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GUADALUPIAN BRACHIOPODS FROM DJEBEL TEBAGA DE MEDENINE, SOUTH TUNISIA

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Abstract. Here we describe a Guadalupian brachiopod fauna from units III to V of the shallow water carbonate succession cropping out at Djebel Tebaga de Medenine, South Tunisia. The fauna comprises 29 taxa of the orders Productida, Orthotetida, Orthida, Rhynchonellida, Athyridida, Spiriferida and Terebratulida, whose distribution is consistent with the Wordian-Capitanian age suggested by the associated fusulinids and conodonts. Most of the brachiopod taxa are pedicle attached genera or cemented ones and thus were permanently attached, and only two were free living concavo-convex semi-infaunal genera. This indicates that they were mostly living in high energy environmental settings, where the settling strategies require firm attachment to the substrate at shallow depth under the influence of fair-weather waves. The brachiopods from South Tunisia are very similar to the fauna from the allochthonous limestones of Pietra di Salomone, Rupe del Passo di Burgio and Rocca di San Benedetto of Sosio Valley, Sicily, Italy, a fauna which is also dominated by cemented and pediculate taxa. Both regions were located at palaeoequatorial latitudes in the western termination of the Tethyan Gulf during Guadalupian.

Riassunto. In questo lavoro viene descritta una fauna a brachiopodi di età Guadalupiana, campionata nella successione carbonatica di acque basse affiorante al Djebel Tebaga de Medenine in Tunisia meridionale. La fauna consta di 29 taxa appartenenti agli ordini Productida, Orthotetida, Orthida, Rhynchonellida, Athyridida, Spiriferida and Terebratulida, la cui distribuzione startigrafica è in accordo con l'età Wordiana-Capitaniana indicata dai conodonti e fusulinidi ad essi associati. La maggior parte dei taxa determinati comprende generi attaccati al substrato tramite peduncolo o addirittura cementati e pertanto permanentemente fissi al substrato, mentre solo due generi risultano essere forme concavo-convesse, libere e semi-infaunali. Questo suggerisce un ambiente ad elevata energia idrodinamica caratterizzato da modo ondoso, dove le strategie migliori di colonizzazione e stabilizzazione sono quelle che garantiscono un attacco saldo al substrato (tramite peduncolo o cementazione), mentre le forme libere sono svantaggiate.

I brachiopodi della Tunisia meridionale risultano molto simili alla fauna coeva dei calcari alloctoni della Pietra di Salomone, della Rupe del Passo di Burgio e della Rocca di San Benedetto nella Valle del Sosio in Sicilia, una fauna che pure è dominata da taxa peduncolati e cementati. Entrambe le regioni si posizionavano a paleolatitudini equatoriali in corrispondenza della terminazione occidentale del Golfo Tetideo nel Guadalupiano.

Introduction

The Permian outcrops of Djebel Tebaga de Medenine (South Tunisia) have been known since the 1950's for their rich and well preserved fossil biota (Angiolini et al. 2008 and refs. therein). They are exposed in a series of hills extending for about 15 km WSW-ENE, 30 km W-NW of Medenine, near the village of Dkhilet Toujane (Fig. 1). The Permian succession is an E-W monoclinal structure, gently dipping south-southeastward, overlain with a spectacular angular unconformity by Jurassic to Cretaceous carbonates.

Fusulinids were the first and most detailed studied fossil group (e.g. Douvillé 1934; Ciry 1948, 1954; Glintzboeckel & Rabaté 1964; Skinner & Wilde 1967; Lys 1988; Vachard & Razgallah 1993). Small foramini-

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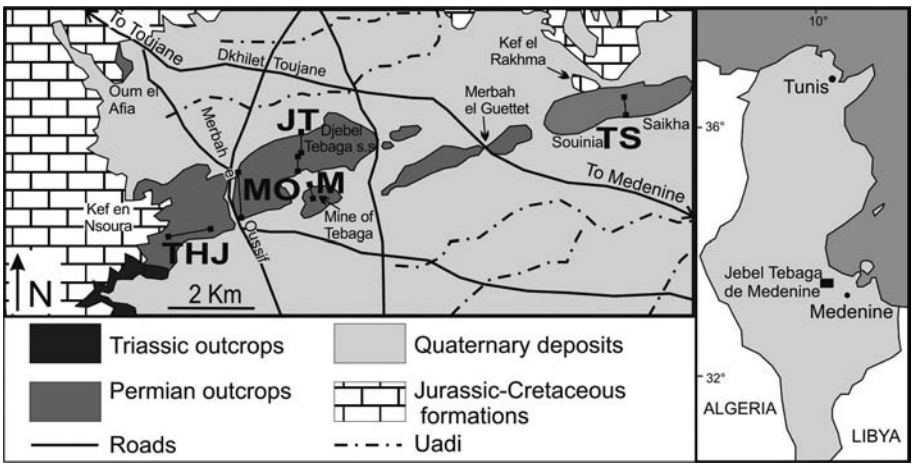


Fig. 1 - Geological sketch map showing the location of the stratigraphic sections. TS: Souinia section; JT: Djebel Tebaga s.s. sections, M: Mine section; MO: Merbah el Oussif section; THJ: Halq Jemel section.

fers, algae, cyanobacteria, ostracods, ammonoids, bivalves, crinoids, corals, and sponges have been studied by several authors, mostly in the seventies and eighties (see summary in Angiolini et al. 2008), whereas brachiopods have been described in a monograph by Termier et al. (1977), which also dealt with several other fossil groups, summarizing previous studies on the region (Termier & Termier 1955, 1957, 1973, 1977).

Field work in Tunisia was completed by the authors in 2007 and 2009 with the goals, 1) to restudy conodonts and fusulinids; 2) to better constrain the age of the succession and the correlation between the International and Tethyan regional scales; and 3) to collect bed-by-bed brachiopod assemblages. Points 1) and 2) have been preliminary addressed in Angiolini et al. (2008) and will be further investigated in specific papers.

The primary aim of this paper is to describe the systematics of the brachiopods and their palaeoecological significance, increasing and up-dating the knowledge on this fauna with respects to the studies undertaken in the seventies. This brachiopod fauna has a considerable importance also for palaeobiogeographic reconstruction, which will be addressed in a following paper.

L. Angiolini and V. Verna collected and studied the brachiopods; V. Davydov studied the fusulinids; C. Henderson and A. Nicora studied the conodonts; L. Angiolini, C. Chaouachi, M. Soussi organized the field work; M. Bougdar participated to the field work.

Geological setting

Different lithostratigrapic subdivisions of the Permian outcrops of Djebel Tebaga de Medenine have been presented by Mathieu (1949), Baird (1967), Newell et al. (1976), Termier et al. (1977), Khessibi (1985), Memmi et al. (1986), Chaouachi (1985, 1988) and Toomey (1991). Due to the discontinuous nature of the outcrops and the significant lateral changes in facies and thickness, the correlation between the different units is not an easy task, as shown by Angiolini et al. (2008).

Here, we follow the stratigraphic subdivisions of Chaouachi (1988) who divided the exposed Permian rocks into six distinct lithologic units (Figs. 2-4):

Unit I (Bateun Beni Zid sandstone), consisting of 50 metres of shallow water sandstone with bioclastic limestone, oncoidal limestone and oolitic limestone capped by regressive sandstones.

Unit II (lower reef complex at Djebel Tebaga *sensu stricto*), comprising about 70 metres of lenticular dolomitized algal/*Tubiphytes* boundstone and bioclastic limestone laterally and vertically delimited by sandstone.

Unit III (intermediate shale), quite variable in thickness from about 40 metres-thick in the east to about 280 metres-thick westward; it has a very articulated and laterally variable lithostratigraphic framework with diversified sponge and algal bioherms and well bedded bioclastic limestone interbedded with sandstone and green shale.

Unit IV, consisting of 120 metres of dolomitized algal/*Tubiphytes* boundstone and bioclastic limestone; it forms the second cliff of Djebel Tebaga.

Unit V (only at Halq Jemel), comprising about 40 metres of bioclastic limestone, oncoidal limestone, dolomitic limestone, shale and fewer algal and sponge patch reefs than the unit below, as well as sandstone with cross stratification, current ripples and wood fragments.

Unit VI (Cheguimi sandstone), initially sandstone and shale of marginal marine to coastal environments, which grade upwards into fluvial red sandy beds and shale.

Units I to III represent a continuous stratigraphic succession, which can be easily laterally traced. These units are capped by thick biohermal limestone and dolostone ascribed to Unit IV by Chaouachi (1988). The

