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Late Eocene brachiopods from the Euganean Hills (NE Italy)

MARIA ALEKSANDRA BITNER¹ & IGINIO DIENI²

Key words: Brachiopoda, new taxa, Upper Eocene (Priabonian), Euganean Hills, Italy

Parole chiave: Brachiopodi, nuovi taxa, Eocene superiore (Priaboniano), Colli Euganei, Italia

ABSTRACT

Five species belonging to five genera and an unidentified rhynchonellid have been recognised in a Late Eocene (Priabonian) brachiopod assemblage from Castelnuovo in the Euganean Hills, north-eastern Italy. One genus and two species are new, i. e. *Venetocrania euganea* gen. et sp. nov. and “*Terebratula*” *italica* sp. nov. *Orthothyris pectinoides* (VON KOENEN 1894) is recorded for the first time from Italy. The other species are *Terebratulina* sp. cf. *T. tenuistriata* (LEYMERIE 1846) and *Lacazella mediterranea* (RISSO 1826), both already known from the Italian Eocene.

RIASSUNTO

Viene descritta un'associazione di brachiopodi del Priaboniano superiore raccolta entro marne contenenti lave a cuscini di composizione basaltica affioranti nei dintorni di Castelnuovo nei Colli Euganei, in provincia di Padova (Italia NE). Essa è costituita da cinque specie appartenenti ad altrettanti generi e da un rhynchonellide non identificato. Un genere e due specie, *Venetocrania euganea* gen. nov., sp. nov. e “*Terebratula*” *italica* sp. nov., sono di nuova istituzione. Una specie, *Orthothyris pectinoides* (VON KOENEN 1894), viene trovata per la prima volta in Italia, mentre le altre due specie, *Terebratulina* sp. cf. *T. tenuistriata* (LEYMERIE 1846) e *Lacazella mediterranea* (RISSO 1826), erano già state segnalate nell'Eocene italiano.

1. Introduction

Since brachiopods are relatively rare in the Eocene of Europe, their occurrence is always of particular interest. Although the brachiopods from the Eocene of Italy have been described or mentioned in several, mainly older, publications (Bayan 1870; Davidson 1870; Oppenheim 1896, 1901, 1903; Sacco 1902; Fabiani 1913; Dainelli 1915; Altichieri 1992), they have never been redescribed or revised in modern terms. The material collected in the Euganean Hills contains five micromorphic species and fragments of one large unidentified rhynchonellid. Two taxa are new, and one species is recorded for the first time from Italy.

This work is part of a research programme by the Department of Geology, Palaeontology and Geophysics of the University of Padua which aims to study some of the less common palaeontological taxa of a marly formation of Early Eocene–Early Oligocene age known as “Marna Euganea” (Euganean Marl) which crops out in the Euganean Hills, to the south-west of Padua. Following work on the verrucid cirripedes (Carriol

& Dieni, in press), this paper marks the continuation of the systematic description of the various organisms (brachiopods, crinoids, bryozoans, etc.) that compose the epibenthic fauna colonising basaltic pillow lavas within the Priabonian part of the Euganean Marl.

2. Geological and stratigraphical setting

In 1963 Dieni & Proto Decima highlighted the presence in the Euganean Hills, to the south-west of Padua, of a particularly interesting exposure of basaltic pillow lavas within marly beds characterized by an unusual fauna of Priabonian age. The exposure is located some 600 metres south-east of Castelnuovo (Teolo district), at the beginning of the street (Via Siesa) which branches off from the main road to Torreglia and leads to Case Gastaldello (Fig. 1). This area is particularly rich in submarine basaltic materials (lava flows and hyaloclastic products) belonging to the first phase of the Euganean volcanism,

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Fig. 1. Sketch map of the Euganean Hills indicating (inset) the locality of Castelnuovo (Via Siesa, asterisk) where the Priabonian brachiopods were collected.

which occurred in the Late Eocene (De Vecchi & Sedeo 1974) and which can be correlated with similar eruptive episodes in the nearby Berici and Lessini mountains.

The widening of a cart track exposed a significant section (ten metres long and four metres high, today largely overgrown by weeds and shrubs) showing the relationship between the sedimentary and volcanic rocks. The extent of the exposure showing the pillow lavas is limited laterally and on the top by compact flow basalts which in turn are overlain by marl (Fig. 2A). The pillows are generally spherical or ellipsoidal, although there are some with irregular shapes. Their maximum length varies from 10 to 80 centimetres, most of them revealing a diameter around 20 centimetres. Single pillows found in contact are rare; generally they are completely isolated within the sedimentary material (Fig. 2B). This particular situation indicates that the pillows were not produced contemporaneously during a single submarine effusive event, but are the result of several short episodes separated by periods of quiescence when sediment deposition continued. The sediment is represented essentially by greyish-yellow marl altogether similar to that which is widespread across the entire Euganean region (=Marna Euganea Formation, Early Eocene-Early Oligocene age) above the Scaglia Rossa Formation (Late Cretaceous-Early Eocene age). In some beds angular palagonitized glassy lava debris is mixed up with the marl. This material (hyaloclasts) derived from the progressive breaking up of the

skin of the pillows during their development and growth, accords well with the mechanism suggested by Rittmann (1958).

