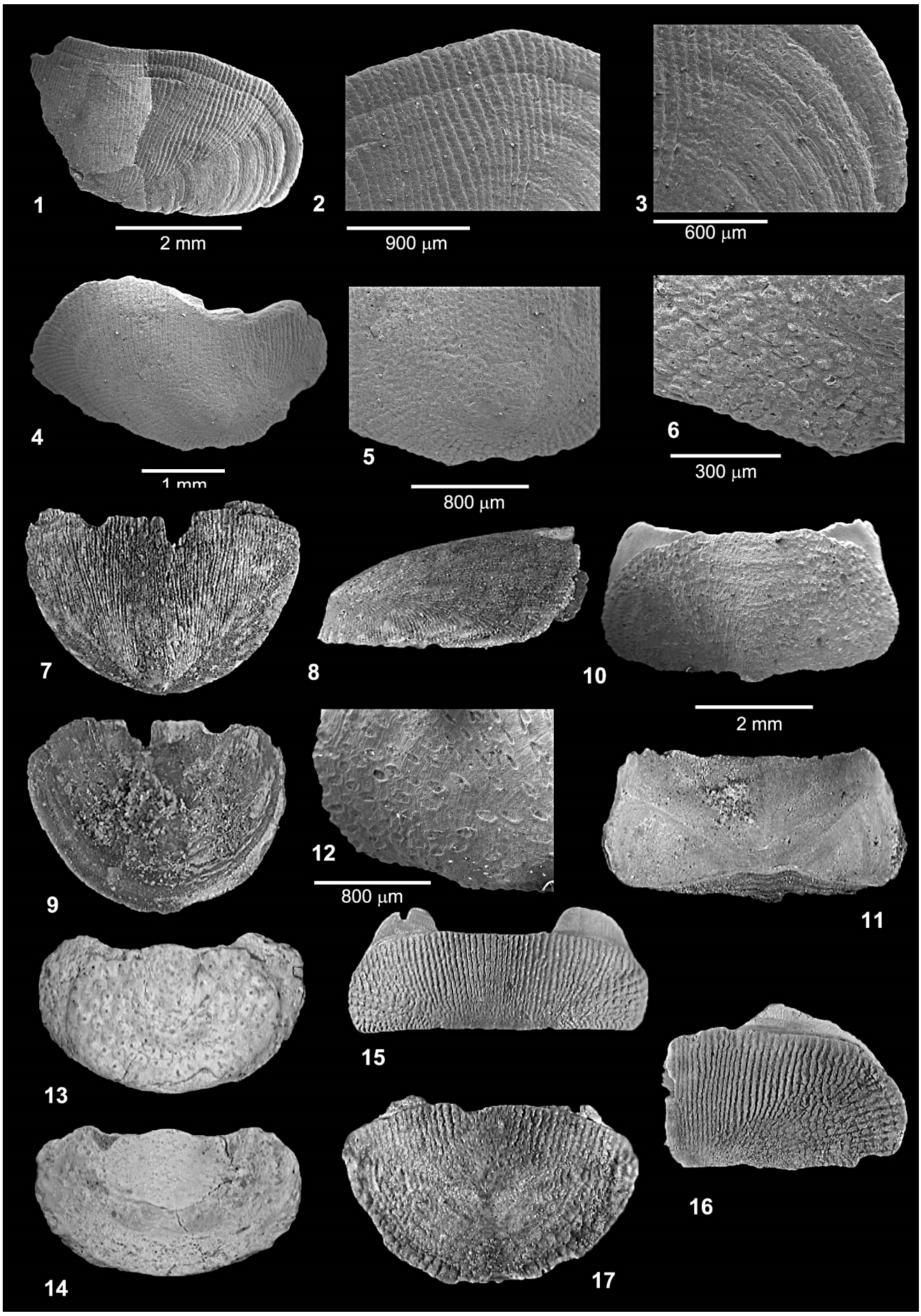
PLATE 4

Figs 1-9 - *Parachiton statianus* sp. n., Rio di Bocca d'Asino.
1-3) half right intermediate valve, paratype MGPT PU 108785. 1 - dorsal view. 2-3 - details of the sculpture of the pleural and lateral areas, respectively. 4-6) tail valve, Paratype NHMW 2014/0450/0002. 4 - dorsal view. 5 - close-up of the mucro. 6 - detail of the sculpture of the postmucronal area. 7-9) tail valve, holotype MGPT PU 108784, dorsal, lateral and ventral views.

Figs 10-12 - *Hanleya nagelfar* (Lovén, 1846).
10-12) Rio di Bocca d'Asino, intermediate valve, MZB 32016. 10-11 - dorsal and ventral views. 12 - detail of the sculpture.

Figs 13-14 - *Hanleya mediterranea* Sirenko, 2014.
13-14) Montegibbio, tail valve, MZB 32017, width 2.8 mm, dorsal and ventral views.

Figs 15-17 - *Ischnochiton rissoi* (Payraudeau, 1826).
15) Rio di Bocca d'Asino, intermediate valve, MZB 32018, width 5.8 mm, dorsal view. 16) Montegibbio, half right intermediate valve, MZB 32019, width 5.7 mm, dorsal view. 17) Rio di Bocca d'Asino, tail valve, MZB 32020, width 3.5 mm, dorsal view.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valve	type material	pl. 4, figs	width (mm)	estimated total width (mm)	longit. rows measured (estimated)	radial rows measured (estimated)
int.	Paratype MGPT PU 108785	1-3	4.2 incomplete	6.7	60 (90)	
int.	Paratype BD 122		2.9 incomplete		52	
int.	Paratype NHMW 2014/0450/0001		3.4 incomplete	6.8	51 (>90)	
tail	Holotype MGPT PU 108784	7-9	5.7 complete	5.7	ca. 95	> 100
tail	Paratype BD 123		2.7 incomplete		54	
tail	Paratype NHMW 2014/0450/0002	4-6	3.6 incomplete		55	62 (85)

Tab. 3 - Type material of *Parachiton statianus* sp. nov.

is from the Miocene (Badenian) of Paratethys. The genus has a Miocene to Recent distribution.

Parachiton statianus sp. n.