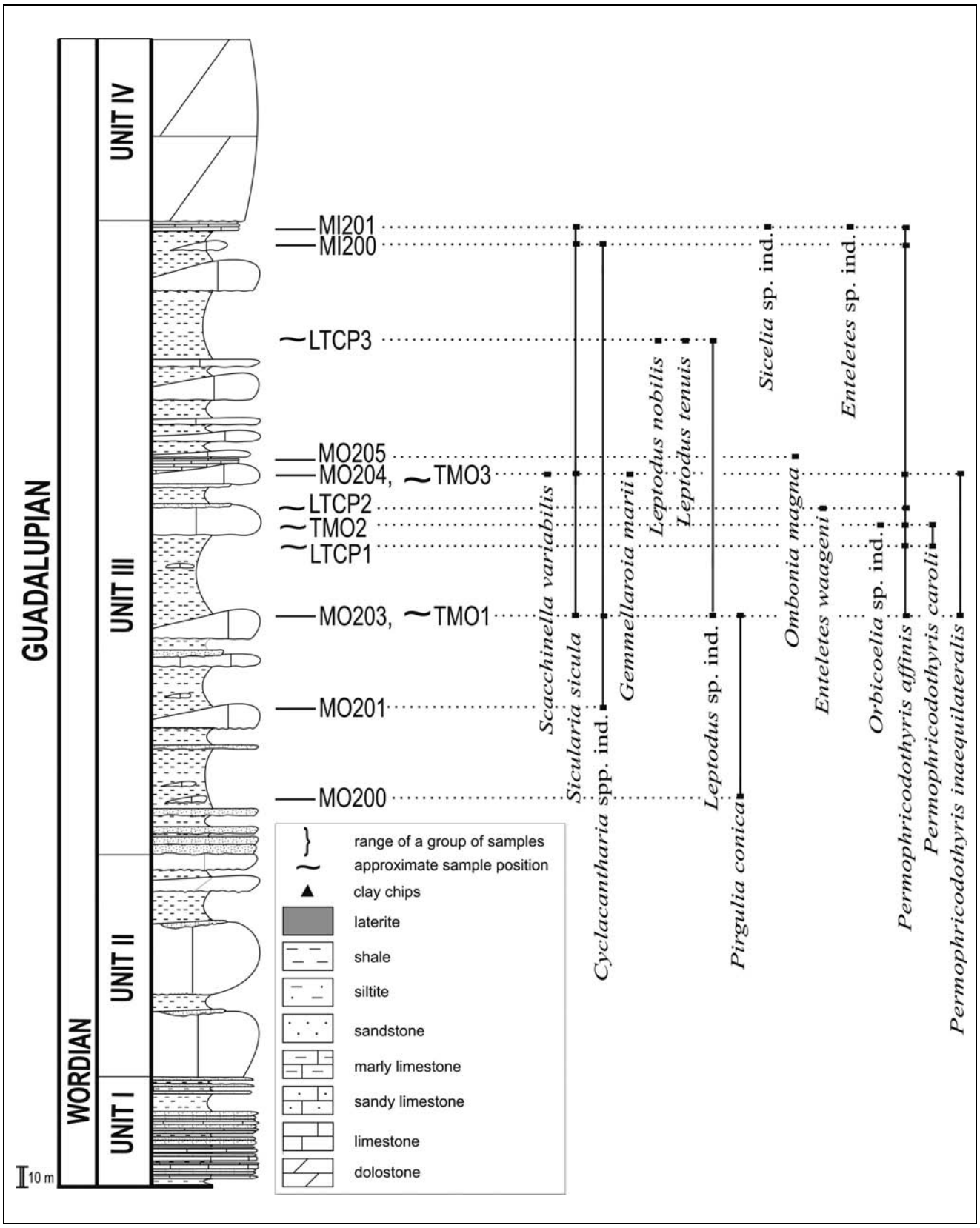


Fig. 2 - Composite section showing the stratigraphic position of the samples collected in Unit III and at the base of Unit IV along the Djebel Tebaga s.s., Merbah el Oussif and Mine sections.

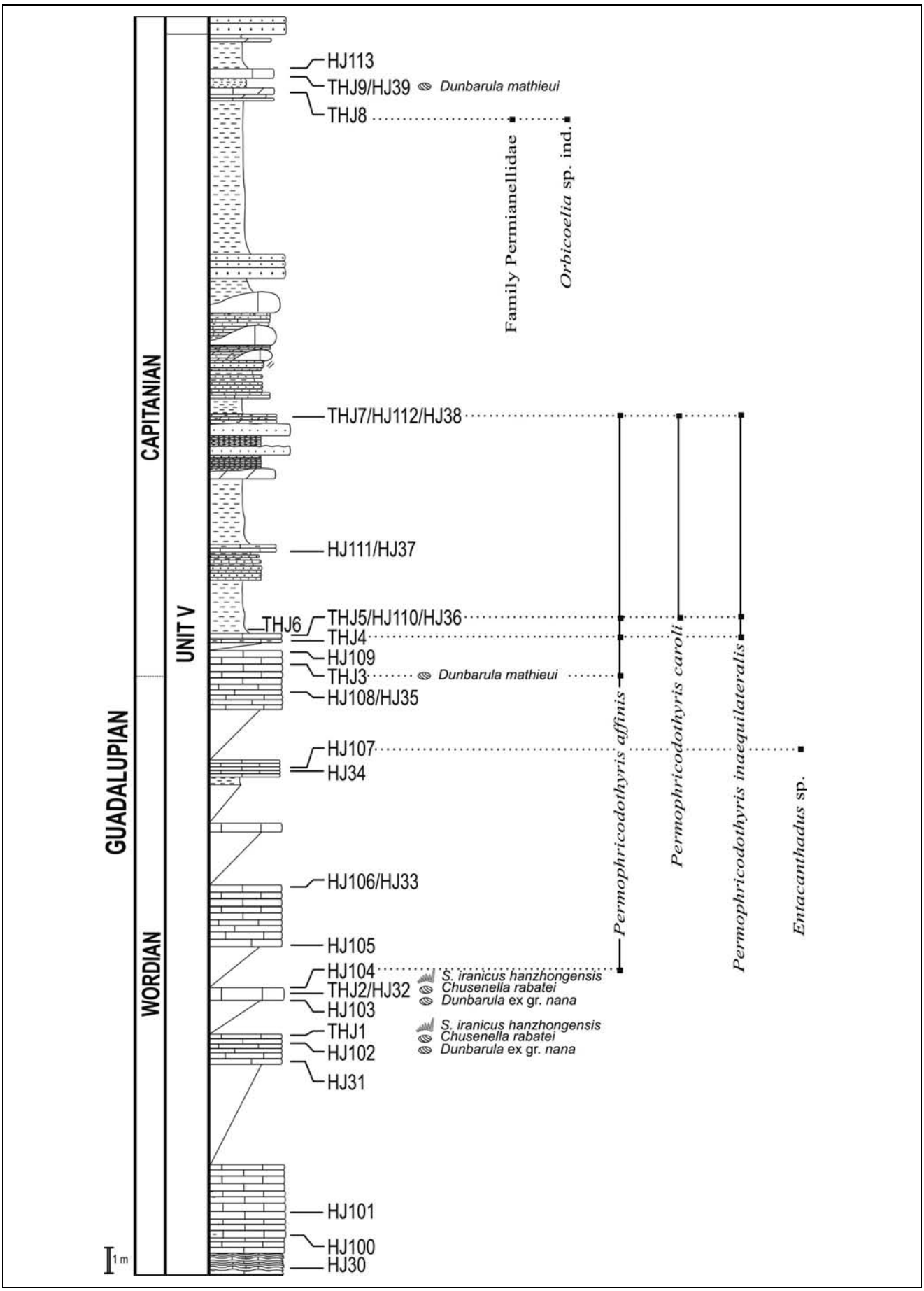


Fig. 3 - Halq Jemel section, coordinate of the base: 33°24′26.8″N, 10°10′37″E. Legend as in Fig. 2.

outcrops of Souinia and Saikra are considered to also represent Unit IV, even if the succession there is different from the typical lithology of Unit IV at Djebel Tebaga s.s., comprising about 43 metres of well bedded bioclastic limestone, lateritic beds, sandstone with dolostone only at the top. Unit V at Halq Jemel is separated by a major fault from the remaining units and it is overlain by sandstone and shale of Unit VI, which are thought to be the uppermost part of the Permian succession in this region.

Units I to V have been interpreted by Chaouachi (1988) as having been deposited on a shallow marine shelf characterized in its inner part by mixed channelized siliciclastics and oolitic/bioclastic carbonates. Towards the north and the northeast, the shelf comprises patch reefs behind a prominent barrier reef delimited by a slope and a relatively deep basin. By the end of the Permian succession, the shelf was progressively covered by the prograding Cheguimi siliciclastics.

Brachiopods have been sampled in units III, IV and V along four sections (all WGS 84 coordinates) (Fig. 1):

Merbah el Oussif section (Unit III) (Fig. 2), base at 33°24′58″N, 10°11′40.7″E, top at 33°24′50″N, 10°11′40.5″E;

Mine section (top Unit III-base Unit IV) (Fig. 2), base at 33°24′50″N, 10°12′33″E;

Halq Jemel section (Unit V) (Fig. 3), base at 33°24′26.8″N, 10°10′37″E. This section is the only one already published in Angiolini et al. (2008).

Souinia section (Unit IV) (Fig. 4), base at 33°25′30.6″N, 10°16′29.7″E;

Three assemblages have been also collected from Unit III along the Djebel Tebaga *sensu stricto* (s.s.): LTCP1 at 33°25′00″N, 10°11′48.9″E, LTCP2 at 33°24′52.4″N, 10°11′44.9″E, LTCP3 at 33°24′52.4″N, 10°11′44.9″E.

Brachiopod distribution in Unit III along the Merbah el Oussif and Mine sections has been combined in the composite section of Fig. 2, which also comprises the assemblages of Djebel Tebaga (s.s.).

Age

The age of the Djebel Tebaga de Medenine outcrop has been established using fusulinids and is generally considered to be Murgabian-early Midian (Vachard & Razgallah 1993), Wordian-Capitanian (Newell et al. 1976) or Capitanian (Vachard et al. 2002).

Recently, Angiolini et al. (2008) reported conodonts from the Halq Jemel section of the Djebel Tebaga outcrops (Fig. 3) for the first time, refining the age assessment of the succession to the Wordian- early Capitanian, and better constraining the debated correlation (e.g. Leven 2009) between the International (Global) and the Tethyan regional time scale, particularly for the Guadalupian series, based on the co-occurrence of both fusulinids and conodonts. They showed the co-occurrence of *Chusenella rabatei* Skinner & Wilde, 1967 and *Dunbarula* ex gr. *nana* Kochansky-Devidé & Ramovs, 1955 with *Sweetognathus iranicus hanzhongensis* (Wang, 1978) in THJ1-2 below an assemblage with advanced *Dunbarula, i.e. D. mathieui* Ciry, 1948 in THJ3-TJH9 (Fig. 3). This finding suggests a late Wordian to early Capitanian age for Unit V, whereas the units below were considered to be Wordian (Angiolini et al. 2008). However, *Dunbarula mathieui* has been also found in Unit IV at Souinia, suggesting that this part of the succession may also be early Capitanian and that units IV and V are synchronous, but the beds THJ1-2 at the base of Unit V at Halq Jemel section are definitely older than either Unit VI or the remainder of Unit V. Additional samples, at the moment under study, may better constrain this age assessment and the correlation between the International and the Tethyan time scales. According to Angiolini et al. (2008, 2009 and refs. therein), the data from Tunisia may support the correlation of the lower Midian Stage of the Tethyan scale to the upper Wordian of International scale of the Permian.

Bivalves collected in Souinia and Djebel Tebaga s.s. sections (samples TS12, TS14, LTS1, LTCP2) comprise the gigantic species *Shikamaia ?ogulineci* (Kochansky-Devidé, 1978) (Fig. 5), a species already described from the Saikra Bioherma Complex by Boyd & Newell (1979). This taxon belong to the family Alatoconchidae which comprises aberrant and gigantic bivalves that are known to occur in Cisuralian to Guadalupian carbonate platforms at low latitudes (Isozaki & Aljinovic 2009). These aberrant, large sized and thick shelled Alatoconchidae become extinct during the late Guadalupian or at the Guadalupian-Lopingian boundary together with large tested fusulinids and rugosa Waagenophyllidae. No large bivalve is known from Lopingian rocks and they are most frequent and largest and thickest in the Wordian, whereas in the mid-Capitanian they underwent a significant reduction in size. The occurrence *Shikamaia ?ogulineci* (Kochansky-Devidé, 1978) in unit III and IV is therefore consistent with a Wordian-Capitanian age.

