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A REVISION OF THE MEDITERRANEAN PLIO-PLEISTOCENE DIMYIDAE FISCHER, 1886

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Key-words: Bivalvia, *Dimyidae*, Mediterranean, Plio-Pleistocene.

Riassunto. Viene proposta la revisione dei generi e delle specie appartenenti alla famiglia *Dimyidae*, presenti nell'area mediterranea durante il Plio-Pleistocene. In tale periodo di tempo solo due sono le specie della famiglia viventi nell'area, appartenenti a due diversi generi, di cui uno di nuova istituzione. Al genere *Dimya* appartiene *D. tenuiplicata*, un taxon che, già rinvenuto in sedimenti miocenici, sembra caratterizzare particolari ambienti di piattaforma esterna e di scarpata fino a tutto il Pleistocene superiore. Il nuovo genere *Emiliomya*, qui istituito, è stato finora rinvenuto, con la specie *malnatensis*, solo nel Pliocene inferiore della zona di Malnate (Varese, Italia settentrionale). Questa limitata distribuzione sembra attribuibile alla ecologia del taxon, legato probabilmente a particolari ambienti nelle zone di testata di canyons sottomarini.

Abstract. The revision of Mediterranean *Dimyidae* recorded from Plio-Pleistocene sediments has demonstrated the validity of *Dimya tenuiplicata* (Seguenza, 1879), occurring from Tortonian to Upper Pleistocene. The new Lower Pliocene genus *Emiliomya* is here suggested and described on the basis of specimens recovered in the northern Italy.

Introduction.

The present paper is dedicated to the revision of the dimyid genera and species which have inhabited the Mediterranean area during Plio-Pleistocene times. The bulk of the studied material was obtained from the Pliocene sediments of a well sinked near Malnate, Varese (Alps margin, Lombardia NW) (Cigognini, 1984; Corselli et al., 1985; Corselli & Bernocchi, in press) and from Upper Pleistocene sediments dredged off southwestern Sardinia (Corselli & Bernocchi, 1990). The rest comes from Upper Tortonian claystones (S. Agata Fossili Formation, Piedmont) (Robba, 1968), Lower Pliocene claystones of Tabiano (Emilia, Northern Italy) (Pelosio, 1966), Middle Pliocene sandstones of Rivarone (Piedmont) (Benigni & Robba, 1990).

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	Pectinacea			Plicatulacea	
	Pr	Pe	S	Pl	D
Cemented (C) or free (F)	F	F*	C	C	C
Prismatic (P) or Foliated (F) calcite	P	F	F	F	?***
Shell auricle (SA)	SA	SA	SA	-	-
Secondary teeth and sockets (TS)	-	-	-	TS	TS
Longitudinal (L) or Transverse (T) ligament	L	L	T	T	T
Overarching "external" secondary ligament (E)	-	-	-	E	E
Monomyarian (M) or Dimyarian (D)	M	M	M	M	D
Foot (F)	F	F	F	-	-
Free (F) or hood-like (H) palps	F	F	F	H	H
Simple (S) or arborescent (A) lips	S	A	A	S	S
Ctenidia: plicate (P), simple (S)	S	P	P	S	S***
Ctenidial ciliation (Atkins' type)	?	B(1b)	B(1a)	B(1a)	B(2b)****
Enlarged inner mantle folds (EMF)	EMF	EMF	EMF	-	-
Pallial eyes (E)	-	E	E	-	-
Gape of valves; wide (W) or narrow (N)	W	W	W	N	N

* Hinnites cemented, many byssally attached.

** Two genera with teeth on right (under) valve.

*** Descending lamellae only.

**** Same form as in *Heteranomia* but no rejection currents observed on ventral margins.

Tab. 1 - Characters of the families *Propeamussidae* (Pr.), *Pectinidae* (Pe) and *Spondylidae* (S) (superfamily Pectinacea) compared with those of the *Plicatulidae* (Pl) and *Dimyidae* (D) (proposed superfamily Plicatulacea). (After Yonge, 1975).

The family *Dimyidae* Fischer, 1886 includes dimyarian forms cemented by the right valve with a transverse internal ligament and a overarching "external" secondary ligament. The hinge is characterized by "secondary teeth and sockets"; the valves are narrowly gaping. The animal has hood-like palps, simple lips and simple ctenidia; the pallial eyes are absent (Yonge, 1975).

During the last twenty years allocation of *Dimyidae* within orders of the subclass *Pteriomorpha* has been the subject of repeated revisions based on new evidences and new points of view. According to the Treatise on Invertebrate Paleontology, the *Dimyidae* belong to the superfamily *Pectinacea* (Hertlein, Cox & Newell, 1969); this superfamily is placed by Newell (1969) in the suborder *Pteriina*, order *Pterioida* of the subclass *Pteriomorpha*.

Yonge (1975) established the new superfamily *Plicatulacea* to comprise the families *Dimyidae* and *Plicatulidae*. In fact, the two families share a conspicuous number of common characters (Tab. 1), differing only as regards the number of adductors. Ac-

Mediterranean Dimyidae

Subclass Autobranchia (in part)^o Cam.?-Rec.

Superorder Isofilibranchia^o Ord.-Rec.

Order Mytiloida^o Ord.-Rec.

Superfamily Mytilacea Ord.-Rec.