Pl. 4, figs 1-9

2004 *Lepidopleurus (Parachiton)* aff. *africanus* Nierstrasz - Dell'Angelo et al., p. 29, pl. 2, figs 2, 6.

Type locality: Rio di Bocca d'Asino (Alessandria), Piedmont, Italy.

Type stage: Miocene (Tortonian).

Type material: Holotype: MGPT PU 108784 (a tail valve, width 5.7 mm, Pl. 4, figs 7-9). Paratypes, all from the type locality: MGPT PU 108785 (an intermediate valve, width 4.2 mm, Pl. 4, figs 1-3); NHMW 2014/0450/0001 (an intermediate valve, width 3.4 mm); NHMW 2014/0450/0002 (a tail valve, width 3.6 mm, Pl. 4, figs 4-6); BD 122 (an intermediate valve, width 2.9 mm); BD 123 (a tail valve, width 2.7 mm).

Other material: Rio di Bocca d'Asino: 1 tail valve, width 2.7 mm, MZB 32047; Velerin Antena (Estepona, Spain, Pliocene): 2 intermediate valves, MZB 32048 (figured in Dell'Angelo et al. 2004: pl. 2, figs 2, 6).

Etymology: From the Latin «gens Statia», the people living in ancient times in Stazzano (near Rio di Bocca d'Asino), and probably giving the name to this locality.

Diagnosis: Intermediate valves broadly rectangular, lateral areas not raised. Tail valve oval, mucro posterior, postmucronal slope short, steep and straight. Tegmentum finely granulose, with granules arranged in ca. 90-95 longitudinal rows on central area of intermediates valves and antemucronal area of tail valve, and in more than 100 radiating rows on postmucronal area of tail valve.

Description. Intermediate valves broadly rectangular with straight posterior margin, evenly rounded in anterior view, lateral areas not raised. Tail valve oval in outline, mucro posterior, antemucronal slope slightly convex, postmucronal slope short, steep, straight.

Tegmentum finely granulose. Granules fairly smoothly coalescing and arranged in ca. 90-95 longitudinal rows on central area of intermediates valves and antemucronal area of tail valve; the rows are enough regular, on the sides diverging anteriorly. Lateral areas of intermediate valves with not very evident irregularly arranged low granules, crossed by concentric lines of growth, that give a rough pattern to the surface. Postmucronal area of tail valve with the more squarish granules arranged in numerous fine radiating rows, more than 100 in the holotype.

Articulamentum weakly developed, small apophyses not preserved in the studied material.

Remarks. In spite of the scarcity and incompleteness of the material, only the holotype is represented by a complete tail valve, the characters are well defined, and suitable for the description of the species as new. We did not find any head valves of this species.

The width and the number of longitudinal rows of granules in central and antemucronal areas, and of radial rows in postmucronal area of the type material are reported in Tab. 3.

Notwithstanding the incompletness of the valves, we have estimated the total width of the valves, the total number of longitudinal rows of granules in central and antemucronal areas, and the number of radial rows in the postmucronal area. In Table 3, these data are put in brackets after the measured values.

Comparisons. This species closely resembles *Parachiton africanus* (Nierstrasz, 1906) in general shape of the valves, position of the mucro in tail valve, and sculpture of the tegmentum. It differs mainly in the number of longitudinal rows of granules in the central and antemucronal areas.

Parachiton africanus is a rare Mediterranean species, described based on a single specimen from Oran, Algeria, whose holotype is in the RMNH, no. 2783, deprived of its end valves (Kaas 1977). As a fossil this species is known also from the Mediterranean Plio-Pleistocene deposits. Nierstrasz (1906) does not report the number of longitudinal rows of granules in the central and antemucronal areas, he says "at least 36" for intermediate valves, and "sculptured like the central area of the middle valves" for tail valve. Kaas & Van Belle (1985) reported 40 longitudinal rows, and, similarly, Dell'Angelo & Smriglio (1999) reported 36-40 rows.

We examined a lot of intermediate and tail valves of *P. africanus* from Pleistocene to Recent (in the BD Collection), and the results are reporting in Tab. 4. Two of these valves (an intermediate and a tail from Banco Scuso) are figured in Dell'Angelo & Smriglio 1999: pl. 23, figs D, F.

We can therefore assume that the number of longitudinal rows of granules in the central and antemucronal areas of *P. africanus* ranges between 36 and 52, while

Tab. 4 - Parameters measured on valves of *P. africanus* from Pleistocene to Recent.

PLEISTOCENE				RECENT			
intermediate valves		tail valves		intermediate valves		tail valves	
width	number of long. rows	width	number of long. rows	width	number of long. rows	width	number of long. rows
3.3	46	2.7 - 4.2	40 - 52	2.4 - 3.7	44 - 51	2.3 - 4.3	40 - 52

the same number for the new species is estimated to be 90. We attribute to the new species also the intermediate valves from the Pliocene of Velerin Antena (Estepona, Spain) reported by Dell'Angelo et al. (2004). The intermediate valve figured (pl. 2, figs 2, 6) is incomplete (width 4.9 mm) but the number of longitudinal rows of granules in the central area is 80, in agreement with the estimated number for the valves from the Miocene of Rio di Bocca d'Asino described here.

The new species differs from *Parachiton africanus* also in the rougher appearance of the lateral area, in the antemucronal slope straight (convex in *P. africanus*) and in the more regular longitudinal rows of granules in the central and antemucronal areas, not converging posteriorly on the jugum (compare pl. 3, fig. 6 in the Nierstrasz's original description of *P. africanus*).

The only known extinct species of *Parachiton* is *P. thielei* Šulc, 1934, described from the Middle Miocene (Badenian) of Steinabrunn, Austria. This species was considered as a synonym of *P. africanus* by several authors, e.g. Kaas (1977), Bałuk (1984), Dell'Angelo & Smriglio (1999), and we confirm this synonymy.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian): Po Basin, North Italy: Rio di Bocca d'Asino (this paper). *Pliocene*: western Mediterranean, Estepona Basin, Spain: Velerin Antena (Dell'Angelo et al. 2004).