Even with the naked eye one can see that the marl surrounding the individual pillows is very rich in crinoidal debris, especially columnals, so much that this facies is known in the regional geological literature as "Marna a crinoidi di Castelnuovo" (Castelnuovo crinoid-bearing marl).

In order to reach a precise bio- and chronostratigraphic assignment of the marly beds with pillows, already referred by Dieni & Proto Decima (1964, p. 555) to the "parte alta dell'Eocene superiore", their planktic foraminiferal content was examined. Among the taxa recovered (Figs. 3A-F) the following are important:

Cribrorhantkenina inflata (HOWE 1928), *Cribrorhantkenina lazzarii* (PERICOLI 1958), *Globigerinatheka index tropicalis* (BLOW & BANNER 1962), *Hantkenina alabamensis* CUSHMAN 1925, *Hantkenina suprasuturalis* BRÖNNIMANN 1950, *Pseudohastigerina micra* (COLE 1927), *Subbotina gortanii* (BORSETTI 1959), *Turborotalia cocoaensis* (CUSHMAN 1928), *Turborotalia cunialensis* (TOUMARKINE & BOLLI 1970).

This association clearly suggests correlation with the *Turborotalia cunialensis*/*Cribrorhantkenina inflata* Concurrent-Range Zone (P 16) of the plankton biostratigraphic scale introduced by Berggren et al. (1995) and particularly the *Cribrorhantkenina lazzarii*/*Cribrorhantkenina inflata* Concurrent-Range Subzone proposed by Coccioni et al. (1988), which both indicate a late Priabonian age.

From a quantitative point of view, excluding the foraminifers, verrucid cirripedes (Carriol & Dieni, in press) and crinoids (Dieni & Jagt, in progress) are most numerous within the marl containing the pillows. In contrast, brachiopods are rare.

3. Material and methods

All the studied brachiopods are from one exposure at Castelnuovo of Teolo (via Siesa) (Figs. 1, 2) and were obtained by processing bulk samples (total amount 3 kg) of sediment surrounding the basaltic pillows. The process, consisting of disaggregation, washing and screening followed by picking under the microscope, isolated 93 specimens (59 complete tests, 34 separated valves) and many fragments.

The investigated material is deposited in the collections of the Museo di Geologia e Paleontologia dell'Università di Padova (acronym MGPD).