Superorder Prionodonta^o Ord.-Rec.

Order Arcoida Ord.-Rec.

Superfamily Cyrtodontacea Ord.-Dev.

Superfamily Arcacea Dev.-Rec.

Superfamily Limopsacea Perm.-Rec.

Superorder Pteriomorphia^o Ord.-Rec.

Order Pterioidea^o Ord.-Rec.

Suborder Pteriina^o Ord.-Rec.

Superfamily Pteriacea Ord.-Rec.

Suborder Pinnina* Dev.-Rec.

Superfamily Pinnacea Dev.-Rec.

Order Limoida* Ord.?-Rec.

Superfamily Limacea Ord.?-Rec.

Order Ostreoida* Ord.?-Rec.

Suborder Ostreina^o Perm.?-Rec.

Superfamily Ostreacea^o Perm.?-Rec.

Superfamily Dimyacea* Jur.-Rec.

Superfamily Plicatulacea* Trias.-Rec.

Suborder Pectinina* Ord.?-Rec.

Superfamily Aviculopectinacea* Ord.?-Jur.

Superfamily Buchiacea* L.Carb.-Cret.

Superfamily Pectinacea^o L.Carb.-Rec.

Family Propeamussiidae^o L.Carb.-Rec.

Family Pectinidae^o Trias.-Rec.

Family Syncyclonemidae* Cret.-Rec.

Family Spondylidae Jur.-Rec.

Superfamily Anomiacea Perm.-Rec.

Position uncertain

Superfamily Ambonychiacea Ord.-Jur.?

^oEmended with respect to taxonomic content or concept appearing in Newell (in Moore 1969: 248) or not appearing in that work. Only the extant families of the Pectinacea are listed.

* New taxon.

Tab. 2 - Classification of bivalve subclass Autobranchia according to Waller, 1978.

According to Yonge (1975), the family name *Dimyidae*, even if proposed earlier, should not be used to denote a superfamily containing also a monomyarian family.

Waller (1978) rectified two morphological paradigms that have long been used in comparative anatomical studies of bivalves: (1) the primary ligament is three-layered, with the layers corresponding to three folds having clearly defined functions. According to Waller, the study of larval development indicate that the primary ligament is completely organic and that the mantle edge of *Bivalvia* is primarily twofold. Waller, on the basis of these morphological concepts and of data on shell ultrastructure, ligament, mantle edges, ctenidia, palps, lips, stomach, muscles, and photoreceptors, suggested a new taxonomic subdivision of the bivalves which have been previously grouped by Newell (1969, in Moore) in the subclass *Pteriomorpha*.

The new superfamily *Dimyacea* P. Fischer, 1886, together with *Plicatulacea* Watson, 1930 and *Ostreacea* Rafinesque, 1815, is included in the suborder *Ostreina* Ferussac, 1822 (emend.) (Waller, 1978) (Tab. 2).

Vokes (1979) seems to have overlooked Waller's report and, following Yonge, pointed out (in accordance with the Rules of Zoological Nomenclature) that the superfamily name must be *Dimyacea* and attributed to Fischer, 1886, although it was first used as of superfamily rank by Pilsbry (in Vokes, 1979).

The present authors do not consider the allocation of the family *Dimyidae* within higher categories which are left undetermined.

Remarks on the family *Dimyidae*.

According to Yonge (1975), the family *Dimyidae* contains the genera: *Dimyodon* Munier-Chalmas in Fischer 1886; *Dimyarina* Iredale, 1936; *Dimyella* Moore, 1969; *Basiliomya* Bayer, 1971; *Dimya* Rouault, 1850.

Cox and Hertlein (in Moore Ed., 1969) consider *Dimyarina* Iredale, 1936, a younger synonym of *Dimya* Rouault, 1850. We are in agreement with these authors and consider *Dimyarina* a younger synonym of *Dimya*.

Cox and Hertlein regarded *Dimyodon* Munier-Chalmas in Fischer, 1886 as having reached extinction during Middle Jurassic. According to Vokes (1979) *Dimyodon* occur from the Upper Triassic to middle Oligocene.

Of the other three taxa, still living in the Atlantic and/or Pacific Oceans, largely in deep water, only *Dimya* is known as fossil.

The genus *Dimya* Rouault, 1850.

Rouault (1850), describing the fossil contents of the Eocene sediments near Pau (France), established the new genus *Dimya*. The original description is the follow: "Testa adhaerens, inaequilateralis, inaequivalvis, inauriculata. Cardo edentulus; foveola in cardinis interno margine excipiens ligamentum. Duus impressiones musculares. Margo pallii plicatae." According to the author, the pallial impression of *Dimya* is wrinkled, like in *Plicatula*.

The description of the type-species *Dimya deshayesiana* Rouault, 1850 reads: "D. testa irregulari ovato-transversa, striis subtilibus et flammulaeformibus extus instructa." Rouault pointed out that the posterior muscle scar is considerably larger than the small anterior one. The former in the right valve is bilobed; the two lobes are separated by a transverse line (plate 15, fig. 3, in Rouault, 1850).

Cox & Hertlein (1969) reported the genus to range from Eocene to Recent.

The genus *Dimyodon* Munier-Chalmas in Fischer, 1886.