Also the brachiopods are consistent with a Wordian-Capitanian age, however their range does not help to discriminate between a Wordian versus a Capitanian age. All species of *Permophricodothyris* and *Orbicoelia* sp. ind. range from Unit III to Unit V. *Ombonia magna* and the species belonging to *Enteletes* and *Sicelia* occur in units III and IV, and there are several species restricted respectively to Unit III or to Unit IV mostly by palaeoecological control, as discussed below.

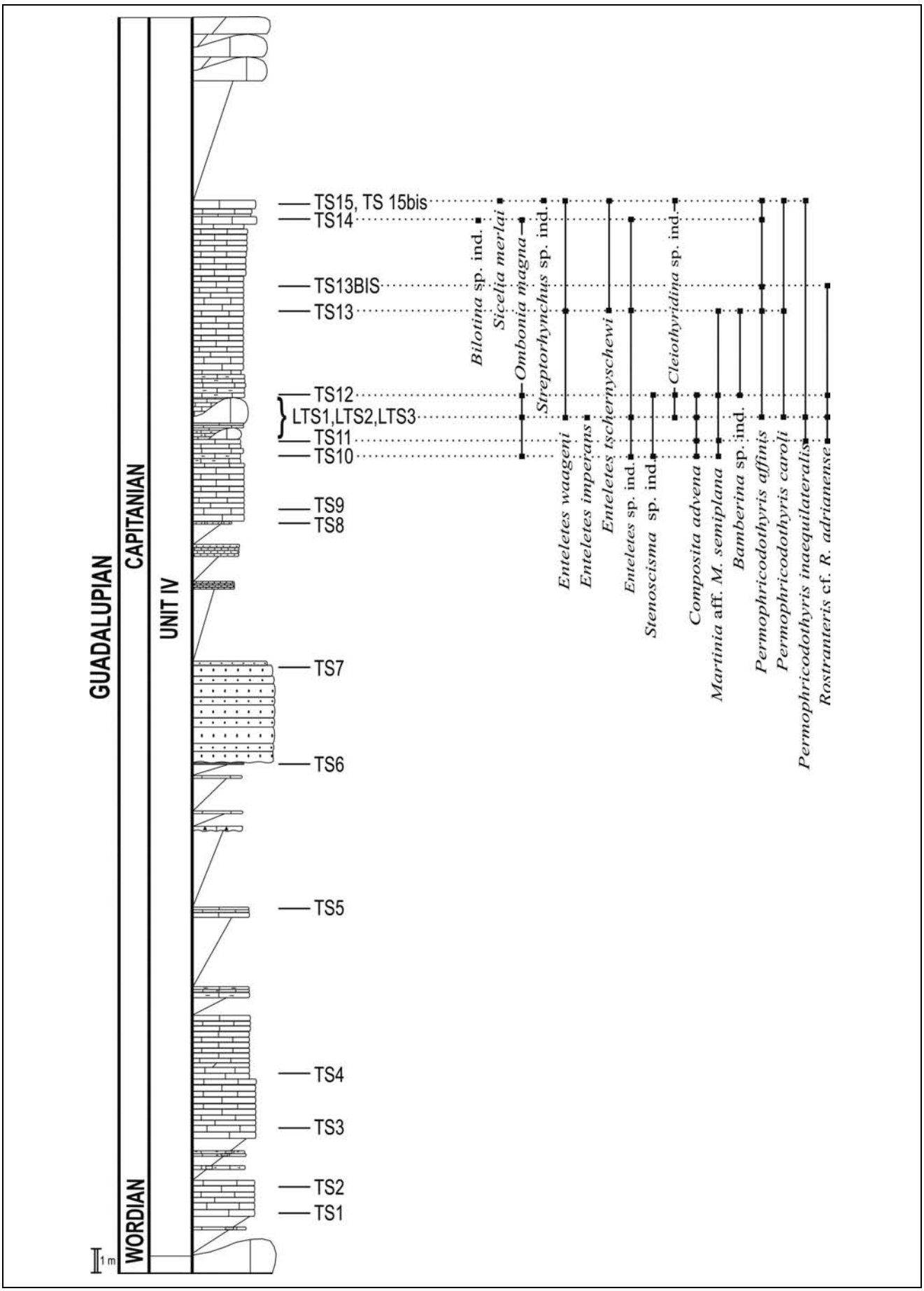


Fig. 4 - Souinia section, coordinate of the base: 33°25′30.6″N, 10°16′29.7″E. Legend as in Fig. 2.

Fig. 5 - Shell fragment of the gigantic species *Shikamaia ?ogulineci* (Kochansky-Devidé, 1978). Souinia section, sample TS14. Scale bar: 1 cm.

The brachiopod fauna, its palaeoecology and comparisons

The brachiopod fauna from South Tunisia described in this study is based on 508 specimens and comprises 29 taxa: *Entacanthadus* sp. ind., *Bilotina* sp. ind., *Scacchinella variabilis* Gemmellaro, 1891, *Sicularia sicula* (Gemmellaro, 1894), *Cyclacantharia* spp. ind., *Gemmellaroia marii* (Gemmellaro, 1894), *Leptodus nobilis* (Waagen, 1883), *Leptodus tenuis* (Waagen, 1883), *Leptodus* sp. ind., *Pirgulia conica* (Gemmellaro, 1891), Permianellidae gen. et sp. ind., *Sicelia merlai* Greco, 1938, *Sicelia* sp. ind., *Ombonia magna* Greco, 1938, *Streptorhynchus* sp. ind., *Enteletes waageni* Gemmellaro, 1892, *Enteletes imperans* De Gregorio, 1930, *Enteletes tschernyschewi* Gemmellaro, 1892, *Enteletes* sp. ind., *Stenoscisma* sp. ind., *Cleiothyridina* sp. ind., *Composita advena* Grant, 1976, *Orbicoelia* sp. ind., *Martinia* aff. *M. semiplana* Waagen, 1883, *Bamberina* sp. ind., *Permophricodothyris affinis* (Gemmellaro, 1899), *Permophricodothyris caroli* (Gemmellaro, 1894a), *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a), and *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894). The fauna from the same region previously reported by Termier & Termier (1957) and Termier et al. (1977) comprises 20 taxa, most of which represented only by fragments or single valves and not adequately illustrated. They reported two dorsal valves each belonging to a different species of *Meekella* White & St. John, 1867 and one dorsal valve and one ventral valve belonging to two species of *Geyerella* Schellwien, 1899, which we did not determine in our material. However, their description is very brief and their illustrations is based on very schematic hand-drawings so that it is impossible to confirm their determination. The same holds true for the two dorsal valves of *Cooperina* Termier, Termier & Pajaud, 1968, the deformed specimen of *Uncinunellina timorensis* (Beyrich, 1865), and the specimen of *Spiriferellina cristata* (von Schlotheim, 1816), which Termier & Termier (1957) and Termier et al. (1977) reported.

65% of the examined brachiopod taxa are pedicle attached genera, of which three (*Sicelia*, *Ombonia*, and *Streptorhynchus*) are not only pediculate, but stabilized by penetration of the elongate umbonal region. Five genera are cemented and thus permanently attached (*Scacchinella, Cyclacantharia*, *Gemmellaroia*, *Leptodus*, and *Sicularia*) and only two (*Entacanthadus*, and *Bilotina*) are free living concavo-convex spiny semi-infaunal genera. Cemented taxa are mostly found in the algal and sponge boundstones of Unit III where they behaved as reef dwellers. The two free living seminfaunal genera have been collected separately in thin bedded bioclastic wackestone/packstone intercalated with oncoidal limestone, suggesting the existence of locally restricted and protected microenvironments with softer substrates. Pedicle attached taxa are considered ubiquitous: the species of *Permophricodothyris* and *Enteletes* are best examples of this life-style occurring both in the bioherms of Unit III and in the bioclastic limestone or in the marly limestone of units IV and V. The dense accumulation of articulated *Permophricodothyris* (especially *P. affinis*) in the dolomitized silty limestone of THJ7 (Halq Jemel section), which are not in life position nor oriented and frequently encrusted by algae (*Ottonosia*), probably indicate wash-over fans in a proximal, more protected environment (lagoons). Most other pediculate genera (i.e. *Stenoscisma, Cleiothyridina, Composita, Martinia, Bamberina,* and *Rostranteris*) are generally small in size and only occur in the bioclastic limestone of Unit IV at Souinia, except for *Orbicoelia,* which has been recorded both from the boundstone of Unit III and from the topmost limestone of Unit V at Halq Jemel.

In general, the great proportion of pediculate and cemented taxa indicate that they were living in high energy settings, where the settling strategies require firm attachment to the substrate at shallow depth around the fair-weather wave base (e.g. Hoel 2008; Lee 2008).

The occurrence of the gigantic bivalve *Shikamaia ?ogulineci* that was probably symbiotic with photosynthetic organisms (Isozaki & Aljinovic 2009), suggests an oligotrophic, stable, warm, shallow water open marine environment for units III and IV.

The brachiopods from South Tunisia are very similar to the fauna from the allochthonous limestones of Pietra di Salomone, Rupe del Passo di Burgio and Rocca di San Benedetto of Sosio Valley, Sicily, Italy, described in several papers by Gemmellaro (1891a, b; 1892; 1894a, b; 1896a, b; 1898; 1899). This fauna is also dominated by cemented and pediculate taxa and mostly come from carbonate platform marginal sponge/algal/bryozoans reefs on the uppermost slope reworked and transported downslope by debris flows and turbidity currents for a

prolonged time interval from the Middle to the Late Permian (Flügel et al. 1991). Most fusulinid, ammonoid and conodont ages for the allochthonous limestone of Sosio suggest an upper Roadian-Wordian age (Flügel et al. 1991; Mei & Henderson 2001; Henderson & Mei 2003; Kozur & Wardlaw 2010).