4. Systematic palaeontology

Phylum Brachiopoda DUMÉRIL 1806

Subphylum Craniiformea POPOV, BASSETT, HOLMER & LAURIE 1993

Class Craniata WILLIAMS, CARLSON, BRUNTON, HOMLER & POPOV 1996

Order Craniida WAAGEN 1885

Superfamily Craniioidea MENKE 1828

Family Craniidae MENKE 1828

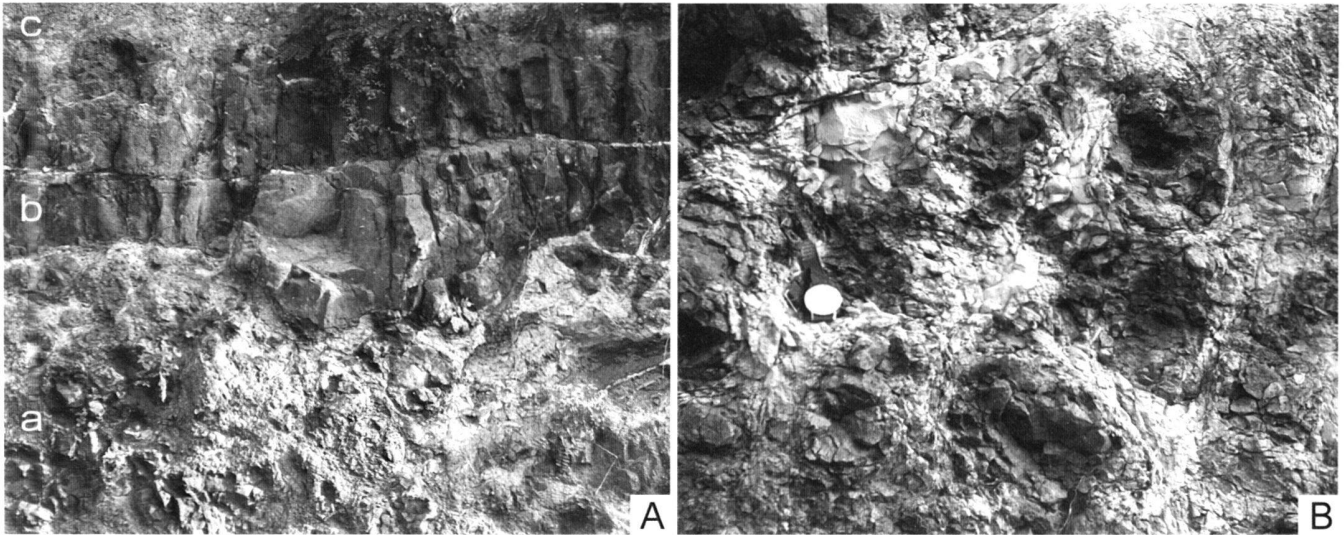


Fig. 2. Exposure of basaltic pillow lavas within marl of late Priabonian age along the initial stretch of Via Siesa at Castelnuovo in the Euganean Hills. A: general view showing that marl and pillow lavas as a whole (a) are overlain by a basaltic flow about 1 m thick (b) (in turn capped by marl devoid of volcanic products, c), with load casting at the base. B: detail of the exposure showing that in most cases the pillows are not in mutual contact. The marl around the pillows is very rich in remains of crinoids and verrucid cirripedes originally living cemented on them.

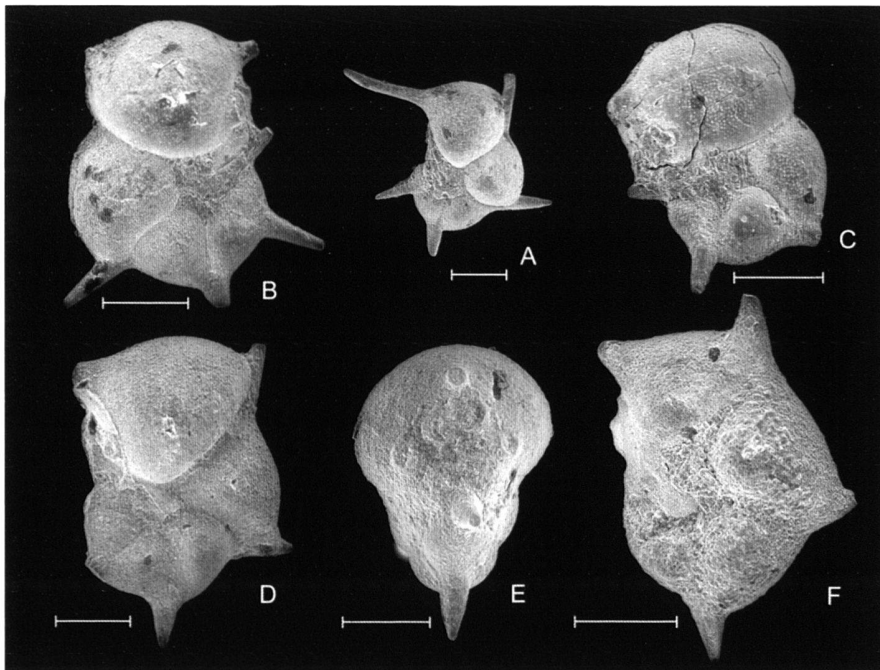


Fig. 3. Some planktic foraminifers associated with the Euganean Priabonian brachiopods: A: *Hantkenina alabamensis* CUSHMAN; B-E: *Cribrohantkenina inflata* (HOWE); F: *Cribrohantkenina lazzarii* (PERICOLI). SEM photos. Bar length: 200 μ m.

Genus *Venetocrania* gen. nov.

Type species. – *Venetocrania euganea* gen. et sp. nov.

Diagnosis. – Small, subcircular craniid shell with rough surface, narrow rim, large, circular posterior adductor muscle scars and anterior adductor muscle scars forming narrow, high ridges.

Etymology. – From Veneto, the region where the Euganean Hills are situated, and *Crania*.

Remarks. – The new genus *Venetocrania* differs markedly from the cosmopolitan genus *Novocrania* LEE & BRUNTON 2001, known from the Eocene to Recent. *Novocrania* has smaller,