Fischer (1886) in his "Manuel de Conchyliologie", considered *Dimyodon* as a subgenus of *Dimya* Rouault, 1850 and published the figure given by Munier-Chalmas (Fig. 1). The original description of Fischer reads: "Bord dorsal horizontal; fossette ligamentaire bordée de chaque côté par un dent cardinale." The author designated *Dimyodon Schlumbergeri* Munier-Chalmas, 1886, a French Bathonian taxon, as type-species. Fischer's figure shows that the cardinal crura are strongly striated, and strictly adjacent to the resilifer.

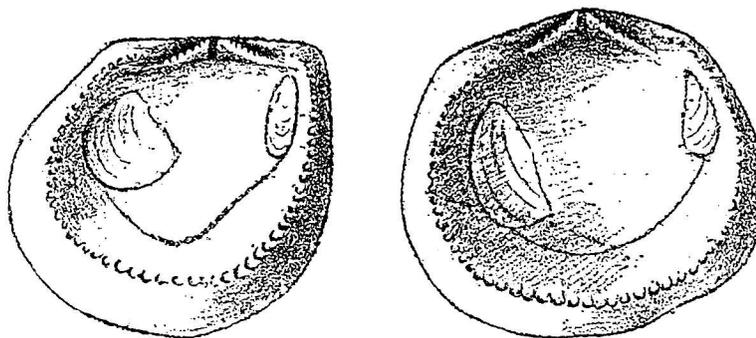


Fig. 1 - Original figure of *Dimyodon Schlumbergeri* Fischer, 1886, p. 937, fig. 705.

According to Vokes (1979), *Dimyodon* differs from *Dimya* Rouault, 1850, in having both the adductor scars located adjacent to the pallial line; moreover the posterior scar is not bilobed.

The stratigraphic distribution of the genus is controversial; according to Cox & Hertlein (1969) *Dimyodon* appears to be a Middle Jurassic taxon (Bathonian). On the contrary Vokes (1979), suggests a wider distribution, from Upper Triassic to Rupelian (Middle Oligocene).

The genus *Dimyella* Moore, 1969.

The original description by Moore (1969) is the follow: "The shell is small and flattened, and is attached by the right valve. The fixed valve is somewhat cupped when mature, but the free valve is flat or slightly convex. A brood chamber is partitioned off along the distal edge of the free valve after reaching maturity. The hinge is

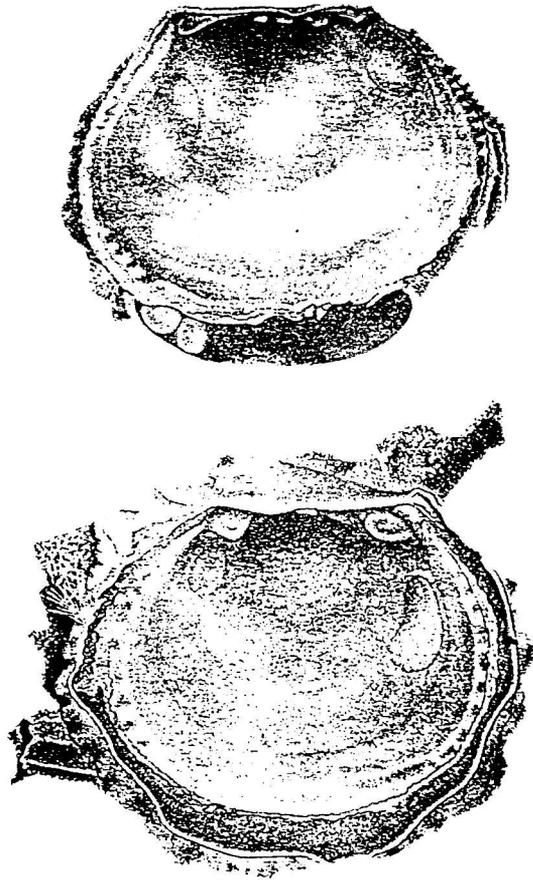


Fig. 2 - Original figure of *Dimyella starcki* Moore, 1969.

straight, and there is a strong tooth at each end of the hinge in the lower valve. There are small sockets in the upper valve which correspond with the hinge teeth. The ligament is a small triangular internal resilium which does not interrupt the hinge line. The adductor muscles are paired, the anterior small and the posterior considerably larger."

This description fully agrees with our observation on the paratype No: 1967617 (BMNH) of *Dimyella starcki* Moore, 1969 the type-species of this monospecific genus. According to Moore (1969), the specimen was found attached to the base of a coral recovered from a submerged cave in the Cozumel Island (Caribbean Coast of Mexico). This cave connects a small salt water lagoon with the sea. Fig. 2 Moore's original illustration reproduces.

Dimyella differs (Moore, 1969) from *Dimya*, *Dimyodon* and *Dimiarina* (= *Dimya* for Cox & Hertlein, 1969) by its smaller size, possession of conical teeth at the outer ends of the hinge, and by the brood chamber for the young. In particular, it differs from *Dimya* in lacking the small external ligament.

The genus is recorded only in the Caribbean Sea.