Both regions were located at equatorial palaeolatitudes (within 5°S of the equator for Tunisia in the Middle Permian according to Muttoni, pers. comm., 2010) in the western termination of the Tethyan Gulf at Middle Permian times and were probably quite isolated from Neotethyan localities, such as Turkey, Oman, and Iran. This caused the development of endemic taxa (e.g. *Sicularia, Sicelia, Scacchinella, Gemmellaroia, Pirgulia*, species of *Enteletes* and *Permophricodothyris*), even if some Cimmerian (*Bilotina, Entacanthadus,* and *Orbicoelia*) and widespread taxa (*Cleiothyridina, Martinia, Composita,* and *Bamberina*) managed to migrate in the gulf by westward flowing current gyres in the Neotethys and Palaeotethys (e.g. Kutzbach et al. 1990).

Systematic Palaeontology (V. Verna and L. Angiolini)

All the described specimens are housed in the Palaeontological Museum of the Department of Earth Sciences "A. Desio", University of Milan, Italy, and are

PLATE 1

Fig. 1 - *Entacanthadus* sp. ind. Ventral valve. MPUM10120 (HJ107), x3.

Fig. 2 - *Bilotina* sp. ind. Ventral valve. MPUM10122 (TS14-11b), x3.

Fig. 3 - *Bilotina* sp. ind. External cast of a ventral valve. MPUM10123 (TS14-11b1), x3.

Fig. 4 - *Bilotina* sp. ind. External cast of a ventral valve. MPUM10124 (TS14-11a1), x3.

Fig. 5 - *Scacchinella variabilis* Gemmellaro, 1891a. Ventral view of a ventral valve. MPUM10127 (V1TMO3-99), x2.

Fig. 6 - *Scacchinella variabilis* Gemmellaro, 1891a. Lateral view of ventral valve. MPUM10127 (V1TMO3-99), x2.

Fig. 7 - *Scacchinella variabilis* Gemmellaro, 1891a. Dorsal view of a ventral valve. MPUM10127 (V1TMO3-99), x2.

Fig. 8 - *Sicularia sicula* (Gemmellaro, 1894b). Ventral valve. MPUM10128 (TMO1-8),

Fig. 9 - *Sicularia sicula* (Gemmellaro, 1894b). Ventral valve. MPUM10129 (MO203-1b), x2.

Fig. 10 - *Sicularia sicula* (Gemmellaro, 1894b). Ventral valve. MPUM10130 (MI200-2), x1.

Fig. 11 - *Sicularia sicula* (Gemmellaro, 1894b). Lateral view of a ventral valve. MPUM10131 (MO203-6), x1.

Fig. 12 - *Sicularia sicula* (Gemmellaro, 1894b). Ventral view of an articulated specimen. MPUM10132 (MI201-3), x1.

Fig. 13 - *Sicularia sicula* (Gemmellaro, 1894b). Ventral valve. MPUM10133 (MO203-1), x1.

Fig. 14 - *Cyclacantharia* spp. ind. Dorsal valve with preserved part of conjoined ventral valve. MPUM10135 (MO203-4b), x2.

Fig. 15 - *Cyclacantharia* spp. ind. Dorsal valve with preserved part of conjoined ventral valve. MPUM10136 (MO203-1b), x1.

Fig. 16 - *Cyclacantharia* spp. ind. Articulated specimen showing the internal view of the dorsal valve. MPUM10137 (MO203-10a), x1.

Fig. 17 - *Cyclacantharia* spp. ind. Dorsal view of a ventral valve. MPUM10138 (MO203-1a), x1.

Fig. 18 - *Cyclacantharia* spp. ind. Ventral valve. MPUM10139 (MO203-1c), x1.

Fig. 19 - *Cyclacantharia* spp. ind. Ventral valve. MPUM10140 (MO203-1d), x1.

Fig. 20 - *Cyclacantharia* spp. ind. Dorsal view of a ventral valve. MPUM10141 (MO203-3b), x1.

Fig. 21 - *Cyclacantharia* spp. ind. Ventral valve. MPUM10142 (MO203-4a), x2.

Fig. 22 - *Cyclacantharia* spp. ind. Dorsal view of a ventral valve. MPUM10143 (MO203-10b), x1.

Fig. 23 - *Cyclacantharia* spp. ind. Dorsal valve. MPUM10144 (DMO-1), x1.

Fig. 24 - *Cyclacantharia* spp. ind. Dorsal valve. MPUM10145 (MO203-11), x1.

Fig. 25 - *Gemmellaroia marii* (Gemmellaro, 1894b). Dorsal view of a ventral valve. MPUM10149 (TMO3-8a), x1.

Fig. 26 - *Gemmellaroia marii* (Gemmellaro, 1894b). Dorsal view of a ventral valve. MPUM10150 (TMO3-8b), x1.

Fig. 27 - *Gemmellaroia marii* (Gemmellaro, 1894b). Interior of dorsal valve. MPUM10151 (TMO3-8d), x1.

Fig. 28 - *Leptodus nobilis* (Waagen, 1883). Internal view of a ventral valve; umbo-down orientation. MPUM10153 (LTCP3-1b), x1.

Fig. 29 - *Leptodus tenuis* (Waagen, 1883). Internal view of a ventral valve. MPUM10154 (LTCP3-1f), x1.

Fig. 30 - *Leptodus* sp. ind. Lobate brachidial plate; umbo-down orientation. MPUM10155 (LTCP3-1g), x1.

Fig. 31 - *Leptodus* sp. ind. Fragment of interior of ventral valve; umbo-down orientation. MPUM10156 (MO203-9), x1.

Fig. 32 - *Pirgulia conica* (Gemmellaro, 1891b). Ventral valve; umbo-down orientation. MPUM10157 (MO200-1), x1.

Fig. 33 - *Pirgulia conica* (Gemmellaro, 1891b). Ventral valve; umbo-down orientation. MPUM10158 (MO203-5), x1.

Fig. 34 - *Pirgulia conica* (Gemmellaro, 1891b). Ventral valve; umbo-down orientation. MPUM10159 (MO203-1A), x1.

Fig. 35 - *Pirgulia conica* (Gemmellaro, 1891b). Fragment of ventral valve; umbo-down orientation. MPUM10160 (DMO-3), x1.

Fig. 36 - *Sicelia merlai* Greco, 1938. Fragment of ventral valve. MPUM10162 (TS15-20), x1.

Fig. 37 - *Sicelia* sp. ind. Ventral valve. MPUM10163 (MI201-1); x1.

Fig. 38 - *Ombonia magna* Greco, 1938. Dorsal view of an articulated specimen. MPUM10164 (TS10-5), x1.

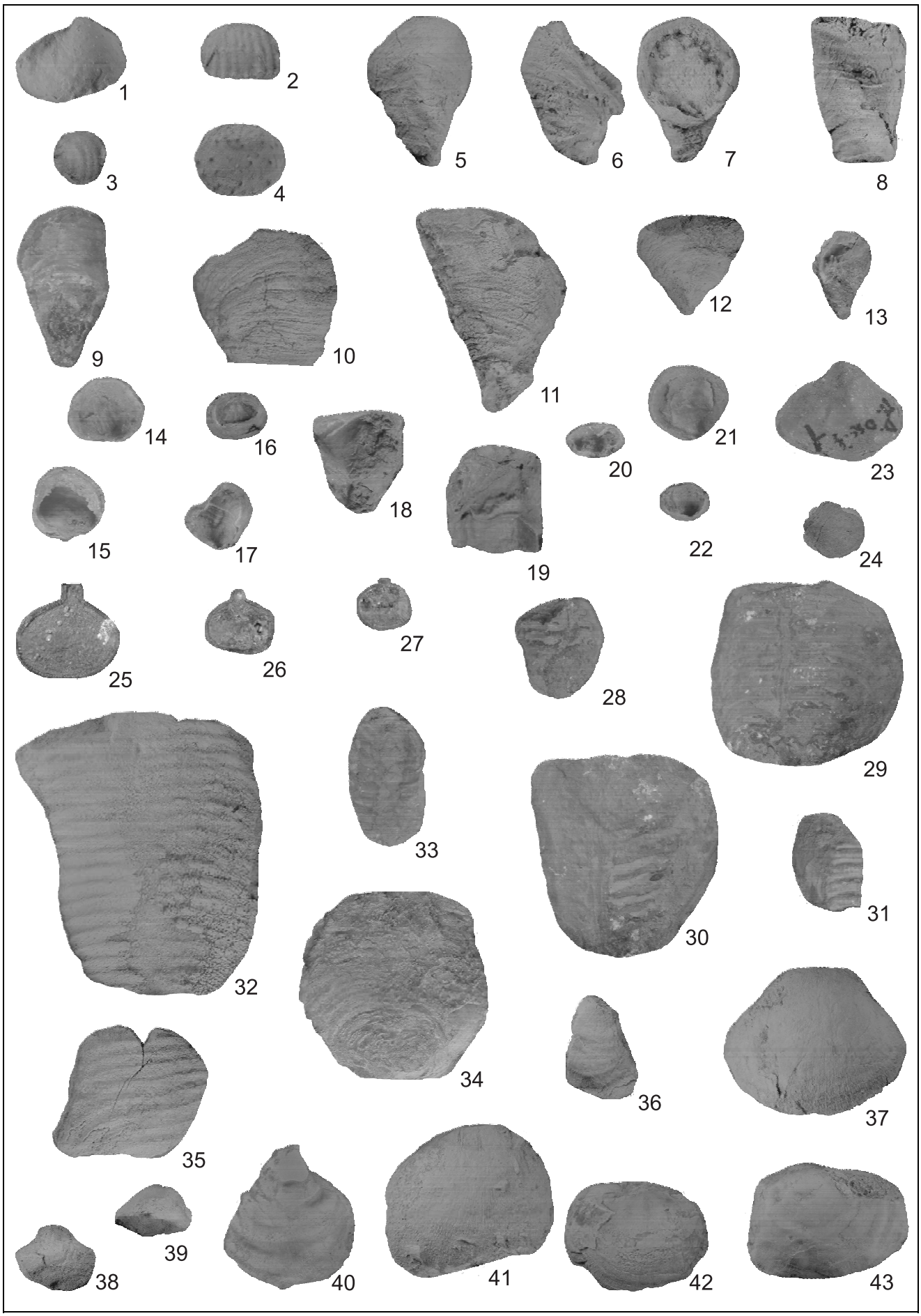
Fig. 39 - *Ombonia magna* Greco, 1938. Anterior view of an articulated specimen, MPUM10164 (TS10-5), x1.

Fig. 40 - *Ombonia magna* Greco, 1938. Ventral valve. MPUM10165 (TS12-7), x1.