Family Hanleyidae Bergenhayn, 1955

Genus *Hanleya* Gray, 1857

Type species: *Hanleya debilis* Gray, 1857 (= *Chiton hanleyi* Bean in Thorpe, 1844), by monotypy

Remarks. In a recent revision of the genus *Hanleya* from the Atlantic Ocean and its adjacent seas, Sirenko (2014) considers only one species (*Hanleya mediterranea* Sirenko, 2014) living in Mediterranean Sea, another species [*H. nagelfar* (Lovén, 1846)] in the Atlantic Ocean from 74.27°N to 09.038°N (southern Greenland, North America, Europe and Atlantic coast of Morocco), while the taxonomic status of the type species *H. hanleyi*, and also its possible presence in the Mediterranean Sea, is still not adequately treated. The original description of this species is brief and information provided by Kaas & Van Belle (1985) is based on somewhat distant Norwegian material and from deeper water than the type locality in the intertidal at Scarborough, England. Furthermore, on the basis of the original description, this species closely resembles juvenile specimens of *H. nagelfar* in shell shape and tegmentum sculpture (Warén & Klitgaard 1991; Sirenko 2014). For these reasons here we have identified the scarce and worn valves of *Hanleya* in this study to either *H. mediterranea* or *H. nagelfar*, depending primarily on corresponding tegmental sculpture differences in those species as presently recognized.

A further revision of the fossil species reported as *H. hanleyi* is still needed but is beyond the aim of this work. The genus is known from the Oligocene to Recent.

Hanleya nagelfar (Lovén, 1846)

Pl. 4, figs 10-12

1846 *Chiton nagelfar* Lovén, p. 158.

1999 *Hanleya hanleyi* (*non* Bean) – Dell'Angelo et al., p. 262, pl. 1, fig. 1 (partim).

2014 *Hanleya nagelfar* (Lovén) – Sirenko, p. 19, figs 9-19.

Type material: NHRM, type collection 1329 (designated by Kaas & Van Belle, 1985).

Type locality: Finnmark, Norway.

Material examined: Rio di Bocca d'Asino: 2 intermediate valves, maximum width 5.5 mm (BD, PG, MZB 32016); Borelli: 1 intermediate valve, width 4.2 mm (MGPT PU 135038).

Remarks. This species is characterized by the sculpture of the central areas of intermediate valves and the antemucronal area of tail valve. This sculpture consists of longitudinal series of small, roundish to oval granules, with very narrow interstices, strongly converging posteriorly towards the sides. The living specimens are of large size, up to 73 mm long (Sirenko 2014), and the differences with *H. hanleyi* were a long time debated. Many authors regard *H. nagelfar* as a *H. hanleyi* of extraordinary size (Kaas & Van Belle 1985; Warén & Klitgaard 1991; Sirenko 2014).

The valve from the Messinian of Borelli (already illustrated in Dell'Angelo et al., 1999: pl. 1, fig. 1) matches with the present species; the two valves from Rio di Bocca d'Asino are worn and poorly preserved, and the occurrence of *H. nagelfar* in that locality should be confirmed by exhaustive, better preserved material.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Rio di Bocca d'Asino, Borelli (Dell'Angelo et al.

1999; this paper). *Recent*: North and Central Atlantic Ocean, the Barents, Norwegian and Greenland seas, near southern Greenland. North America, Europe and Northern Africa, on Mid-Atlantic Ridge from 74.27°N to 09.038°N (Sirenko 2014).

Hanleya mediterranea Sirenko, 2014

Pl. 4, figs 13-14

1999 *Hanleya hanleyi* (*non* Bean) – Dell'Angelo et al., p. 262, pl. 1, fig. 3 (partim).
2014 *Hanleya mediterranea* Sirenko, p. 11, figs 6-8A-J.

Type material: Holotype ZISP 2201, length 4.7 mm, now disarticulated, and three paratypes ZISP 2202.
Type locality: Mediterranean Sea, off Begur (Girona, Spain), 200-300 m deep.
Material examined: Montegibbio: 2 valves, 1 intermediate, width 1.5 mm, and 1 tail, width 2.8 mm (BD, MZB 32017); Borelli: 1 intermediate valve, width 3.8 mm (MGPT PU 135039).

Remarks. This species is characterized by the tegmentum sculptured with roundish/oval granules arranged without pattern; some are joined forming larger granules in pleural areas. This species is distinguished from other congeners by the lack of longitudinal rows of granules across the entire pleural area, and by the presence of large granules comprising two or more small granules in pleural areas (Sirenko 2014: 18).

The valve from the Messinian of Borelli (already illustrated in Dell'Angelo et al. 1999: pl. 1, fig. 3) matches with the present species; the two valves from Montegibbio are worn and poorly preserved, but, notwithstanding the scarcity of the material examined, we consider these valves within the variability of *H. mediterranea*.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Montegibbio, Borelli (Dell'Angelo et al. 1999; this paper). *Recent*: Mediterranean Sea (Sirenko 2014).

Order **Chitonida** Thiele, 1909
Suborder **Chitonina** Thiele, 1909
Superfamily Chitonoidea Rafinesque, 1815
Family Ischnochitonidae Dall, 1889
Genus *Ischnochiton* Gray, 1847

Ischnochiton Gray, 1847a: 126. Type species: *Chiton textilis* Gray, 1828, by subsequent designation (Gray, 1847b: 168).

For synonymy, see Kaas & Van Belle 1990.

Remarks. The genus is known from the Eocene to the Recent. The diagnoses of subgenera within *Ischnochiton* is based mainly on girdle characters, so it is preferable to not use subgenera for fossil species.

Ischnochiton rissoi (Payraudeau, 1826)

Pl. 4, figs 15-17

1826 *Chiton rissoi* Payraudeau, p. 87, pl. 3, figs 4-5.
Additions to the bibliography in Dell'Angelo et al. (2013: 76):
2013 *Ischnochiton rissoi* (Payraudeau) – Dell'Angelo et al., p. 76, pl. 3, figs G-K.

Type material: Syntype at MNHN 6109.
Type locality: Bonifacio, Corse, France (41°23'10"N, 9°09'31"E).
Material examined: Villa Monti: 2 valves (1 intermediate, and 1 tail) (BD, MZB 32049); Rio di Bocca d'Asino: 12 valves (6 intermediate, and 6 tail) (BD, MZB 32018, MZB 32020, PG); Montegibbio: 4 valves (3 intermediate, and 1 tail) (BD, MZB 32019); Borelli: 1 tail valve (MGPT PU 135040). Maximum width of the valves: – / 7.5 / 5 mm.