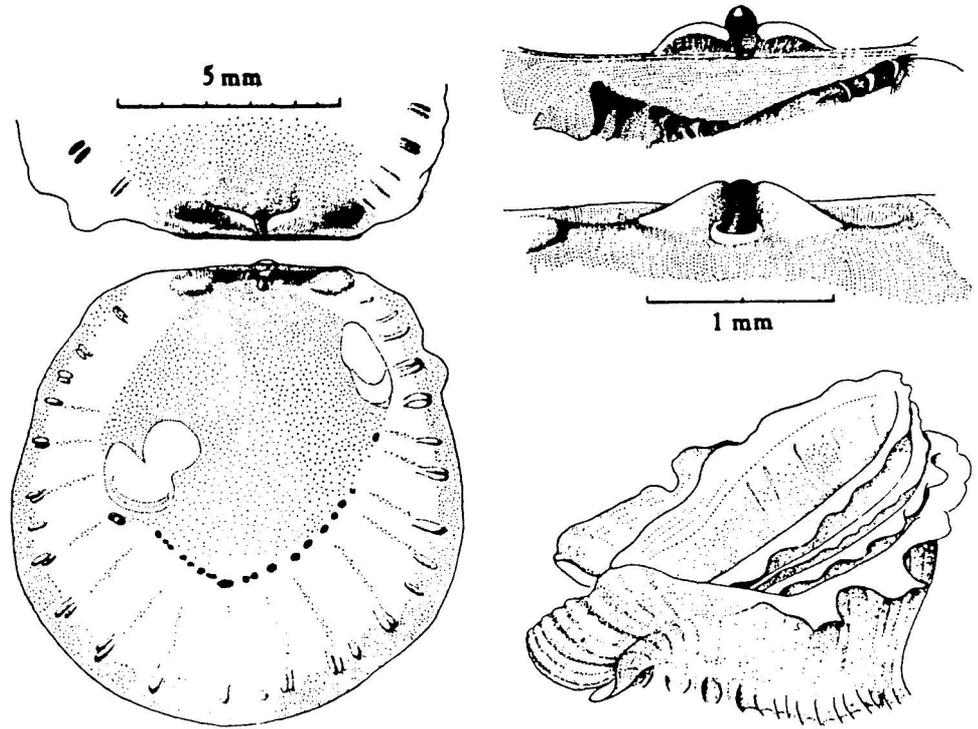


Fig. 3 - Original figure of *Basiliomya goreau* Bayer, 1971, p. 228, fig. 71.

The genus *Basiliomya* Bayer, 1971.

The original description is: "Shell subcircular in outline, translucent, with negligible iridescence; left valve smooth externally, but sometimes reproducing irregularities of the substrate; radial sculpture on outer surface of free margin of right valve; edge of right valve more or less widely extended as a thin, lobate marginal frill. Hinge of right valve with a blunt, triangular tooth on each side of the internal ligament and a shallow socket at each end of the hinge line; left valve with a shallow groove on each side of the internal ligament and a blunt tooth at each end of the hinge line; a series of interlocking small teeth and pits around the perimeter of both valves. Anterior adductor near end of hinge line; posterior adductor remote from hinge, conspicu-

ously bilobed, pallial impression marked by a row of shallow pits." According to Bayer (1971), the presence of an additional tooth at each end of the hinge line in the left valve and corresponding sockets in the right one as well as the presence of a distinctly bilobed posterior adductor impression represent diagnostic characters which distinguish *Basiliomya* from *Dimyodon*.

Fig. 3 shows *Basiliomya goreau* Bayer, 1971 the type-species of the genus. Yonge (1978) points out the presence of a delicate secondary periostracal ligament connecting the dorsal margin of the valves, not mentioned by Bayer (1971). *Basiliomya goreau* was found attached to the lower surface of scleractinian corals (- 170/200 feet).

This monospecific genus has a Caribbean distribution only.

Systematic descriptions

Family *Dimyidae* Fischer, 1886

Genus *Dimya* Rouault, 1850

Dimya tenuiplicata (Seguenza, 1879)

Text-fig. 4 a-i

1879 *Ostrea tenuiplicata* Seguenza, p. 123, tav. 12, fig. 1, 1a, 1b.

1886 *Dimya tenuiplicata* - Dall, p. 231.

1897 *Ostrea extenuiplicata* Sacco, p. 42.

1897 *Dimya fragilis miopliocenica* Sacco, p. 41, tav. 11, fig. 41-56.

1897 *Dimya fragilis crassiplicata* Sacco, p. 42, tav. 11, fig. 58.