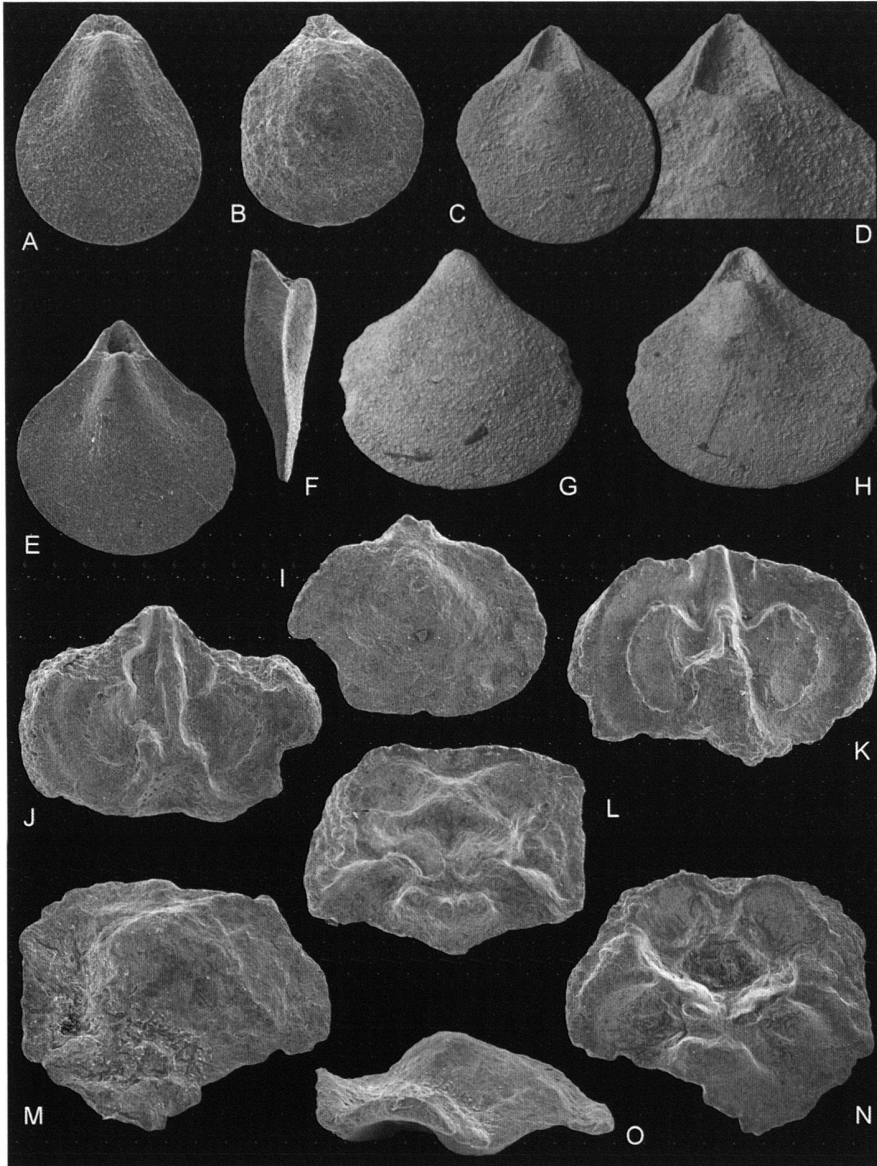


Fig. 4. A–H: “*Terebratulina italica* sp. nov.; A–B: dorsal views of juvenile complete specimens, MGPD 28980 and 28981, x 40; C–D: complete specimen, paratype, MGPD 28982 (C: dorsal view, x 26; D: enlarged of C to show details of the posterior part of the shell, x 60); E–F: dorsal and lateral views of complete specimen, holotype, MGPD 28979, x 26; G–H: ventral and dorsal views of complete specimen, paratype, MGPD 28983, x 26. I–K: *Lacazella mediterranea* (Risso 1826), dorsal valves, x 13; I: outer view, MGPD 28994; J–K: inner views, MGPD 28995 and 28996. L–O: *Venetocrania euganea* gen. et sp. nov., dorsal valves, x 13; L: inner view, paratype, MGPD 28978; M–O: outer, inner and lateral views, holotype, MGPD 28977. All SEM photos.

more separated posterior adductor muscle scars and oval, small anterior adductor scars, situated medially (Lee & Brunton 1986, 2001). *Venetocrania* has anterior adductor muscle scars raised on ridges, similar to the genus *Craniscus* DALL 1871 (see Lee & Brunton 1986, p. 146) but the valve interior of the latter genus is partitioned into three sections by three wall-like septa.

***Venetocrania euganea* gen. et sp. nov.**

(Figs. 4L–O)

Holotype. – Specimen MGPD 28977, figured on Figs. 4 M–O.

Type horizon and type locality. – Castelnuovo in the Euganean Hills (Padua Province, NE Italy); marl with pillow lavas of late Priabonian age cropping out at Via Siesa (Fig. 1).

Etymology. – Geographic name, from the Euganean Hills, type area of the taxon.

Diagnosis. – As for the genus.

Material. – Three dorsal valves.

Dimensions. – Length 2.5 mm, width 2.9 mm.

Description. – Shell outline subcircular with straight posterior margin, wider than long. Dorsal valve slightly conical (Fig. 4O) with eccentric umbo directed posteriorly. Shell surface is rough, irregular, no growth lines visible. The rim is very narrow. A pair of large, subcircular posterior adductor muscle scars is situated near the hinge line. Anterior adductor muscle scars form narrow, high ridges diverging from near the centre towards the lateral margins. Beneath them there is an attachment scar for brachial protractor muscles shaped as a horizontal oval elevation.