Remarks. The species is characterized by a tegmental sculpture consisting of concentric vermicular ribs, often intersected by fine radial furrows, on the head valve, lateral areas of intermediate valves and postmucronal area of the tail valve. The ribs continue longitudinally on the central area of intermediate valves and on the antemucronal area of the tail valve, more spaced near the lateral margins, thinner and closer together in the jugal area. The species is highly variable, with a complicated synonymy, and detailed descriptions are in Kaas & Van Belle (1990) and Dell'Angelo & Smriglio (1999).

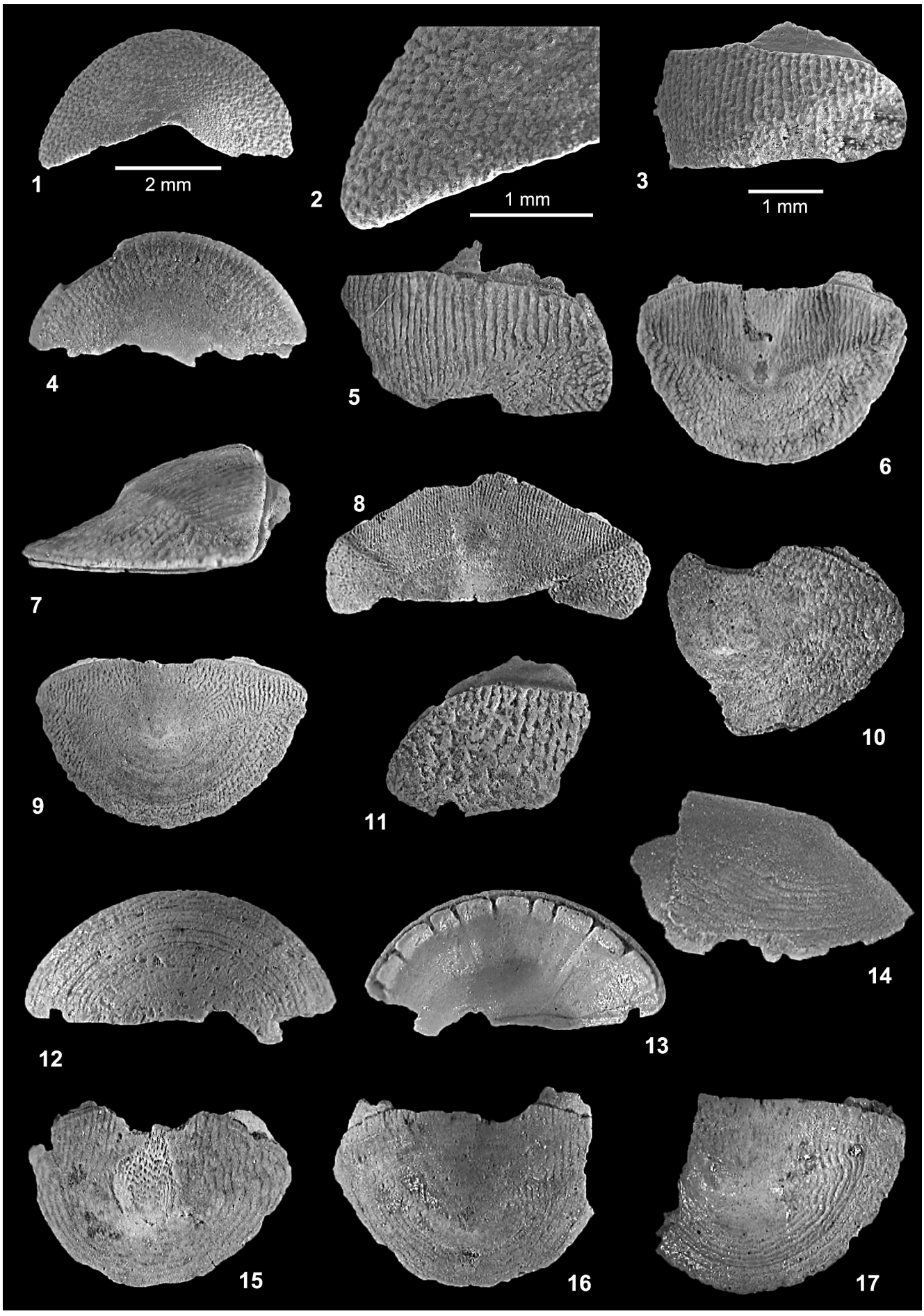
The material found is scarce, the valves are mainly incomplete and eroded, and show some differences in their ornamentation: radial ribbing is stronger than concentric ribbing on head valve, the lateral areas of inter-

PLATE 5

Figs 1-9 - *Ischnochiton korytnicensis* Bałuk, 1971.
1-3) Montegibbio. 1-2, head valve, MZB 32021, dorsal view. 3 - half right intermediate valve, MZB 32022, dorsal view. 4-7) Rio di Bocca d'Asino. 4 - head valve, MZB 32023, width 5.5 mm, dorsal view. 5 - half right intermediate valve, MZB 32024, width 3.7 mm, dorsal view. 6-7 - tail valve, MZB 32025, width 6 mm, dorsal and lateral views. 8-9) Borelli. 8 - intermediate valve, MZB 32026, width 9.5 mm, dorsal view. 9 - tail valve, MZB 32027, width 5 mm, dorsal view.

Figs 10-11 - *Ischnochiton ligusticus* Dell'Angelo, Sosso, Prudenza & Bonfitto, 2013, Rio di Bocca d'Asino.
10) tail valve, MZB 32028, width 2.5 mm, dorsal view. 11) half left intermediate valve, MZB 32029, width 2.2 mm, dorsal view.

Figs 12-17 - *Stenoplax paviai* Dell'Angelo, Giuntelli, Sosso & Zunino, 2014.
12-13) Albugnano, head valve, MZB 32030, width 5.5 mm, dorsal view. 14) Rio di Bocca d'Asino, Holotype MGPT PU 108791, lateral view. 15) Rio di Bocca d'Asino, tail valve, MZB 32031, width 3.5 mm, dorsal view. 16) Rio di Bocca d'Asino, tail valve, MZB 32032, width 4.2 mm, dorsal view. 17) Borelli, tail valve, MGPT PU 135042, width 3.5 mm, dorsal view.