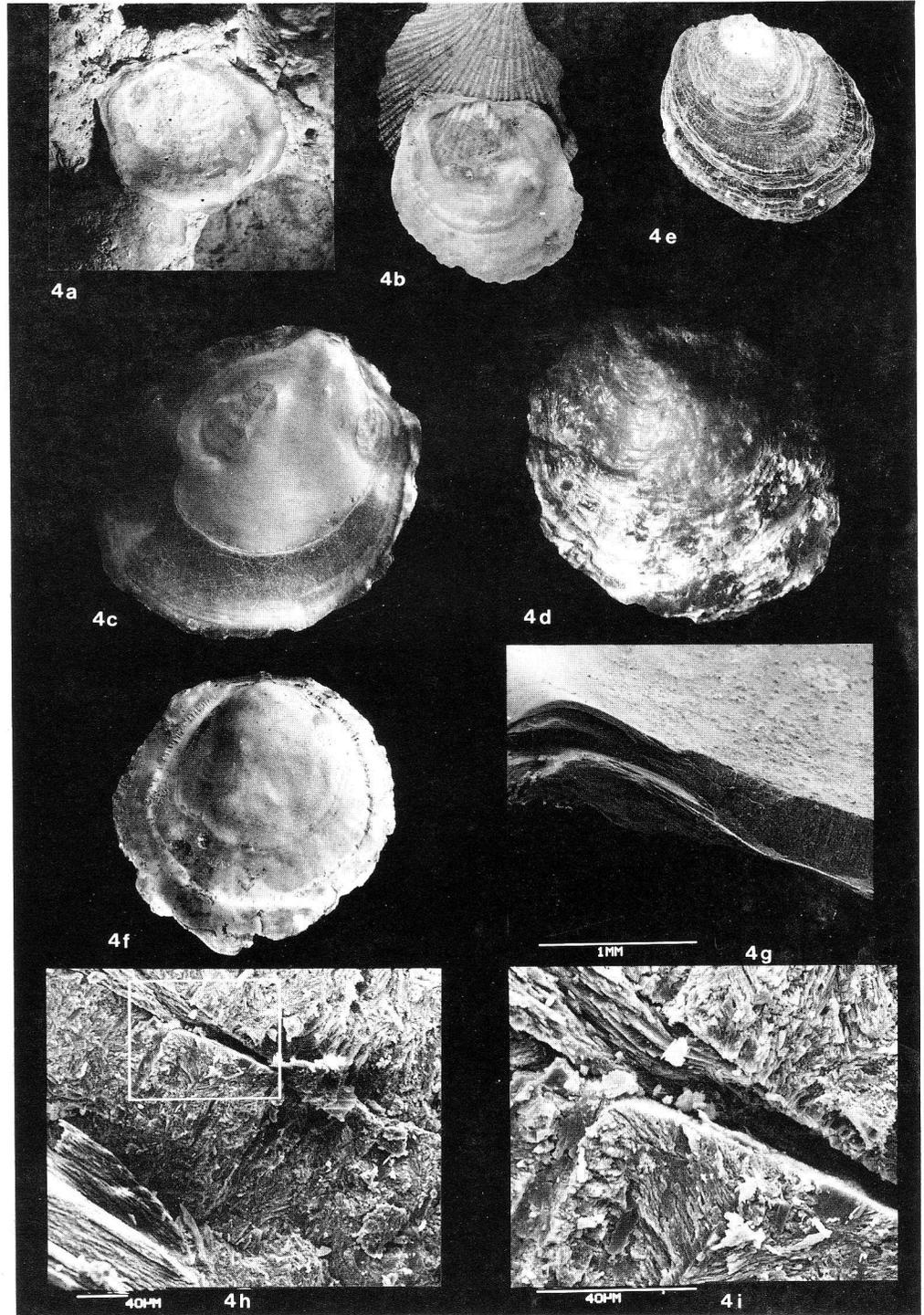
1966 *Dimya fragilis crassiplicata* - Pelosio, p. 171, tav. 47, fig. 20, 21.

1968 *Dimya fragilis miopliocenica* - Robba, p. 491, tav. 38, fig. 2 a-c.

1990 *Dimya tenuiplicata* - Benigni & Robba, p. 350.

Material examined. Station DT8 (-340 m), Upper Pleistocene off western Sardinia Island: 11 right valves attached to branches of *Madrepora oculata*, 8 left valves from the sediment. Rivarone (Piedmont), Middle Pliocene: 7 right valves attached to different bivalve shells or to stones, 3 left valves. Malnate (Lombardia NW), Lower Pliocene: 8 left valves. Tabiano (Emilia, Northern Italy), Lower Pliocene claystones (Tabianian Mayer, 1867): 2 left valves; Sant'Agata Fossili (Piedmont), Upper Tortonian: 2 right valves. The Pleistocene shells are rather well preserved; only some valves lack the umbonal area. The Neogene material is in a fair state of preservation.

Fig. 4 - *Dimya tenuiplicata* (Seguenza). a) Right valve (inner side), Upper Pleistocene, Sardinia; x 2.2. b) Right valve (inner side), Lower Pliocene, Rivarone; x 2.25. c, d) Left valve (inner side) (c), (external side) (d), Upper Pleistocene, Sardinia; x 4.5. e) Left valve (external side), Lower Pliocene, Tabiano; x 2.2. f) Left valve (inner side), Lower Pliocene, Malnate; x 4.6. g) Left valve, investigated area for shell microstructure, Upper Pleistocene, Sardinia. h) Transition from foliated and crossed-lamellar structure at the pallial line boundary. i) Detail of the transition.



Diagnosis. Original diagnosis given by Seguenza is the follow: "Testa parva, tenuis, ovata, utraque valva extus plicis tenuis, depressis, dichotomis, confertissimis, subsquamosis, radiatim dispositis praedita, intusque radiatim striata, margo prope cardinem tenuissime crispatus. Valva dextera concaviuscula ad umbonem convexo-gibbosa, concentrice squamosa; sinistra regulariter convexa; concentrice squamoso-lamellosa, parte adfissa maxima vel parva. Cardo parvus, canalis 1/3 latitudinis superans, parum profundatus, brevissimus, marginibus prominentibus, sulcis profundatis. Impressio muscularis ovato-oblonga utrinque profunde emarginata unde videtur sub-bipartita."