Fig. 41 - *Ombonia magna* Greco, 1938. Ventral valve. MPUM10166 (MO205-1), x1.

Fig. 42 - *Ombonia magna* Greco, 1938. Dorsal valve. MPUM10167 (TS12-9), x1.

Fig. 43 - *Ombonia magna* Greco, 1938. Dorsal view of an articulated specimen. MPUM10168 (TS12-1), x1.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registered with a prefix MPUM followed by a five digit number and by the field number in parentheses. The systematic study follows the classifications of Brunton et al. (2000) for the productidines and strophalosiidines, Williams et al. (2000) for the lyttoniidines, Williams and Brunton (2000) for the orthotetidines, Williams and Harper (2000) for the orthids, Savage et al. (2002) for the rhynchonellids, Alvarez and Rong (2002) and Alvarez (2007) for the athyridids, Johnson et al. (2006) for the ambocoelioids, Carter and Gourvennec (2006) for the martinioids and reticularioids, Carter (2006) for the spiriferoids, and Smirnova (2007) for the centronelloids.

Phylum **Brachiopoda** Duméril, 1806

Subphylum **Rhynchonelliformea** Williams et al., 1996

Class **Strophomenata** Williams et al., 1996

Order **Productida** Sarytcheva & Sokolskaya, 1959

Suborder **Productidina** Waagen, 1883

Superfamily Productoidea Gray, 1840

Family Productellidae Schuchert, 1929

Subfamily Marginiferinae Stehli, 1954

Tribe Marginiferini Stehli, 1954

Genus *Entacanthadus* Grant, 1993a

Type species: *Entacanthadus chioticus* Grant, 1993a, from the Guadalupian of Chios Island, Greece.

Remarks. *Entacanthadus* Grant, 1993a can be confused with *Echinauris* Muir-Wood & Cooper, 1960, from which it differs by having spine bases only on the ventral valve, small ears, more convex ventral valve, uniform size of the spines on the trail and on the flanks, and by the absence of a sulcus on the ventral valve and a fold on the dorsal one. Also *Entacanthadus* is characterized by the presence of numerous long endospines in the ventral umbonal region.

According to Grant (1993a, p. 14) *Entacanthadus* differs from *Marginifera* Waagen, 1884 by the absence of rugae or costellae; from *Dyschrestia* Grant, 1976 by the lack of dorsal spines and the presence of a dorsal marginal rim.

Entacanthadus sp. ind.

Pl. 1, fig. 1

Material: One figured ventral valve: MPUM10120 (HJ107); one ventral valve: MPUM10121 (DHJemel-4).

Occurrence: Tunisia, Halq Jemel section (HJ107, scree of section DHJemel-4).

Description. Weakly geniculate, small sized shell, with subrectangular outline. The width of specimen MPUM10121 (DHJemel-4) is ~12.5 mm, the length is >9.5 mm. Maximum width at midlength, slightly greater than cardinal margin; ears small and subtriangular; umbo usually small, pointed. No sulcus. The ornamentation consists of spine bases, 0.15-0.3 mm wide, widely scattered on the venter and flanks; concentric rugae on the posterior region.

Discussion. The present specimens are placed in the genus *Entacanthadus* because of their ornamentation of spines of uniform size on the venter and flanks, the lack of rugae and costellae and absence of a ventral sulcus, however the specific determination is left in open nomenclature due to the state of preservation and the absence of dorsal valves.

The specimens described as *Echinauris opuntia* (Waagen, 1884) by Termier et al. (1977, p. 53, text-fig. 5) probably belong to the genus *Entacanthadus,* based on the brief description and schematic illustration they provide.

Superfamily Echinoconchoidea Stehli, 1954

Family Echinoconchidae Stehli, 1954

Subfamily Juresaniinae Muir-Wood & Cooper, 1960

Tribe Juresaniini Muir-Wood & Cooper, 1960

Genus *Bilotina* Reed, 1944

Type species: *Strophalosia (Bilotina) subtecta* Reed, 1944, from the Wordian Amb Formation, Kishor Range, Pakistan.

Remarks. The genus *Bilotina*, which is an important marker for the Wordian of the southern margin of the Neotethys, is characterized by the internal characters of the dorsal valve, consisting of a bilobed cardinal process with ridges connected to raised adductor platforms and of a long and low median septum. Another feature of the genus is that the ribs on the ventral trail are in fact elongated bases of spines (Angiolini & Bucher 1999).

Bilotina sp. ind.

Pl. 1, figs 2-4

Material: One figured ventral valve: MPUM10122 (TS14-11b); two ventral valves: MPUM10125 (TS14-11a, TS14-12); two figured external casts of ventral valves: MPUM10123 (TS14-11b1), MPUM10124 (TS14-11a1); two external casts of ventral valves MPUM10126 (TS14-11c, TS14-1).

Occurrence: Tunisia, Souinia section (TS14).

Description. Small, geniculated shell, with oval to sub-rectangular outline. Ventral valve very convex, lacking sulcus, geniculated, with elongated trail. Ornamentation of large spine bases which may be in quincunx or simply concentrically arranged; they are 0.1-0.38 mm wide and are elongated to form coarse ribs on the ventral trail.

Dimensions (in mm)

Specimens	Width	Length	Maximum spine base width	Minimum spine base width
TS14-1	4.8	3.5	0.35	0.2
TS14-11a	4.5	3	0.3	0.2
TS14-11b	5	3.5	0.3	0.2
TS14-11c	4.8	4.2	0.38	0.25
TS14-12	/	3	0.25	0.1

Discussion. The specimens under study have smaller size than *Bilotina acantha* (Waterhouse & Piyasin, 1970) and *Bilotina subtecta* Reed, 1944; the available specimens differ from *Bilotina yanagidai* Angiolini & Bucher, 1999 because of the spine base size and pattern; in the Tunisian specimens the spine bases are smaller and in quincunx or concentrically arranged, whereas in *B. yanagidai* they are larger, and nearly radially aligned. The Tunisian *Bilotina* is rare and not well preserved and difficult to identify to a specific level.

Suborder **Strophalosiidina** Schuchert, 1913

Superfamily Aulostegoidea Muir-Wood & Cooper, 1960

Family Scacchinellidae Licharew, 1928

Subfamily Scacchinellinae Licharew, 1928

Genus *Scacchinella* Gemmellaro, 1891a

Type species: *Scacchinella variabilis* Gemmellaro, 1891a from the Guadalupian of Sosio Valley, Sicily, Italy

Remarks. *Scacchinella* Gemmellaro, 1891a resembles *Gemmellaroia* Cossmann, 1898 through the general conical shape, the high and wide interarea, the overall ornamentation, the presence of a median septum and the dorsal valve capping the ventral valve, but *Scacchinella* differs by the absence of a pseudodeltidium and in possessing a bilobed and elongated cardinal process, different from the massive and blade-like one of *Gemmellaroia*.

Scacchinella variabilis Gemmellaro, 1891a

Pl. 1, figs 5-7

1891a *Scacchinella variabilis* Gemmellaro, p. 22.

1892 *Scacchinella variabilis* - Gemmellaro, p. 26.

1896b *Scacchinella variabilis* - Gemmellaro, p. 6, pl. A, figs 1-13.

1930 *Scacchinella variabilis* - De Gregorio, p. 20.

1930 *Scacchinella variabilis* var. *erecta* De Gregorio, p. 24, pl. 5, figs 1-2, 13-15.

1947 *Scacchinella variabilis* - Greco, p. 13, pl. 2 [17], figs 12-15; pl. 3 [18], figs 1-12.

1967 *Scacchinella variabilis* - Rudwick & Cowen, p. 126, pl. 34, figs 1-12.

Material: One figured ventral valve: MPUM10127 (V1TMO3-99).

Occurrence: Tunisia, Merbah el Oussif section (V1TMO3).

Description. Curved, conical ventral valve, 14.8 mm long and 10 mm wide. High, triangular and wide interarea, apparently without pseudodeltidium. The umbo is pointed and tilted sideways. Ornamentation consisting of slightly rugose, fine growth lamellae and of spine bases, 0.2-0.5 mm wide, irregularly arranged on the valve surface. Interior of ventral valve with a median longitudinal septum starting from the apical region. The internal margins are spinose, with 0.30-0.55 mm wide spines.

Discussion. *Scacchinella variabilis* is very similar to *Scacchinella depressa* Gemmellaro, 1891a, but the latter differs by its subtriangular or rhomboidal shape and the curvature trend. In *S. depressa,* the longitudinal curvature is high only in the posterior region, than the valve is flat, whereas *S. variabilis* has a more recurved cone of the ventral valve which in lateral view assumes a bow-like profile (Pl. 1, fig. 6); also the median septum of the ventral valve is more extended anteriorly, and the lobes of the cardinal process are relatively larger in *S. depressa* than in *S. variabilis*.

S. variabilis and *S. depressa* are the only species of *Scacchinella* from Sosio Valley, Sicily. According to Rudwick & Cowen (1967, p. 126), the variability of the former species is so high that the species *S. depressa* could fall within the intraspecific variability of *S. variabilis*. Therefore, there may be only one biological species represented at Sosio. Also, the specimens distringuished as a new variety *S. variabilis* var. *erecta* by De Gregorio (1930) are not really different from the typical form of *S. variabilis,* and are considered synonyms.

Stratigraphic and geographic occurrence. *S. variabilis* is known elsewhere from the allochthonous limestones of Pietra di Salomone and of Rocca di San Benedetto of Sosio Valley, Sicily, Italy (Gemmellaro 1891a, 1892, 1896b).

Superfamily Richthofenioidea Waagen, 1885

Family Hercosiidae Cooper & Grant, 1975

Genus *Sicularia* Grant, 1993a

Type species: *Richthofenia sicula* Gemmellaro, 1894b, from the Guadalupian of Sosio Valley, Sicily, Italy.

Remarks. The genus *Sicularia* has been established by Grant (1993a) with type species *Richthofenia sicula* Gemmellaro, 1894b.

Sicularia differs from *Coscinarina* Muir-Wood & Cooper, 1960 in having more concentric rugae, the absence of a false dorsal valve, less numerous transverse septa (which are often rare in the ventral valve), shorter

myophore cavities, and a higher and thickened median septum. Di Stefano (1914, p. 22) suggested that *Sicularia* shows more numerous spines, a shorter interarea with a wider and more swollen pseudodeltidium, and a wider, low and squat shape. However, this particular shape is not shown in the illustrations of Di Stefano (1914, pl. 3[3], figs 9, 10, 12) which show that *Sicularia* can attain an elongate shape. *Sicularia* differs from *Richthofenia* Kayser, 1881 in having a long and thin median septum along the posterior wall of the ventral valve and in lacking a myocoelidium.