1
2 mm
2
1 mm
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1 mm
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mediate valves and the postmucronal area of tail valve. They are similar to the valves from the Pliocene of Liguria (Dell'Angelo et al. 2013: pl. 3, figs I, K) and from Serre di Rapolano in Tuscany (Dell'Angelo et al. 2001b: figs 20, 23).

Distribution. *Middle Miocene*: Paratethys (Langhian-Serravallian): Austria, Czech Republic, Hungary, Poland, Romania, Ukraine (Dulai 2005; Studencka & Dulai 2010). *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Villa Monti, Rio di Bocca d'Asino, Montegibbio, Borelli (Laghi 1977; Dell'Angelo et al. 1999; this paper). *Pliocene*: western Mediterranean, Estepona Basin, Spain (Dell'Angelo et al. 2004); central Mediterranean, Italy (Dell'Angelo et al. 2013). *Pleistocene*: central Mediterranean, Italy, Greece (Garilli et al. 2005). *Recent*: Mediterranean Sea (Dell'Angelo & Smriglio 1999).

Ischnochiton korytnicensis Bałuk, 1971

Pl. 5, figs 1-9

1971 *Ischnochiton korytnicensis* Bałuk, p. 458, pl. 3, figs 1-4.

Additions to the bibliography in Dell'Angelo et al. (2013: 77):

2013 *Ischnochiton korytnicensis* Bałuk – Dell'Angelo et al., p. 77, pl. 3, figs L-T.

Type material: Holotype in Bałuk's collection, reg. No. BkK-A15, an intermediate valve illustrated in Bałuk (1971: pl. 3, fig. 2).

Type locality: Korytnica, 24 km SSW of Kielce (50°39'49"N, 20°31'41"E), southern slopes of the Holy Cross Mts. (Poland), Middle Miocene (Badenian).

Material examined: Villa Monti: 3 valves (1 intermediate, and 2 tail) (BD, MZB 32050); Rio di Bocca d'Asino: 39 valves (3 head, 18 intermediate, and 18 tail) (BD, MZB 32023-32025, PG); Montegibbio: 21 valves (2 head, 16 intermediate, and 3 tail) (BD, MZB 32021-32022); Borelli: 9 valves (1 head, 5 intermediate, and 3 tail) (MGPT PU 135041, MZB 32026-32027, PG). Maximum width of the valves: 8.3 / 9.5 / 7.2 mm.

Remarks. The species is characterized by a tegmental sculpture consisting of closely spaced, elevated, irregularly shaped nodules on the head valve, the lateral areas of the intermediate valves and the postmucronal area of the the tail valve, and longitudinal, clearly undulating ribs on the central area of the intermediate valves and the antemucronal area of the tail valve. Bałuk (1971) provided a detailed description of *I. korytnicensis*.

This species is similar to *I. rissoi*, from which it differs mainly in the ornamentation of head valve, the lateral areas of the intermediate valves and the postmucronal area of the tail valve composed of irregular, closely spaced, and elevated nodules, whereas *I. rissoi* shows concentric vermicular ribs.

This species shows a wide variability. A very large (9.5 mm wide) valve from Borelli (pl. 5, fig. 8) has ca. 80 longitudinal ribs in the central area. The valve from the same site, illustrated in pl. 5, fig. 9, shows a more irregular sculpture of the central part of the antemucronal area.

Distribution. *Middle Miocene*: Paratethys (Langhian-Serravallian): Poland (Bałuk 1984; Macioszczyk 1988). *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Villa Monti, Rio di Bocca d'Asino, Montegibbio, Borelli (Laghi 1977; Dell'Angelo et al. 1999; this paper). *Pliocene*: central Mediterranean, Italy: Liguria (Dell'Angelo et al. 2013).

Ischnochiton ligusticus Dell'Angelo, Sosso, Prudenza & Bonfitto, 2013

Pl. 5, figs 10-11

2013 *Ischnochiton ligusticus* Dell'Angelo, Sosso, Prudenza & Bonfitto, p. 78, pl. 4, figs B-M.

Type material: Holotype: MZB 49983, an intermediate valve from Bussana. Paratypes: MZB 49981-49982; MSNG 56536; MGPT PU 109800-109801, and private collections.

Type locality: Bussana (Imperia), Italy (43°49'60"N, 7°49'52"E); early Pliocene (Zanclean).

Material examined: Rio di Bocca d'Asino: 3 valves (1 intermediate, width 2.2 mm, and 2 tail, maximum width 2.7 mm) (BD, MZB 32028-32029); Montegibbio: 2 valves (1 intermediate, width 3.8 mm, and 1 tail, width 3 mm) (BD, MZB 32051).

Remarks. This species, is characterized by the tegmentum uniformly sculptured with very irregular granules, arranged in segments of various size and shape, slightly overlapping each other, forming rugosities. It was recently described by Dell'Angelo et al. (2013) from the Pliocene of Liguria. Here we extend its distribution to the Miocene (Tortonian).

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian): Po Basin, North Italy: Rio di Bocca d'Asino, Montegibbio (this paper). *Pliocene*: central Mediterranean, Italy: Liguria (Dell'Angelo et al. 2013).

Genus *Stenoplax* Carpenter MS, Dall, 1879

Type species: *Chiton limaciformis* Sowerby, 1832, by original designation

Remarks. *Stenoplax* is a distinct taxon whose members are highly elongate, and whose intermediate valves have prominent sutural laminae and generally raised lateral areas. The depressed and much more elongated (relative to other valves) tail valve with prominent diagonal line is diagnostic for this genus. The genus is known from the Eocene to the Recent.

Stenoplax paviai Dell'Angelo, Giuntelli, Sosso & Zunino, 2014

Pl. 5, figs 12-17

2014 *Stenoplax paviai* Dell'Angelo, Giuntelli, Sosso & Zunino, p. 49, pl. 1, figs 1-9.

Type material: Holotype: MGPT PU 108791 (a tail valve); Paratypes: MGPT PU 108792 – 108795; MSNG 57252; ZISP 2199 – 2200; MZB 60085 – 60087; NHMW 2013/0272/0001.

Type locality: Rio di Bocca d'Asino (Alessandria), Piedmont, Italy. Miocene (Tortonian).