Description. Right valve outline irregularly ovate, broader behind. The external surface free parts of the shell bear growth lamellae and coarse divaricating radii. The shell material has a distinctly micaceous appearance, especially in the marginal areas. Hinge-line, generally straight, variable in length, depending upon nature of attachment; the umbonal area is small and bordered, on both sides, by a row of small and numerous radial riblets, that result in poorly developed cardinal crura. Resilifer placed strictly below the umbo area, forming a triangular deep pit. The pallial line is entire, and often bordered by rather distant radiating wrinkles aligned with the cardinal crura. There are two adductor muscle scars; the anterior, rather small, is elliptical in outline, elongated and appears to straddle the pallial line. The posterior is larger, bilobed and square in shape, and is located adjacent but inside of the pallial line.

Left valve outline irregular and obliquely sub-ovate, posteriorly elongated; prominent umbo area, dorsal margin sub-angular, others sub-rounded. External surface with growth lamellae having an irregular arrangement. Marginal area sculptured with low and irregular radial ribs. Inner side concave; resilifer placed below the umbo and weakly along-side of the dorsal margin. Cardinal crura present but poorly developed. There are two adductor muscle scars similar to those of the right valve. The pallial line bounds an internal area white in color and with a porcellanaceous coating.

The shell ultrastructural fabric is characterized by two different aspects depending on the investigated shell zone. Inside the pallial line a thin foliated structure overlies a very thick crossed-lamellar structure. Outside the pallial line only the foliated structure is present (Fig. 4 g-i) as pointed out by Waller (1978) for the superfamily *Dimyacea*. No prismatic outer layer has been found.

Remarks. Seguenza's (1879) figure of *Ostrea tenuiplicata*, in agreement with the original diagnosis, depicts a monomyarian bivalve. Dall (1886), comparing his *Dimya argentea* with specimens of Seguenza's species, pointed out the presence of two adductor scars. According to Dall, the taxon of Seguenza is an "undoubted *Dimya*" which differs from *Dimya deshayesiana* Rouault (1850) and from the Recent *Dimya argentea* Dall by the coarser sculpture and the position of the muscular impressions.

Sacco (1897) made no reference to Dall's remarks and, on the basis of Seguenza's figures, simply considered the taxon to belong to the genus *Ostrea*. In particular, since the name *Ostrea tenuiplicata* is preoccupied by a species of Sowerby, he renamed Seguenza's species *Ostrea extenuiplicata*. In his discussion Sacco noted many similarities

between *O. tenuiplicata* Seguenza, 1879 and *Dimya fragilis* von Koenen, 1893, the former lacking the characteristic double muscle impressions of *Dimya* only. For this reason the author referred his Neogene specimens from Northern Italy to *D. fragilis*.

Later authors, describing Neogene northern Italy specimens of *Dimyidae*, followed Sacco's opinion.

We compared some Neogene specimens of *Dimya fragilis miopliocenica* Sacco, 1897 and of *Dimya fragilis crassiplicata* Sacco, with Pleistocene *Dimya tenuiplicata* from Sardinian off shore, and can state that they are identical.

In our opinion Dall's assertion support that *Dimya tenuiplicata* (Seguenza, 1879) is to be regarded as a valid distinct species.

Stratigraphic range. Seguenza (1879) recorded *D. tenuiplicata* from Aquitanian and Upper Pliocene deposits of southern Italy; the latter age is probably Pleistocene according to modern stratigraphic assignments. The taxon resulted to be present also in Tortonian and Pliocene units of Northern Italy, and in Upper Pleistocene deposits of Sardinia.

The genus *Dimya* is actually, absent from the Eastern Atlantic Ocean and the Mediterranean Sea. Several species of *Dimya* are known in the Western Atlantic Ocean (Caribbean Sea) and in the Pacific Ocean.

Paleoecology. According to Corselli & Bernocchi (1990), *Dimya tenuiplicata* is an epifaunal member of a Pleistocene paleocommunity characterized by ahermatipic corals (*Madrepora oculata* and *Lophelia pertusa*) and by several molluscan species. The paleoenvironment was inferred to have been located at the transition between the circalittoral and the bathyal zones (sensu Pérès & Picard, 1964).

Benigni & Robba (1990) regard *D. tenuiplicata* as a deep-circalittoral and bathyal element of a Micromorph Brachiopod-Pectinid Community inferred to have lived on a sandy bottom at an approximate depth of 150 m (Pliocene, Piedmont, Northern Italy).

The Recent species of the genus *Dimya* are inhabitants of outer shelf and continental slope (Vokes, 1979).

Genus *Emiliomya* gen. n.

Derivation of name. After Prof. Emilio De Domenico, marine biologist at Messina University.

Diagnosis. Shell small, averaging 5 mm in length and 4.5 mm in height (max. respectively 9 and 6 mm), round to roundly ovate in outline, inequivalve, attached by the right valve; left valve smaller, fitting inside the outer edges of the right valve.

Right valve. Hinge with strong cardinal crura on each side of the resilifer, but spaced out and close to the dorsal margin; dorsal side of the crura strongly striated. Internal ligament located in a triangular pit. Anterior adductor scar elongate, elliptical, impressed on the pallial line dorsal to mid-height of the visceral area of the valve; posterior scar larger, roundly ovate, well removed from the end of the hinge line, bilobed. Internal margins crenate.