Rudwick & Cowen (1967, p. 144, text-fig. 9E, pl. 36, figs 7 and 8) carefully described the ontogenetic development of the median septum of *Sicularia*: "*The upper edge of the stout median buttress forms a fairly narrow ridge or keel, but below this the buttress is thickened into a more massive structure. [...] In transverse section, the buttress has the appearance of a thin median septum that has been progressively smothered by deposition of later shell material: this of course simply reflects the simultaneous upward growth of the thin keel and of the more massive proximal parts of the buttress. Specimens broken near the apex show that the buttress was initiated very early in ontogeny*", providing a useful tool to distinguish the genus.

According to Grant (1993a), among the Richthofenioidea only the Hercosiidae contains a ventral median septum and thus he compared *Sicularia* to the other genera in this family. The Texan genus *Hercosestria* Cooper & Grant, 1969 differs because it is characterized by the occurrence of an apertural coscinidium. *Hercosia* Cooper & Grant, 1969 has a median septum which is attached only at its apical end, and then it is free-standing, whereas the septum in *Sicularia* is very low and thin, but long, extending all along the posterior wall of the valve and being attached to it for nearly all of its length. Also the two genera have a very different size, with *Sicularia* being twice the size of *Hercosia* (Grant 1993a). According to Grant (1993a), no specimen of *Sicularia* in the USNM collection shows evidence of apertural spines, although Rudwick & Cowen (1967, p. 33) suggested they were present. He stated that their absence could be the result of breakage, but it seemed unlikely to him the spines would have been uniformly broken from *Sicularia*.

Sicularia sicula (Gemmellaro, 1894b)

Pl. 1, figs 8-13

1894b *Richthofenia sicula* Gemmellaro, p. 7.
1896a *Richthofenia sicula* - Gemmellaro, 114.
1900 *Richthofenia* sp. - Schellwien, p. 28, figs. 1 a, b.
1914 *Richthofenia sicula* - Di Stefano, p. 22, pl. 2, figs 6, 17-19, 22, 24-29; pl. 3, figs. 1-4, 6-12, 14-17, 19, 20.
1926 *Richtofenia sicula*- Fabiani, p. 614.
1930 *Richthofenia sicula* - De Gregorio, p. 29, pl. 8, figs. 7-10.
1947 *Richthofenia sicula* - Greco, p. 18, pl. 3 [18], figs. 21-25.
1957 *Richthofenia sicula* - Termier & Termier, p. 204, pl. 3, figs i-l; pl. 4, figs a-d.
1967 *Richthofenia sicula* - Rudwick & Cowen, p. 139, pl. 36, figs. 1-2, 4-12; pl. 37, figs. 2-9; pl. 40, fig. 4.
1977 *Coscinarina communis* - Termier, Termier & Vachard, p. 55.

Material: One figured articulated specimen: MPUM10132 (MI201-3); five figured ventral valves: MPUM10130 (MI200-2), MPUM10129 (MO203-1b), MPUM10131 (MO203-6), MPUM10128 (TMO1-8), MPUM10133 (MO203-1); two ventral valves: MPUM10134 (MI200-1, MO204-1).

Occurrence: Tunisia, Merbah el Oussif section (TMO1, MO201, MO203, MO204); Mine section (MI200, MI201).

Description. Medium to large sized, irregularly conical, elongate shell, with axe of the cone recurved. The shell substance is 0.2-1.6 mm thick. The surface is covered by sinuose, irregular, fine growth lamellae, by few spine bases, 0.1-0.6 mm wide which are irregularly arranged along the growth lamellae, and by irregular rugae.

Interior of ventral valve with a thin septum along the internal posterior wall of the ventral valve; this septum can extend to almost the antero-posterior mid-length and separates two short miophore cavities delimited externally by short folds. The median septum is thickened and becomes a buttress near the umbo; its ontogenetic development is similar to the one described by Rudwick & Cowen (1967, p. 144). Interior of dorsal valve with a thin, just perceptible septum and one kidney-shaped postero-lateral ridge on one side.

Dimensions (in mm)

Specimens	Antero-posterior width	Lateral width	Length
MI200-1	12	/	13
MI200-2	31.5	21.5	>35
MI201-3	20	20.5	14.5
MO203-1b	/	11	16
MO203-6	~32	37.5	37
MO204-1	/	~11.5	13.3
TMO1-8	9.5	/	~20

Discussion. The Tunisian specimens comprise both elongated cones and squat ones. The elongated forms are very similar to specimen 417B (collection of "G. G. Gemmellaro" Museum of Palermo), type-material of *Richthofenia sicula* Gemmellaro, 1894b.

Greco (1947) considered *Socraticum firmum* De Gregorio, 1930 a junior synonym of *Richthofenia sicula*. However, if on one hand the specimens drawed by De

Gregorio (1930, pl. 7, fig. 20-23.), show the shape, the profile, and the concentric ornamentation similar to *Richthofenia sicula*, on the other hand he described the ventral valve as smooth.

According to Rudwick & Cowen (1967, p. 139) there is a wide intraspecific and ontogenetic variation in shape; in mature specimens, the cone distally flares out into a broad flange, or into an outer cone, which however is rarely perfectly preserved.

Stratigraphic and geographic occurrence. *Sicularia sicula* occurs in the allochthonous limestones of Pietra di Salomone, Rupe del Passo di Burgio and of Rocca di San Benedetto of Sosio Valley, Sicily (Gemmellaro 1894b, 1896a; Schellwien 1900; Di Stefano 1914).

Family Cyclacanthariidae Cooper & Grant, 1975

Subfamily Cyclacanthariinae Cooper & Grant, 1975

Genus *Cyclacantharia* Cooper & Grant, 1969

Type species: *Cyclacantharia kingorum* Cooper & Grant, 1969, from the Guadalupian Word Formation, West Texas.

Remarks. *Cyclacantharia* Cooper & Grant, 1969 is easily distinguished from the other richthofeniids by the presence of a complete circle of very developed rhizoid spines around the base of the cone, and for the absence of a myocoelidium. It differs from *Sicularia* Grant, 1993a by having no median septum in the ventral valve and by showing a less flared cone; from *Sestropoma* Cooper & Grant, 1969, which has a similar interior, by the absence of a coscinidium.

Cyclacantharia spp. ind.

Pl. 1, figs 14-24

Material: Three figured dorsal valves with preserved part of conjoined ventral valves: MPUM10136 (MO203-1b), MPUM10135 (MO203-4b), MPUM10137 (MO203-10a); two dorsal valves with preserved part of relative ventral valves: MPUM10146 (MI200m1-4, MO203-2); six figured ventral valves: MPUM10138 (MO203-1a), MPUM10139 (MO203-1c), MPUM10140 (MO203-1d), MPUM10141 (MO203-3b), MPUM10142 (MO203-4a), MPUM10143 (MO203-10b); ten ventral valves: MPUM10147 (MI200m1-5, MI200-6, MI200-10(a-b), MO201-9(a-c), MO203-3a, MO203-8(a-b)); two figured dorsal valves: MPUM10144 (DMO-1), MPUM10145 (MO203-11); two dorsal valves: MPUM10148 (MO203-3c), MPUM 10463 (DMO-2).

Occurrence: Tunisia, Mine section (MI200); Merbah el Oussif section (MO201, MO203, DMO (scree of the section)).

Description. Small to medium sized, conical ventral valve with rather short axe. Ornamentation of concentric rugae or coarse growth lamellae, and of few spine bases with fragments of spines around 0.35 mm wide in diameter. Dorsal valve, nearly flat or slightly convex, showing a suboval to pear-shaped outline, a well developed neck, and the maximum width at mid-length; ornamentation of irregularly arranged spine bases.

Interior of ventral valve with a thick aulacoterma and a hingement; specimen MO203-10 records the growth path of the sockets and the groove in which the cardinal process is located. The internal ventral surface is characterized by numerous endospines along the internal edge. Interior of dorsal valve with a small bilobed cardinal process, a long median septum, two pairs of muscle scars and endospines.

Dimensions (in mm)

Specimens	Width of dorsal valve or of the section of ventral valve	Length of dorsal valve or of the section of ventral valve	W/L
DMO-1	25	20.5	1.21
MI200m1-4	14	12	1.16
MI200m1-5	16	14.5	1.10
MO201-9a	15	13.5	1.11
MO203-1b	15	12.5	1.2
MO203-2	18.5	18	1.02
MO203-3b	12.5	8	1.56
MO203-4a	9	8.9	1.01
MO203-10a	11	8.5	1.29
MO203-10b	9.5	7.5	1.26
MO203-11	11.8	10.9	1.08

Discussion. The diagnostic features which distinguish the species of *Cyclacantharia*, i.e. the ratio between the total height of the cone and the length of the shell, the apical angle, the nature of the spines and their distribution, the presence of widely flaring aperture and the nature of body chambers, are not clearly observable on the Tunisian specimens, because of their state of preservation; therefore, we cannot proceed with a specific determination. There is a possibility that the present specimens could represent two different species, because they group in two clusters of different size and some of the smaller ones (e.g. MPUM10137 (MO203-10a)) are not juveniles, showing adult characters as pairs of well developed muscular scars.

Termier et al. (1977, p. 55, pl. 14, fig. 4) reported the occurrence of clusters of *Cyclacantharia* cf. *C. kingorum* Cooper & Grant, 1969 from Merbah el Oussif, which probably belong to the same species as the ones here described. However, they do not describe the morphology of their specimens and do not adequately illustrate them.

Family Gemmellaroiidae Williams, 1953

Genus *Gemmellaroia* Cossmann, 1898

Type species: *Megarhynchus marii* Gemmellaro, 1894b, from the Guadalupian of Sosio Valley, Sicily, Italy.

Remarks. According to Grant (1993b, p. 56) and Grant (1995, p. 665), *Gemmellaroia* Cossmann, 1898 has a conical shape, prominent pseudodeltidium, peripheral denticles, and lid-like dorsal valve all of which suggest a strong resemblance to *Cyndalia* Grant, 1993a. A main distinction, however, is the flat, but narrow interarea at each side of the pseudodeltidium of *Cyndalia*. This is absent from *Gemmellaroia*. Furthermore, the cardinalia and the arrangement of septa in the two genera are different, although both of these genera were attached by byssus-like pedicular fibers (Grant 1993b).