Remarks. – Several species of craniids have been described from the Eocene deposits of Europe, including Italy, nevertheless none of them is similar to the specimens collected at Castelnuovo. *Crania bayaniana* DAVIDSON 1870, from the Upper Eocene of Italy, differs in having a wide, pustulate rim and distinct growth lines with numerous, small spines (Davidson 1870; Oppenheim 1901; Fabiani 1913; Altichieri 1992). The investigated Priabonian specimens differ also from the Middle Eocene *Crania fabianii* DAINELLI in Fabiani 1913, of NE Italy, which has regular growth lines, much smaller posterior adductor muscle scars and anterior adductor muscle scars forming two small, transversally oval ridges joined medially (Fabiani 1913; Dainelli 1915). Davidson (1874) described a new species *Crania nysti*, from the Eocene of Belgium, which was considered by Vincent (1893) to be synonymous with *C. adani* MALZINE 1867. This species is externally similar to the studied specimens, but it differs in the muscle scar pattern. Its posterior adductor muscle scars are separated from each other by a flat space, while the anterior adductor muscle scars form irregularly oval ridges, diverging from the centre towards the posterior lateral margin. It is worth mentioning that in the revision of Craniidae, Lee & Brunton (1986) attributed *C. nysti* to their genus *Novocrania*.

Makarenko (1974) described *Crania belokrysi* from the Upper Eocene of Ukraine; this is externally similar to the specimens discussed here but differs in being much larger and having small, oval anterior adductor muscle scars.

Subphylum Rhynchonelliformea WILLIAMS, CARLSON, BRUNTON, HOLMER & POPOV 1996

Class Rhynchonellata WILLIAMS, CARLSON, BRUNTON, HOLMER & POPOV 1996

Order Rhynchonellida KUHN 1949

Rhynchonellid gen. et sp. indet.

Remarks. – The material consists of four fragments, one of them of the posterior part. The impunctate shell and a tooth supported by a short dental plate visible in one fragment indicate that these fragments belong to the Rhynchonellida. The absence of other diagnostic features precludes any more precise taxonomic assignment.

Order Terebratulida WAAGEN 1883

Family uncertain

“Terebratula” italica sp. nov.

(Figs. 4A–H)

v. ? 2000 *“Terebratula”* n. sp.; Bitner: 124, figs. 7, 8.

Holotype. – Specimen MGPD 28979, figured on Figs. 4E–F.

Type horizon and type locality. – Castelnuovo in the Euganean Hills (Padua Province, NE Italy); marl with pillow lavas of late Priabonian age cropping out at Via Siesa (Fig. 1).

Etymology. – Geographic name referring to the country where the species was found.

Diagnosis. – Micromorphic, smooth terebratulid species with large, hypothyrilid foramen restricted by rudimentary deltidial plates, short, straight hinge line, and rectimarginate anterior commissure.

Material. – 24 complete specimens and one ventral valve.

Dimensions (in mm). –

Specimen no.	Length	Width	Thickness
MGPD 28984	1.0	0.8	0.3
MGPD 28982 (paratype)	1.1	0.9	0.3
MGPD 28983 (paratype)	1.1	1.05	0.4
MGPD 28979 (holotype)	1.2	1.1	0.4

Description. – The shell is very small (max. length 1.3 mm) and thin. The outline is variable from ovaly elongate to circular. The shell is weakly biconvex, smooth with no growth lines visible, densely punctate. The beak is moderately long, nearly straight to suberect. The hypothyrilid foramen is very large, triangular, bordered by two very narrow deltidial plates. The hinge line is short, straight to slightly curved. Two weakly defined ears are present between hinge line and posterior sides. The anterior commissure is rectimarginate. The teeth are small without dental plates. The internal characters of the dorsal valve are unknown.

Remarks. – Similar micromorphic, smooth terebratulid brachiopods with uncertain systematic positions have been reported from the Lower Paleogene of Europe (Elliott 1954; Pajaud & Tambareau 1970; Pajaud & Plaziat 1972; Bitner 2000). Because of the absence of any characteristic features, except punctation, their assignment to a particular genus was very difficult. Thus, the informal generic name *“Terebratula”* was adopted for those brachiopods. As the studied specimens present the same problem, following previous workers they have been also attributed informally to *“Terebratula”*.

The specimens from the Euganean region, although being much smaller, are similar in having triangular, hypothyrilid pedicle opening with incipient deltidial plates and rectimarginate anterior commissure to *“Terebratula”* n. sp. from the Lower Eocene of north-eastern Spain described by Bitner (2000, p. 124, fig. 7). However, the significant difference in size (the Spanish specimens are more than twice as large) raises some doubts about their possible conspecificity.

The rectimarginate anterior commissure of the investigated specimens resembles also that of *“Terebratula” cogidumni* ELLIOTT 1954 from the Eocene of England, differing, however, in the outline of the foramen which is rounded oval in *“T.” cogidumni*.

Superfamily Cancellothyridoidea THOMSON 1926

Family Cancellothyrididae THOMSON 1926

Subfamily Cancellothyridinae THOMSON 1926

Genus *Terebratulina* D’ORBIGNY 1847

Type species. – *Anomia retusa* LINNAEUS 1758.