Left valve. Hinge with two sockets corresponding to the crura of the right valve, sometimes with raised margins and internally striated. Resilifer, adductor scars and margins as in the right valve.

Type species. *Emiliomya malnatensis* sp. n., here designated.

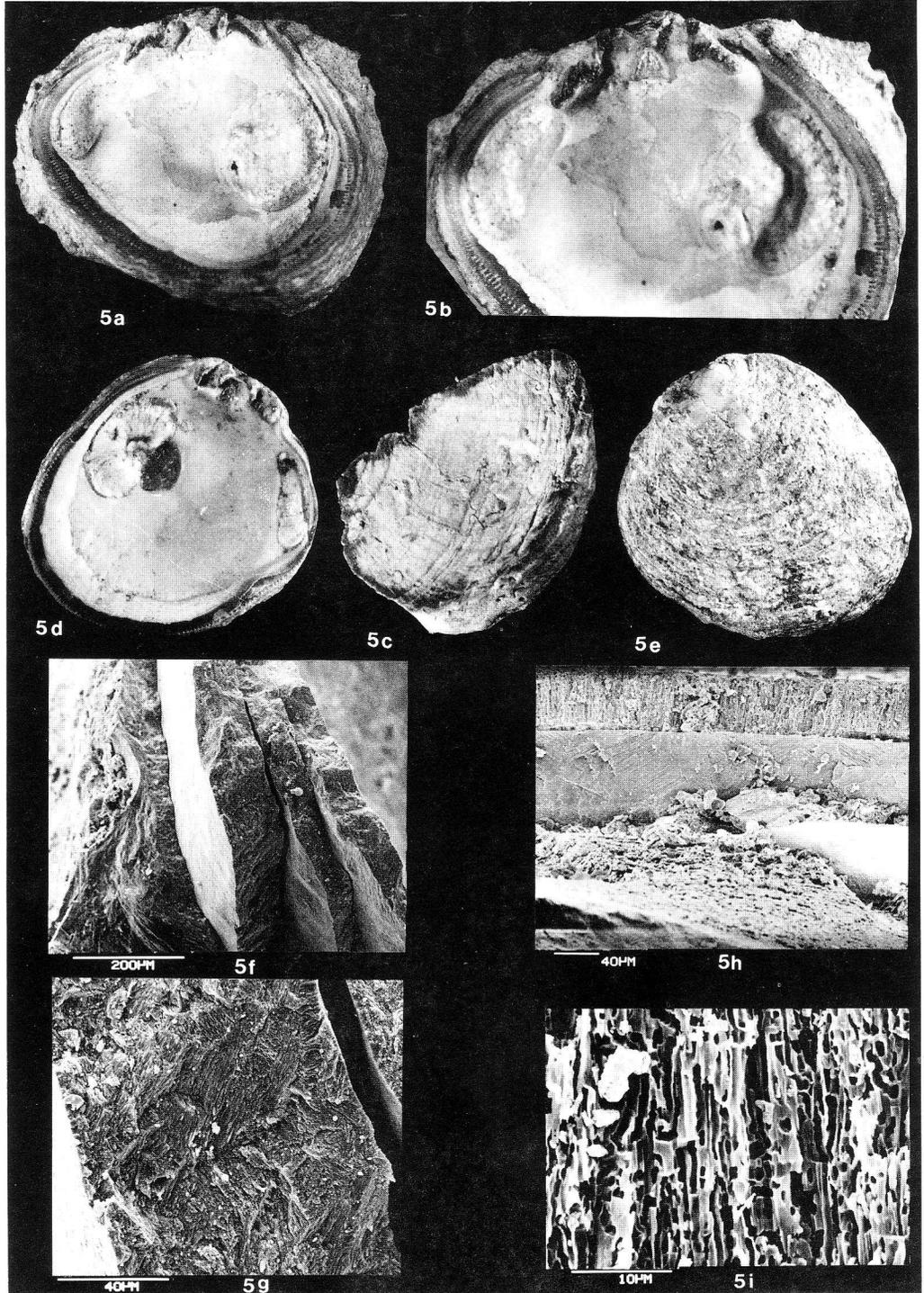
Remarks. This distinctive genus differs from the other known genera of the family by its peculiar hinge (two strong cardinal crura on the right valve, and corresponding sockets on the left valve). Moreover it is distinguished from *Dimya* Rouault, 1850 also by its stronger shell, and from *Dimyodon* Munier-Chalmas in Fischer, 1886 in having the posterior adductor impression distinctly bilobed, whereas that genus has a simple one. *Emiliomya* lacks the brood chamber for the young, present in *Dimyella* Moore, 1969. In respect to *Basiliomya* Bayer, 1971 which bears the tooth at the each end of the hinge line on the left valve, the present new genus has cardinal crura on the right valve.

Tab. 3 shows the most significant differences among *Emiliomya* and the other genera of *Dimyidae*.