Gemmellaroia marii (Gemmellaro, 1894b)

Pl. 1, figs 25-27

1894b *Megarhynchus marii* Gemmellaro, p. 7.

1896b *Megarhynchus marii* - Gemmellaro, p. 118, pl. A, figs 18-29.

1926 *Megarhynchus marii* - Fabiani, p. 614.

1928 *Gemmellaroia marii* - Licharew, p. 279, text-fig. 12.

1930 *Megalorhynchus* (sic) *marii* - De Gregorio, p. 20.

1933 *Megarhynchus marii* - Douvillè, Solignac & Berkaloff, p. 22.

1934 *Megarhynchus marii* - Solignac, p. 10 and 21.

1957 *Gemmellaroia marii* - Termier & Termier, p.202, pl. 3c-h.

1977 *Gemmellaroia marii* - Termier, Termier & Vachard, p. 54, pl. 14, figs. 1-2, text-fig. 6.

1947 *Gemmellaroia marii* - Greco, p. 21, pl. 3 [18], figs. 26-32.

1967 *Gemmellaroia mariae* (sic) - Rudwick & Cowen, p. 132, pl. 35, figs. 1-14.

Material: Two figured interiors of ventral valves: MPUM10149 (TMO3-8a), MPUM10150 (TMO3-8b); one figured interior of dorsal valve: MPUM10151 (TMO3-8d); one fragment: MPUM10152 (TMO3-8c).

Occurrence: Tunisia, Merbah el Oussif section (TMO3).

Description. Two ventral valves, 14.2-20.5 mm wide and 13.1-19 mm long, have a sac-shaped profile in transversal section, and show the section of the pseudodeltidium; the myocoelidium is present and seems to be 3.9 mm wide and 2.8 mm long in specimen MPUM10150 (TMO3-8b). The internal margins of the valves are denticulate, with 0.1-0.2 mm wide denticles. Dorsal valve with oval outline, 10.9 mm wide and 10.7 mm long.

Interior of dorsal valve with a small cardinal process, disposed on the internal floor of the lophidium, and a median septum, 2.5 mm long; adductors scars start from the base of the septum, next to two lateral, butterfly-shaped brachial ridges; denticulate internal margins, well adapted to the corresponding ventral denticulation.

Discussion. Notwithstanding their poor state of preservation, the present specimens are identified as *Gemmellaroia marii* (Gemmellaro, 1894b), based on their dimensions, the shape and the nature of the myocoelidium and the internal structures of the dorsal valve. According to Rudwick & Cowen (1967), most other species of *Gemmellaroia,* including *G. granulosa* (Gemmellaro, 1896a), *G. ornata* (Gemmellaro, 1896a), *G. minima* (De Gregorio, 1930), and *G. brevis* (Gemmellaro, 1896a), have a variable external shape, but it is doubtful whether more than one biological species is represented. In fact, Branson (1948) placed *G. brevis* and *G. granulosa* in synonymy with *G. marii*.

Stratigraphic and geographic occurrence. *Gemmellaroia marii* has been known from the allochthonous limestones of Pietra di Salomone, of Rupe del Passo di Burgio, of Rocca di San Benedetto and of Rupe di San Calogero of Sosio Valley, Sicily, Italy (Gemmellaro 1894b; 1896b; Fabiani 1926), and from Tunisia (Solignac 1934; Termier & Termier 1957; Termier et al. 1977).

Suborder **Lyttoniidina** Williams, Harper & Grant, 2000

Superfamily Lyttonioidea Waagen, 1883

Family Lyttoniidae Waagen, 1883

Subfamily Lyttoniinae Waagen, 1883

Genus *Leptodus* Kayser, 1883

Type species: *Leptodus richthofeni* Kayser, 1883 from the Lopingian of Lo-Ping, China

Remarks. The poor preservation of the type material of *L. richthofeni* and the almost simultaneous publication in 1883 of *Leptodus* and *Lyttonia* by Kayser and Waagen respectively for congeneric species have played an important part in the proliferation of subjective synonyms. *Spinolyttonia* Sarytcheva, 1964, *Juxoldhamina* Liang, 1990, *Semigublerina* Liang, 1990, are considered junior synonyms of *Leptodus* after Williams et al. (2000).

Leptodus nobilis (Waagen, 1883)

Pl. 1, fig. 28

1883 *Lyttonia nobilis* Waagen, p. 398, pl. 29, figs 1-3; pl. 30, figs 1-2, 5-6, 8, 10-11.

1891b *Lyttonia waageni* Gemmellaro, p. 5.

1897 *Lyttonia nobilis* - Diener, p. 37, pl. 1, figs 5-7.

1905 *Lyttonia nobilis* - Noetling, p. 140, pl. 17, figs 1-2; pl. 18, figs 1-11; text-fig. 2.

1913 *Lyttonia nobilis* - Mansuy, p. 123, pl. 13, fig. 10.

1924 *Lyttonia nobilis* - Albrecht, p. 289, figs 1a-b.

1931 *Lyttonia nobilis* - Grabau, p. 285, pl. 28, figs 4-5.

1932 *Lyttonia nobilis* - Huang, p. 89, pl. 7, figs 9-10; pl. 8, figs 8-9; pl. 9, figs 1-8.

1933 *Lyttonia nobilis* - Huang, p. 93, pl. 11, fig. 22.

1933 *Lyttonia nobilis* - Simic, p. 49, pl. 4, fig. 1.

1933 *Lyttonia richthofeni* var. *nobilis* - Parona, p. 12, figs. 10-18.

1957 *Leptodus nobilis* - Termier and Termier, p. 207, fig. 4h, not figs. 4e-g.
1958 *Leptodus nobilis* - Ramovs, p. 497, pl. 2, fig. 3.
1961 *Leptodus nobilis* - Chi-Thuan, p. 274, pl. 1, fig. 1.
1962 *Leptodus nobilis* - Chi-Thuan, p. 488, pl. 1, fig. 1.
1963 *Leptodus nobilis* - Schréter, pl. 3, figs 7-8.
1964 *Leptodus nobilis* - Glaus, p. 504, pl. 1; pl. 2, fig. 1.
1965 *Leptodus nobilis* - Sarytcheva and Sokolskaja in Ruzhentsev and Sarytcheva, pl. 39, figs 6-8.
1967 *Lyttonia* "Form A" - Rudwick & Cowen, p. 153, pl. 42, figs 2-5, 8-10, 12.
1974 *Leptodus nobilis* - Cooper and Grant, pl. 191, figs 8-9.
1976 *Leptodus nobilis* - Grant, pl. 43, figs 18-19.
1977 *Leptodus nobilis* - Termier, Termier & Vachard, p. 56, pl. 14, fig.5.
1978 *Leptodus nobilis* - Feng and Jiang, p. 269, pl. 100, fig. 2.
1979 *Leptodus nobilis* - Jin and Ye in Jin et al., p. 82, pl. 23, fig. 15.
1984 *Leptodus nobilis* - Yang, p. 226, pl. 35, fig. 12.
1986 *Leptodus nobilis* - Sremac, p. 30, pl. 10, figs 1-2.
1987 *Leptodus nobilis* - Tazawa, figs 30.5, 31.2.
1990 *Leptodus nobilis* - Liang, p. 225, pl. 40, figs 1, 5.
1990 *Semigublerina* sp. 1 Liang, p. 233, pl. 41, figs 1, 2.
1990 *Semigublerina flabelata* Liang, p. 231, pl. 41, figs 4-8.
1990 *Semigublerina gabata* Liang, p. 232, pl. 41, fig. 9.
1990 *Semigublerina ovata* Liang, p. 233, pl. 41, fig. 10.
1994 *Leptodus nobilis* - Leman, pl. 1, figs 3-4.
1995 *Leptodus nobilis* - Zeng et al., pl. 11, fig. 3.
1998 *Leptodus nobilis* - Tazawa et al., p. 241, figs 2.1, 2.2, 4.
2001 *Leptodus nobilis* - Tazawa, p. 297, figs 7.13-7.14.
2002 *Leptodus nobilis* - Shen et al., p. 679, fig. 5.28.
2003 *Leptodus nobilis* - Tazawa, p. 31, figs 4.1-4.2.
2005 *Leptodus nobilis* - Campi et al., p. 125, pl. 4, figs A-B.

Material: One figured ventral valve with impression of the interior: MPUM10153 (LTCP3-1b).

Occurrence: Tunisia, Djebel Tebaga section, LTCP3 loose block at the top of Unit III.

Description. Convex ventral valve with oval outline, 19 mm wide and 21.5 mm long. Interior of ventral valve with almost straight median septum, 0.9 mm wide, and straight lateral septa, which can be weakly arcuate, intersecting at 90° to median septum. The distance between the lateral septa is 1.7-1.9 mm.

Discussion. The present specimen belongs to *Leptodus nobilis* (Waagen, 1883) for the numerous and straight or slightly arcuate lateral septa, intersecting at 90° the median septum. The synonymy here reported is mostly taken from Tazawa (2001; 2003).

Termier & Termier (1957) identified the specimens *e-g*, figured on their text-plate 4, p. 205, as *Leptodus* cf. *L. nobilis*, and not as *Leptodus tenuis* (Waagen, 1883) or *Leptodus richthofeni* Kayser, 1883, because of the presence of bending lateral septa; however, the other observable characters are not sufficient for a specific determination.

Stratigraphic and geographic occurrence. *Leptodus nobilis* occurs in the Guadalupian of Southern Tunisia (Termier & Termier 1957; Termier et al. 1977), in the allochthonous limestones of Pietra di Salomone and of Rocca di San Benedetto of Sosio Valley, Sicily, Italy, (Gemmellaro 1891b; Parona 1933), in the Lopingian of Transcaucasia and Iran (Ruzhentsev & Sarytcheva 1965; Glaus 1964). This species also occurs in the Guadalupian-Lopingian of South China, Salt Range, Malaysia, Cambodia, Japan, Mongolia, SW Yunnan (Baoshan Block), Kashmir, Timor and Southeastern Europe (see Tazawa 2003; Campi et al. 2005).