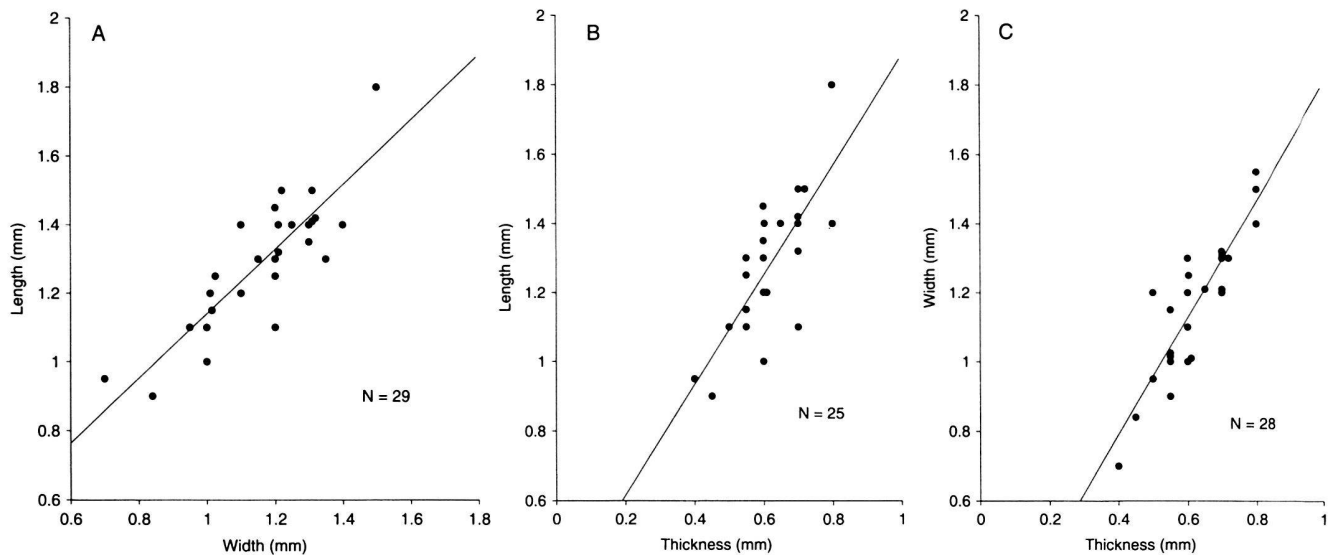


Fig. 5. Intraspecific variability of *Orthothyris pectinoides* (VON KOENEN 1894) from the Euganean Hills. Scatter diagrams plotting length/width (A), length/thickness (B) and width/thickness (C). N = number of specimens.

***Terebratulina* sp. cf. *T. tenuistriata* (LEYMERIE 1846)**

(Fig. 6A)

v. cf. 2000 *Terebratulina tenuistriata* (LEYMERIE); Bitner: 118, figs. 2, 3, 4A–F, 5A–G (cum syn.).

Material. – Three complete specimens, one ventral valve, four dorsal valves, and several fragments.

Dimensions. – Max. length 2.1 mm, width 1.4 mm, thickness 1 mm.

Remarks. – The studied material is represented only by juvenile specimens making specific determination difficult. The shell is elongate oval, biconvex with the surface covered with 7 to 9 single ribs, strongly granulate. The pedicle opening is large, restricted by two small, triangular, disjunct deltidial plates. The anterior commissure is rectimarginate. The cardinalia with the high inner socket ridges are typical of the genus. The specimens under study are probably juvenile representatives of *Terebratulina tenuistriata* (LEYMERIE 1846), an Eocene species widely distributed in Europe (e.g. Leymerie 1846; Doncieux 1905, 1926; Fabiani 1913; Elliott 1938; Bitner 2000) as they resemble specimens of similar size from Spain, assigned to *T. tenuistriata* by Bitner (2000, figs. 5B–D).

Family Chlidonophoridae MUIR-WOOD 1959
Subfamily Orthothyridinae MUIR-WOOD 1965

Genus *Orthothyris* COOPER 1955

Type species. – *Orthothyris radiata* COOPER 1955.

***Orthothyris pectinoides* (VON KOENEN 1894)**

(Figs. 5, 6B–N)

v. 1894 *Terebratulina pectinoides* v. KOENEN; von Koenen: 1354, pl. 99, figs. 8, 9, 1975 *Terebratulina pectinoides* VON KOENEN; Zelinskaya: 116, pl. 13, figs. 5–19.

Material. – 29 complete specimens, 5 ventral valves, 9 dorsal valves, and several fragments.