Material examined: Albugnano: 1 head valve (PG, MZB 32030); Villa Monti: 1 tail valve (BD, MZB 32052); Rio di Bocca d'Asino: type material (14 valves, see above), and other 27 valves (4 head, 8 intermediate, and 15 tail) (BD, MZB 32031-32032, PG); Borelli: 1 tail valve, width 3.5 mm (MGPT PU 135042). Maximum width of the valves: 5.5 / 4.2 / 4.8 mm.

Remarks. This species is characterized by the tegmentum sculptured by many close-set, irregularly undulating concentric grooves on head valve, lateral areas of intermediate valves, and postmucronal area of tail valve, and by some longitudinal grooves on central and antemucronal areas, more marked towards the periphery. It was described by Dell'Angelo et al. (2014) from the Miocene (Tortonian) of Rio di Bocca d'Asino. We illustrate a lateral view of the holotype (pl. 5, fig. 14), not figured in the original description.

Our findings extend the distribution of this species to the Langhian (Albugnano) and Messinian (Borelli).

Distribution. *Early Miocene*: Proto-Mediterranean Sea (Langhian): North Italy: Albugnano (this paper). *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Villa Monti, Rio di Bocca d'Asino, Borelli (Dell'Angelo et al. 2014; this paper).

Genus *Stenosemus* von Middendorff, 1847

Type species: *Chiton albus* Linnaeus, 1767, by subsequent designation (Winckworth 1926)

Remarks. The genus is known from the Pliocene to the Recent.

Stenosemus dolii (Van Belle & Dell'Angelo, 1998)

Pl. 6, figs 1-9

1998 *Ischnochiton* (*Stenosemus*) *dolii* Van Belle & Dell'Angelo, p. 115, fig. 53, pls 36-38.

Additions to the bibliography in Dell'Angelo et al. (2013: 82):

2013 *Stenosemus dolii* Van Belle & Dell'Angelo – Dell'Angelo et al., p. 82, pl. 5, figs A-I.

Type material: Holotype: an intermediate valve, 3 x 7.5 mm (MZB 11302). Paratypes: MZB 11303 (five valves), IRSN IG 28523 (four valves), MNHN (three valves), and private collections.

Type locality: Tyrrhenian Sea, off Civitavecchia, Italy, in a Roman amphora ("dolium") at a depth of 550 m (42°04'04"N, 11°45'31"E).

Material examined: Rio di Bocca d'Asino: 1 head valve (PG, MZB 32053); Sant'Agata Fossili: 1 head valve (PG, MZB 32054); Montegibbio: 2 valves, 1 head, and 1 intermediate (MZB 32039); Borelli: 6 valves, 1 head, and 5 intermediate (BD, MZB 32040-32041, MGPT PU 135043, PG). Maximum width of the valves: 7.5 / 8.4 / – mm.

Remarks. The species was described on the basis of many separate subfossil valves found in a Roman amphora ("dolium") off Civitavecchia, at a depth of 550 meters (Van Belle & Dell'Angelo 1998); other valves from a thanatocoenosis (death assemblage of accumulated fossils) from the South Ligurian Sea, between Corsica and Capraia Island, at a depth of 350-500 m were collected (Dell'Angelo & Giusti 1997, 2000). Later live specimens from Thyrrenian Sea were found, at a depth between 150 and 480 m (Dell'Angelo & Smriglio 1999; Dell'Angelo et al. 2001).

The species shows a large variability, as reported by Dell'Angelo et al. (2012, 2013) from the Pliocene of Altavilla (Sicily) and Western Liguria.

The valves from the Messinian of Borelli, previously identified by Dell'Angelo et al. (1999) as *Ischnochiton* (*Simplischnochiton*) *exaratus* (Sars, 1878) were identified as *Stenosemus dolii* by Dell'Angelo et al. (2013), and further confirmed here.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Tortonian and Messinian): Po Basin, North Italy: Rio di Bocca d'Asino, Sant'Agata Fossili, Montegibbio, Borelli (Dell'Angelo et al. 1999; this paper). *Pliocene*: western Mediterranean, Estepona Basin, Spain (Dell'Angelo et al. 2004); central Mediterranean, Italy (Dell'Angelo et al. 2012, 2013). *Pleistocene*: central Mediterranean, Italy: valves dredged between Capraia and Capo Corso, at a depth of 350-500 m (Van Belle & Dell'Angelo 1998; Dell'Angelo & Giusti 1997, 2000). *Recent*: Mediterranean Sea, off the Latium coast and in the Tuscan Archipelago, between 150 and 560 m, and in association with white coral biocoenosis (Dell'Angelo & Smriglio 1999).

Stenosemus sp. A

Pl. 6, figs 10-11

Material examined: Borelli: 1 tail valve, width 4 mm (BD, MZB 32042).

Remarks. This unique tail valve differs by the species discussed above in the sculpture of the antemucronal area, smooth with only very fine lines of growth, except in the jugal area, where some faint granules are scarcely visible. The sculpture of the postmucronal area (many subgranulose, rather flat, radial ribs, tending to be splitted near the posterior margin) and the articulamentum (insertion lamina divided into 8 short and rough denticles of irregular width, not pectinated) are consistent with assignment to *Stenosemus*.

Because only a single valve was found, we could not identify it with certainty so have left it as *Stenosemus* sp. A, awaiting for more material for any more specific determination.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Messinian): Po Basin, North Italy: Borelli (this paper).

Stenosemus sp. B

Pl. 6, figs 12-13

Material examined: Montegibbio: 1 intermediate valve, width 1.8 mm (BD, MZB 32043).

Remarks. This unique and incomplete intermediate valve differs by *Stenosemus dolii* in the sculpture of the raised lateral area, with two (likely more, as the lateral area is incomplete) radial striae of large, elevated, irregular granules, with the granulose interstices. The pleural area shows some longitudinal ribs, curved towards the contact with the lateral area. These characters suggest it belongs to *Stenosemus*. Unfortunately, the insertion lamina and the teeth in the articulamentum are not visible.

A more precise classification awaits further study.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Messinian): Po Basin, North Italy: Montegibbio (this paper).