Genus	hinge	p.a scar shape	resilifer
<i>Emiliomya</i>	r.v. 2 strong cardinal crura l.v. 2 sockets corresponding	bilobed	triangular pit
<i>Dimya</i>	cardinal crura short and weak	bilobed	small, triangular pit-like socket
<i>Dimyodon</i>	cardinal crura prominent elongated and transversally striated	not bilobed	strictly bordered by cardinal crura
<i>Dimyella</i>	r.v. a strong conical tooth at each end of the hinge l.v. small sockets corresponding with the hinge teeth	bilobed	small located under the centre of the hinge plate
<i>Basiliomya</i>	r.v. a blunt, triangular tooth on each side of the internal ligament and a shallow socket at each end of the hinge line l.v. a shallow groove on each side of the resilifer and a blunt tooth at the each end of the hinge line	bilobed	r.v. an umbonal depression flanked on both side by a low bluntly triangular tooth l.v. a subumbonal pit

Tab. 3

Fig. 5 - *Emiliomya malnatensis* sp. n. a) Holotype, right valve (inner side), MPUM 6649; Lower Pliocene, Malnate; x 5.8. b) Holotype, detail of the hinge line, MPUM 6649; x 6.9. c) Paratype, right valve, MPUM 6659, xenomorphic aspect of the external side; Lower Pliocene, Malnate; x 5.4. d, e) Paratype, left valve, inner side (d), external (e), MPUM 6651, Lower Pliocene, Malnate; x 6. f) Paratype, right valve, MPUM 6652, investigated area for shell microstructure, Lower Pliocene, Malnate. g) Paratype, right valve, MPUM 6652, crossed lamellar microstructure, Lower Pliocene, Malnate. h) Paratype, MPUM 6652, shell ultrastructure fabric, muscle scar area. i) Detail of the irregular prismatic structure of the myostracum; Lower Pliocene, Malnate.



Emiliomya malnatensis sp. n.

Text-fig. 5 a-i

Derivation of name. After the town off Malnate (Varese, northern Italy).

Types. Holotype: right valve 9 mm long by 7.5 mm high (Fig. 5 a, b). Museo di Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Milano, no. 6649.

Paratypes. All paratypes were found in the same level of the holotype. 26 right valves and 31 left valves. The length average is 5 mm (max 9 mm), the height average 4.7 mm (max 6 mm). The paratypes are housed in the Museo di Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Milano, no. 6650, 6651, 6652, 6653/1-25, 6654/1-30.

Type locality. Bagoderi well near Malnate (Varese, Lombardia NW).

Horizon. Muddy sands of level -81/-85 m, Lower Pliocene.

Diagnosis. Shell small, round to roundly ovate in outline, inequivalve, attached by right valve; strong cardinal crura on each side of the triangular resilifer of the right valve. Two adductor scars, anterior elliptical, elongate, posterior larger, ovate, bilobed. Left valve with two sockets corresponding to the crura of the right valve; resilifer and adductor scars as in the right valve. Surface unsculptured.

Description. Shell inequivalve, more or less irregular in shape, depending on the morphology of the attachment area, but usually roundly ovate and tending to be slightly produced posteriorly. Shell attached through the right valve which is larger than the left one; the latter fitting inside the outer edge of the former.

The right valve as a more or less strongly up turned ventral margin rising vertically from the substrate, hence the valve is deep. Dorsal margin usually short and straight or slightly arched. Hinge line characterized by two strong, generally straight, cardinal crura parallel to the dorsal margin; normally they are strongly striated on the dorsal side. Slight modifications in shape of the crura can occur during individual growth, due to the morphology of the attachment surface. The resilifer is a triangular socket recessed at the top of a calcareous process. This is located in between the crural teeth and takes up to a third of the available space. The height of the calcareous process is related to the growth modifications of the whole shell.

The outline of the two adductor muscle scars, commonly deeply impressed, greatly depends on individual shape of the valve. However the anterior is elliptical, closer to hinge area and appearing to straddle or terminate the pallial line. The posterior scar, roundly ovate and well removed from the end of the hinge line, is bilobed; the outer lobe tends to be more impressed than the inner one, reaching the pallial line. This latter is devoid of sinus and defines a white chalky coating area, which in some specimens can touch the margins. These, except for the dorsal one, are thinly crenate. External surface inside of the attachment areas, is characterized by xenomorphic sculpture; outside it is ornamented by irregular and coarse radial ribs.

Left valve flat to concave, more or less thick probably in accordance with the right valve shape; hinge characterized by two sockets in correspondence with the cardinal crura of the right valve. These sockets, commonly striated on the internal sides, may be surrounded by an irregular calcareous "wall", rising from the shell floor. In

some specimens sockets and surrounding "walls" are similar to decaying teeth. The resilifer, similar to that of the right valve is less prominent. Adductor scars and margins as in the right valve. External surface showing growth lamellae micaceous in appearance.

Shell microstructure. The architectural patterns of *Emiliomya malnatensis* shell are those typical of the family *Dimyidae* (Waller, 1978). There are two shell layers secreted by the mantle; an outer foliated layer, generally thin, and an inner very thick crossed-lamellar structure (Fig. 5 f-h). Usually a large myostracum, with an irregular prismatic structure, is present (Fig. 5 i).

Stratigraphic range. Lower Pliocene.

Paleoecology. The species is an epifaunal element, attached to small hard substrata (i.e. shells, corals, stones), and is supposed to have inhabited the deeper part of the continental shelf and the upper continental slope. In particular, the autochthonous thanatocoenosis including *Emiliomya malnatensis* is referable to a paleobiotope transitional between continental shelf and slope, probably on the higher part of a submarine canyon (Corselli, personal data; Corselli et al., 1985; Corselli & Bernocchi, in press).

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