Dimensions (in mm; see also Fig. 5). –

Specimen no.	Length	Width	Thickness
MGPD 28987	1.2	1.1	0.6
MGPD 28988	1.4	1.2	0.6
MGPD 28993	1.5	1.3	0.7
MGPD 28989	1.8	1.5	0.8

Description. – The shell is very small (max. length 1.8 mm), circular to elongately oval in outline, unequally biconvex with the ventral valve more arcuate, to plano-convex. The shell surface is covered with distinct, rounded, bifurcating ribs that vary in number from 12 to 18. The surface microornament consisting of fine granules can be observed on the best preserved specimens (see Figs. 6E–F, H–I). On the ventral valve there is a wider median groove which corresponds internally to a low ridge. The hinge line is wide and straight to slightly curved. The foramen is small, subtriangular, hypothyrid, margined by elevated deltidial plates. The pedicle collar is present. The beak is high, erect, with strong, sharp ridges. The lateral commissure is slightly ventrally curved, while the anterior commissure is incipiently broadly sulcate. The teeth are short but wide without dental plates. The inner socket ridges are high extending beyond the posterior margin. The internal margin is weakly crenulated. Attempts to investigate the loop failed; however, very short crura and large, expanded, blunt crural processes have been observed, consistent with Coop-

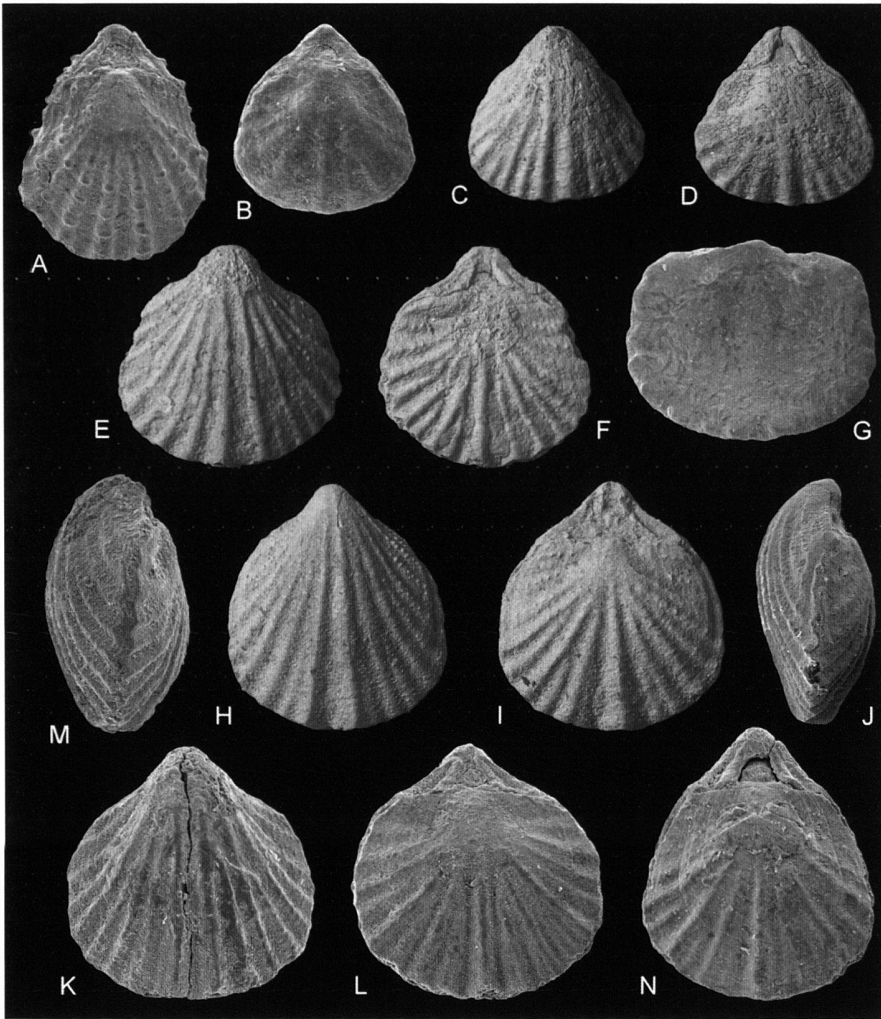


Fig. 6. A: *Terebratulina* sp. cf. *T. tenuistriata* (LEYMERIE 1846), dorsal view of juvenile complete specimen, MGPD 28985, x 18. B–N: *Orthothyris pectinoides* (VON KOENEN 1894); B: dorsal view of juvenile complete specimen, MGPD 28986, x 26; C–D: ventral and dorsal views of complete specimen, MGPD 28987, x 17; E–F: ventral and dorsal views of complete specimen, MGPD 28988, x 20; G: inner view of dorsal valve, MGPD 28992, x 20; H–J: ventral, dorsal and lateral views of complete specimen, MGPD 28989, x 16; K–M: ventral, dorsal and lateral views of complete specimen, MGPD 28990, x 26; N: dorsal view of complete specimen, MGPD 28991, x 26. All SEM photos.

er's (1973) observations concerning internal structures of *Orthothyris radiata* COOPER 1955, type species of the genus.

Remarks. – Earlier this species was attributed to the genus *Terebratulina* D'ORBIGNY 1847 (von Koenen 1894; Zelinskaya 1975). However, it differs from any *Terebratulina* species in the beak region by having a wide interarea bordered by sharp beak ridges and deltidial plates forming two elevations along the opening. Also the loop seems to lack a ring. Instead this species shows externally and internally all the characters typical of the genus *Orthothyris* created by Cooper (1955) for material from the Upper Cretaceous of Cuba. The Cretaceous *O. radiata* COOPER 1955 differs from *O. pectinoides* in being larger and in having simple ribs while the ribs on *O. pectinoides* are bifurcate.