Family Callistoplacidae Pilsbry, 1893

Genus *Callistochiton* Carpenter MS, Dall, 1879

Type species: *Callistochiton palmulatus* Carpenter MS, Dall, 1879, by monotypy.

Remarks. The genus is known from the Oligocene to the Recent.

Callistochiton borellianus sp. n.

Pl. 6, figs 14-18

Type locality: Borelli, Torino (Piedmont, Italy).

Type stage: Miocene (Messinian).

Type material: Holotype: MGPT PU 108786 (an intermediate valve, width 5.7 mm, Pl. 6, figs 14-18).

Etymology: Named for Borelli, the type locality of the species.

Diagnosis: Intermediate valve solid, broadly rectangular, carinated, elevated. Lateral areas raised, sculptured with two nodulose ribs of different width, the rib near the diagonal ridge wider. Pleural areas sculptured with 11 longitudinal, elevated, granulose riblets. Jugal area large, smooth.

Description. Intermediate valve solid, broadly rectangular (Pl. 6, fig. 14), carinated, elevated (dorsal elevation 0.61) (Pl. 6, fig. 15), anterior and posterior margins straight, side margins rounded, slightly bilobated, apices inconspicuous. Lateral areas raised, distinctly defined, sculptured with two nodulose ribs (Pl. 6, figs 16-17) of different width, the rib near the diagonal ridge wider (Pl. 6, fig. 18), crossed by numerous concentric grooves, and separated by a narrow, deep sulcus. Pleural areas sculptured with 11 longitudinal, elevated, granulose riblets, becoming larger towards the lateral margins, jugal area large, smooth, only marked by some growth lines.

Articulamentum with apophyses wide, insertion plates well developed, apical area prominent, teeth not pectinated, a single short slit for each side (Pl. 6, fig. 18), slit rays hardly discernible.

Remarks. Identification of the unique intermediate valve at generic level is difficult. Even thought the single valve has relatively good preservation, it is eroded enough that some features are not visible. We provisionally assign the valve to the genus *Callistochiton*, on the basis of strong similarities to species included in this genus.

The sculpture of the valve tegmentum of this genus is similar to that of *Lepidozona* Pilsbry, 1892 (Vendrasco et al. 2012). *Callistochiton* can be separated from *Lepidozona* based mainly on features of the articulamentum (e.g., in *Callistochiton* but not in *Lepidozona* the slits in the head valve generally correspond in number and position to the radial ribs of the tegmentum). Another diagnostic character of *Lepidozona* emphasized by Kaas and Van Belle (1987), that is lacking in *Callistochiton*, is the presence in intermediate valves of a delicately denticulate jugal plate (or lamina) across the sinus, separated from the sutural laminae (or apophyses) on each side by small notch. This was not present in the valve examined.

The valve's characters are very distinctive and well defined, and for these reasons, and also considering that this is the first record of this genus for the Italian Miocene, and that the fossil records of European *Callistochiton* are really very scarce, we have described the single intermediate valve as a new species.