The specimens from the Eocene of Germany and Ukraine, described respectively by von Koenen (1894) and Zelinskaya (1975), are slightly larger than those described herein.

This is the first record of this species from Italy.

Order Thecideida ELLIOTT 1958
Superfamily Thecideoidea GRAY 1840
Family Thecideidae GRAY 1840

Genus *Lacazella* MUNIER-CHALMAS 1881

Type species. – *Thecidea mediterranea* RISSO 1826.

***Lacazella mediterranea* (Risso 1826)**

(Figs. 4I–K)

1870 *Thecidium Mediterraneum* (Risso); Davidson: 407, pl. 21, figs. 17, 17a, 17b.

1970 *Lacazella mediterranea* (Risso); Pajaud: 128, text-figs. 50, 52, pl. 1, fig. 4; pl. 5, fig. 4; pl. 7, fig. 3; pl. 10, figs. 1–6; pl. 11, fig. 3; pl. 12, fig. 2; pl. 16.

1972 *Lacazella mediterranea* (Risso); Pajaud & Plaziat: 455, text-fig. 7, pl. 2, fig. 4.

1979 *Lacazella mediterranea* (Risso); Logan: 73, text-fig. 22, pl. 10, figs. 1–8.

Material. – 14 dorsal valves and several fragments.

Remarks. – The material consists only of dorsal valves possibly due to the mode of life of the species, e.g. *L. mediterranea* lives

cemented to the substratum by its ventral valve (at Castelnuovo the specimens were attached to pillow lavas). Despite the fact that the material is not well preserved and no complete valve was found, the characters observed are consistent with those of *L. mediterranea* (see Pajaud 1970; Logan 1979). The shell is very small, max. length of dorsal valve does not exceed 2.5 mm. The dorsal valve is of semi-circular to transversely oval in outline, almost flat with straight hinge line. The shell surface is smooth, growth lines not visible. The cardinal process is prominent, rectangular, extending beyond the hinge margin. The bridge in front of cardinal process is well developed. A trifurcating median septum is clearly visible in some specimens.

L. mediterranea has been reported from the Eocene deposits of Italy (Davidson 1870; Fabiani 1913; Pajaud 1970; Altichieri 1992). It was also collected from the Eocene of Poland (Popiel-Barczyk & Barczyk 1987) and Germany (von Koenen 1894; Oppenheim 1901). *L. mediterranea* was also recorded from the Upper Paleocene of the Spanish Basque Country (Pajaud & Plaziat 1972). Living today, it could be an example of an unusually long ranging species. On the other hand, this long range may merely demonstrate that *L. mediterranea* has so few characteristics that it is difficult to differentiate it from other possible species in the same genus.

5. Discussion

The Late Eocene (Priabonian) brachiopod assemblage from Castelnuovo in the Euganean Hills, north-eastern Italy, contains five micromorphic species and fragments of one unidentified large rhynchonellid. One genus and two species are new, *Venetocrania euganea* gen. et sp. nov. and "*Terebratulina*" *italica* sp. nov. Three other species, i.e. *Terebratulina* sp. cf. *T. tenuistriata* (LEYMERIE), *Orthothyris pectinoides* (VON KOENEN), and *Lacazella mediterranea* (RISSO) are already known from the Eocene, although *O. pectinoides* is reported for the first time from Italy.

If compared with the other Eocene assemblages hitherto described from Italy (Davidson 1870; Sacco 1902; Fabiani 1913), this fauna is much poorer in species and compositionally different. Only *Terebratulina* and *L. mediterranea* occur in all assemblages. The main feature of the Euganean assemblage is the absence of large smooth terebratulids as well as megathyrids which are numerous in other assemblages of this age. This difference may be due to the peculiarity of the sedimentary environment which was characterised by the presence of volcanic material.

Among the species considered here, only *Lacazella mediterranea* has a very long stratigraphical range and has representatives today in the Mediterranean Sea (Logan 1979) where it is regarded as a neoendemic species (Logan et al. 2004). Other species are limited to the Paleogene. From the ecological point of view the Castelnuovo fauna contains two groups. Three species, i.e. "*Terebratulina*" *italica*, *Terebratulina* sp. cf. *T. tenuistriata* and *Orthothyris pectinoides*, belong to

small, pedunculate taxa inhabiting soft, marly bottom. They attached either directly to the fine sediment by a root-like, divided pedicle (*Terebratulina*) or using very small patches of hard substrates ("*T.*" *italica* and *O. pectinoides*). The second group comprises the brachiopods that live cemented to the substrate by the ventral valve. *Venetocrania euganea* and *L. mediterranea* belong to this latter group. Their presence at Castelnuovo must be related to the rocky substrate formed by the basaltic pillows and hyaloclasts.

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