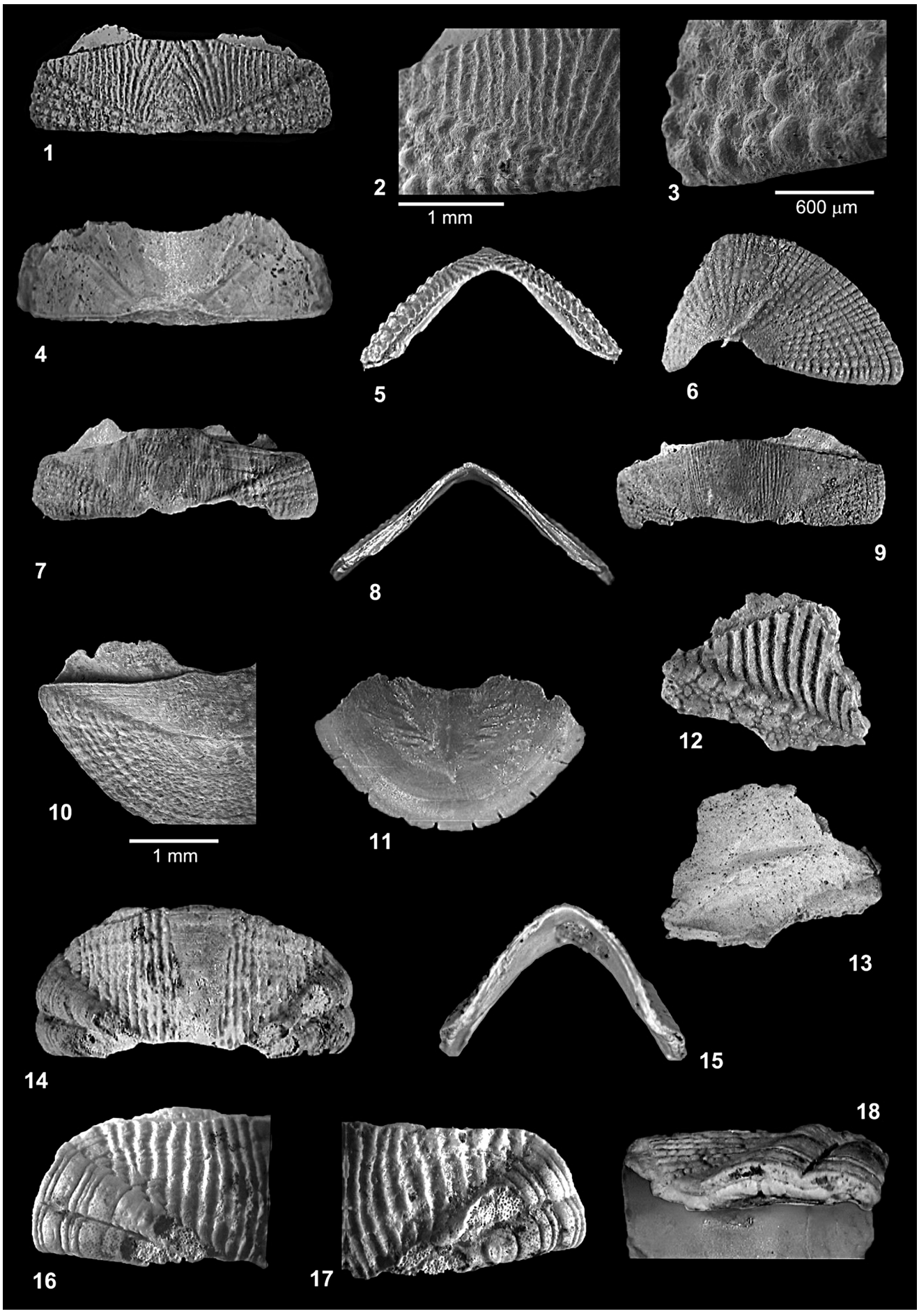
PLATE 6

Figs 1-9 - *Stenosemus dolii* (Van Belle & Dell'Angelo, 1998). 1-5) Montegibbio, intermediate valve, MZB 32039, width 5.7 mm. 1 - dorsal view. 2-3, details of the sculpture. 4-5 - ventral and frontal views. 6-9) Borelli. 6 - head valve, MZB 32040, width 5.3 mm, dorsal view. 7-8 - intermediate valve, MZB 32041, width 7 mm, dorsal and frontal views. 9 - intermediate valve, MGPT PU 135043, width 8.5 mm, dorsal view.

Figs 10-11 - *Stenosemus* sp. A, Borelli, tail valve, MZB 32042, width 4 mm, dorsal and ventral views.

Figs 12-13 - *Stenosemus* sp. B, Montegibbio, half left intermediate valve, MZB 32043, width 1.8 mm, dorsal and ventral views.

Figs 14-18 - *Callistochiton borellianus* sp. n., Borelli, Holotype MGPT PU 108786, intermediate valve, width 5.7 mm. 14-15) dorsal and frontal views. 16-17) details of the sculpture. 18) details of the radial ribs, by a lateral view.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	Burdigalian		Langhian		Serr.	Tortonian						Messinian		
localities	1	2	3	4	5	6	7	8	9	10	11	12	13	**tot**
Lepidopleurus cajetanus						79	61			1	22	40		203
Lepidopleurus benoisti	3	2												5
Leptochiton cancellatus						1	8				2			11
Leptochiton scabridus							3				1			4
Leptochiton salicensis			1									1		2
Parachiton statianus sp. n.							7							7
Hanleya nagelfar							2					1		3
Hanleya mediterranea											2	1		3
Ischnochiton rissoi						2	12				4	1		19
Ischnochiton korytnicensis						3	39				21	9		72
Ischnochiton ligusticus							3				2			5
Stenoplax paviai				1		1	41					1		44
Stenosemus dolii							1	1			2	6		10
Stenosemus sp. A												1		1
Stenosemus sp. B											1			1
Callistochiton borellianus sp. n.												1		1
total	**3**	**2**	**1**	**1**	**0**	**86**	**177**	**1**	**0**	**1**	**57**	**62**	**0**	**391**

Tab. 5 - Number of valves found by locality/species. Localities: 1- Sciolze; 2 - Valle Ceppi; 3 - Rocco di Passerano; 4 - Albugnano; 5 - Monchio di Sarzano Casina; 6 - Villa Monti; 7 - Rio di Bocca d'Asino; 8 - Sant'Agata Fossili; 9 - Vargo; 10 - Vigoleno; 11 - Montegibbio; 12 - Borelli; 13 - Moncucco Torinese.

Comparisons. The genus *Callistochiton* is widespread, occurring in cool to warm waters worldwide (Kaas & Van Belle 1994). The sole NE Atlantic and Mediterranean species is *C.* (*Allerychiton*) *pachylasmae* (Monterosato, 1879), with only three specimens so far known (Dell'Angelo & Oliverio 1997). The fossil record for *Callistochiton* is largely incomplete (Puchalski et al. 2008), and the few records do not allow us to suggest a diversification scenario for the group. The oldest record is known from the Oligocene deposits of Germany (Janssen 1978; Dell'Angelo et al. 2011). The other fossil records are from the Miocene of Japan (Itoigawa et al. 1981) and Tanzania, E. Africa (Davis 1954), the Pliocene of California, U.S.A. (Vendrasco et al. 2012), and the Pliocene-Pleistocene of Calabria, Italy (Dell'Angelo et al. 1998).

Regarding the European species, *Callistochiton borellianus* sp. n. is different from *C. zitteli* from the Oligocene of Germany (see Janssen 1978: pl. 16, figs 36-38) and from *C. pachylasmae* (which shows a single nodulose rib on lateral areas, and the central area sculptured by quincuncially disposed tubercles, see Dell'Angelo & Oliverio 1998: figs 1-13), and is not comparable to *Callistochiton* sp. described from the Plio-Pleistocene of Gallina near Reggio Calabria, Italy, of which a unique head valve is known.

Distribution. *Late Miocene*: Proto-Mediterranean Sea (Messinian): Po Basin, North Italy: Borelli (this paper).

Conclusion

This paper greatly extends the knowledge of Miocene chitons, after the works of Laghi (1977), Dell'Angelo et al. (1999), and the scarce informations supplied by Sacco (1897).

The studied chitons from the thirteen Miocene localities, represented by 391 valves, include 16 species in this first part, 12 of which are already known, two are described as new, and two assigned only at generic level (Tab. 5).

A full discussion on the chiton fauna from the Miocene of North Italy will be given in a second, forthcoming part of this work.

Acknowledgements. The authors wish to thank Boris Sirenko (ZISP) and Jean-François Lesport (Sainte-Hélène, France) for the helpful comments; Luca Bertolaso (Reggio Emilia), Mauro Brunetti (Bologna), and Massimo Rocca (Torino) for the loan of material; Simona Cavagna (Dipartimento di Scienze della Terra dell'Università di Torino) for the SEM photos; Daniele Ormezzano (PMRSN) for helping during the visit to the Bellardi Sacco collection and for providing additional photos of *Middendorffia subcajetana*; Laurent Charles (MHNBx) for useful information and the photos of the syntypes of *Gymnoplax benoisti*; Andreas Kroh (NHMW) for the photos of the syntype of *Gymnoplax orbignyi* and for helpful comments; Vittorio Garilli (Palermo) for polishing the English and for helpful comments. Douglas J. Eernisse (California State University, Fullerton, USA) and Julia Sigwart (Queen's University Belfast, Ireland) are thanked for their constructive comments on the manuscript.

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