Leptodus tenuis (Waagen, 1883)

Pl. 1, fig. 29

1883 *Lyttonia tenuis* Waagen, p. 401, pl. 30, figs. 3, 4, 7, 9.
1913 *Leptodus tenuis* - Mansuy, p. 19, pl. 4, fig. 4; pl. 5, fig.1.
1932 *Leptodus tenuis* - Huang, p. 95, pl. 19, figs. 9, 11.
1932 *Oldhamina squamosa* var. *anshunensis* Huang, p. 77, pl. 6, fig. 7 only.
1962 *Leptodus* cf. *tenuis* - Chi-Thuan, p. 489, pl. 1, fig.2.
1964 *Leptodus* cf. *tenuis* - Glaus, p. 505, pl. 3.
1979 *Leptodus tenuis* - Zhan, p. 94, pl. 9, fig.24; pl. 12, fig.14; pl. 13, fig. 15.
1979 *Oldhamina minor* Zhan, p. 93, pl. 13, fig. 16.
1984 *Leptodus tenuis* - Yang, p.226, pl. 35, fig. 13.
1990 *Leptodus tenuis* - Liang, p. 226, pl. 40, fig. 9.
1995 *Leptodus tenuis* - Zeng et al., pl. 11, fig. 4.
2002 *Leptodus tenuis* - Campi et al., fig. 6J.
2005 *Leptodus tenuis* - Campi et al., p. 126, pl. 4, figs. C, F.

Material: One figured ventral valve with impression of the interior: MPUM10154 (LTCP3-1f).

Occurrence: Tunisia, Djebel Tebaga section, LTCP3 loose blocks at the top of Unit III.

Description. Ventral valve with oval outline, 40 mm wide and >39.5 mm long. Interior with straight median septum, >26.5 mm long, 0.5-1.1 mm wide; lateral septa bending at their distal terminations, intersecting at nearly 90° to median septum. The distance between the lateral septa is 1.9-2.5 mm.

Discussion. *Leptodus tenuis* differs from *Leptodus nobilis* (Waagen, 1883) because of its lateral septa bending at their lateral termination, and not straight as in *L. nobilis*; also the distance between the lateral septa is greater. However, Campi et al. (2005, p. 125, pl. 4) states that in *L. nobilis* the lateral septa are relatively widely spaced. *Leptodus richthofeni* Kayser, 1883 shows lateral septa which are more bent than those of *L. tenuis*. Therefore, *Leptodus tenuis* appears intermediate between *L. richthofeni* and *L. nobilis* in terms of the lateral septa arrangement. In *L. richthofeni* the lateral septa intersect the median septum at an angle of 30-75°.

Stratigraphic and geographic occurrence. *Leptodus tenuis* occurs in the Guadalupian-Lopingian of South China, Salt Range, Cambodia, Yunnan, Ussuriland and Malaysia (Campi et al. 2005); *L. tenuis* has been also found in the Changhsingian of Iran (Glaus 1964).

Leptodus sp. ind.

Pl. 1, figs 30-31

Material: One figured lobate brachidial plate: MPUM10155 (LTCP3-1g); one figured fragment of ventral valve interior MPUM10156 (MO203-9).

Occurrence: Tunisia, Djebel Tebaga section, LTCP3 loose block at the top of Unit III. Merbah el Oussif section (MO203).

Description. Lobate brachidial plate with slightly sinuose median incision, >40 mm long and 1,1 mm wide, and with straight lateral lobes, 0.9-1.1 mm wide and 1.8-2.5 mm spaced. The lateral lobes intersect the median incision at nearly 75°. The maximum width of the specimen is 36.5 mm, the length is >43 mm. Interior of ventral valve with almost straight and rough-edge lateral septa, which seem intersecting the median septum at 90°. The distance between the lateral septa is 2.5-2.6 mm. The surface is covered by small and numerous endospines.

Discussion. The uncertainty about the specific determination of specimen MPUM10155 (LTCP3-1g) is prompted by its state of poor preservation and by the simultaneous presence of characters typical of different species, i.e. the low angle between the median incision and the lateral lobes, typical of *L richthofeni*; the straight lateral lobes, characteristic of *L. nobilis*; and the distance between the lateral lobes, typical of *L. tenuis*. It is also difficult to give a specific determination to specimen MO203-9 because of its poor preservation.

Genus *Pirgulia* Cooper & Muir-Wood, 1951

Type species: *Lyttonia conica* Gemmellaro, 1891b, from the Guadalupian of Sicily, Italy.

Remarks. De Gregorio (1930) erected *Lyttonia* (*Pirgula*)? *pedicula* for lyttoniids with conical forms. The name *Pirgula* was pre-occupied, hence Cooper & Muir-Wood (1951) renamed it *Pirgulia* and raised it to generic rank. The Sicilian specimens with the ventral valve strongly conical referred to as *Lyttonia* "Form B" by Rudwick & Cowen (1967) should belong to *Pirgulia* based on their conical shape, as also suggested by Rudwick & Cowen (1967, p. 153). These authors raised doubts on the possible inclusion of their *Lyttonia* "Form A" in *Pirgulia*, as it does not have a conical ventral valve. We agree with this exclusion, and we consider *Lyttonia* "Form A", which also includes *Lyttonia waageni* Gemmellaro, 1891b (see Rudwick & Cowen 1967, p. 153), as belonging to the genus *Leptodus*.

In 1933, Parona noted that *Lyttonia pedicula* De Gregorio, 1930 and *Vincia asymmetrica* De Gregorio, 1930 were probably synonyms of *Lyttonia conica* Gemmellaro, 1891b. After having examined the literature and the type specimens of *Lyttonia conica* housed in "G. Gemmellaro" Museum in Palermo we conclude that *Lyttonia pedicula* De Gregorio, 1930 is a junior synonym of *Lyttonia conica* Gemmellaro, 1891b, now in *Pirgulia*, because it shows the same size, shape, and outline, and the same number, arrangement and spacing of lateral septa.

As Cooper & Grant (1974, p. 407) pointed out, another completely conical lyttoniid is *Eolyttonia gigantea* Cooper & Grant, 1974, from the Permian of Texas. However, it is not a tapering cone like *Pirgulia*, but it has a broadly rounded base with a fairly broad surface of attachment. *Pirgulia* principally differs from *Choanodus* Cooper & Grant, 1974, in having a slender and symmetric shaped ventral valve and lateral septa more symmetrically disposed, and from *Collemataria* Cooper & Grant, 1974, in showing a greater symmetry and often a greater number of lateral septa, so that they appear thinner.

Williams et al. (2000, p. 623) observed that in the lyttonioid ventral valve there is no interarea, but the posterior part of the ventral valve is extended antero-dorsally as a flap to overlie the dorsal valve, which is accommodated by a triangular impression. In at least two distinct genera, *Keyserlingina* Tschernyschev, 1902 and *Pirgulia*, the flap grew forward with the rest of the ventral valve to form a deep cone. *Keyserlingina* differs from *Pirgulia* in having smaller dimensions, subconical shape, broader attached posterior surface, less numerous and relatively wider lateral septa, and the median septum splitting at the anterior end.

Pirgulia differs from *Leptodus* because of its conical and compressed ventral valve, the more closely spaced and blunt lateral septa, which usually are oblique, with their distal extremities located more anteriorly than their point of intersection with the median septum.

Pirgulia conica (Gemmellaro, 1891b)

Pl. 1, figs 32-35

1891b *Lyttonia conica* Gemmellaro, p. 1.

1930 *Lyttonia*? *(Pirgula) pedicula* De Gregorio, p. 30, pl. 9, figs 8-10.

1933 *Lyttonia conica* - Parona, p. 8, figs. 1-9.

1967 *Lyttonia* " Form B" - Rudwick & Cowen, p. 153, pl. 43, figs. 1-11.

Material: Three figured ventral valves: MPUM10157 (MO200-1), MPUM10159 (MO203-1a), MPUM10158 (MO203-5); one figured fragment of ventral valve: MPUM10160 (DMO-3).

Occurrence: Tunisia, Merbah el Oussif section (MO200, MO203, DMO (scree of section)).

Description. Medium to large sized, conical ventral valve, elongate and triangular in outline; maximum width anterior to the umbo, at the opposite end. The axis of the ventral valve is recurved in the antero-postero

direction only in the umbonal region; the umbo is pointed and obliquely broken, showing an elongate and small opening; the distal part of the cone has an oval outline. Interior of ventral valve MPUM10157 (MO200-1) with numerous, symmetric and blunt lateral septa, which can be almost straight or rather arcuate; they intersect the median septum at about 90° or lower angle; the distance between the lateral septa is 1-2.9 mm.

Dimensions (in mm)

Specimens	Width	Length	W/L
MO200-1	44	82	0.53
MO203-1a	36	39.5	0.91
MO203-5	16	28	0.57

Discussion. The present form is identified with *Pirgulia conica* (Gemmellaro, 1891b) because of their conical and compressed ventral valve and the blunt septa.

Stratigraphic and geographic occurrence. *P. conica* has also been found in the allochthonous limestones of Pietra di Salomone and of Rocca di San Benedetto of Sosio Valley, Sicily, Italy (Gemmellaro 1891b, De Gregorio 1930, Parona 1933, Rudwick & Cowen 1967).

Superfamily Permianelloidea He & Zhu, 1979

Family Permianellidae He & Zhu, 1979

Genus et Species indet.

Material: Two ventral valves: MPUM10161 (THJ8-3, THJ8-7).
Occurrence: Tunisia, Halq Jemel section (THJ8).

Description. Small sized, with subtriangular and elongated outline. The specimen MPUM10161 (THJ8-3) is 13 mm wide and 18 mm long; the specimen MPUM10161 (THJ8-7) is 7.5 mm wide and 12.5 mm long. The ventral valves show a thick shell and a prominent but not recurved umbo with a foramen.

Discussion. The two specimens do not have sufficient diagnostic characteristics to allow generic determination. However, they seem to be similar to the genus *Dicystoconcha* Termier & Termier in Termier et al., 1974, because of the weak asymmetry, the subtriangular profile, the presence of a foramen and the shallow anterior indentation.

Order **Orthotetida** Waagen, 1884

Suborder **Orthotetidina** Waagen, 1884

Superfamily Orthotetoidea Waagen, 1884

Family Meekellidae Stehli, 1954

Subfamily Meekellinae Stehli, 1954

Genus *Sicelia* Gortani & Merla, 1934

Type species: *Canavaria acropedion* Merla, 1928, p. 5, from the Guadalupian of Sosio Valley, Sicily, Italy.

Remarks. Ruiz (1932) replaced the generic name *Canavaria* Merla, 1928 with *Gemmellaria* and attributed it to Fabiani nom. mut. (*in schedis*) because *Canavaria* was preoccupied. Later, in 1934, Gortani & Merla replaced *Gemmellaria* with *Sicelia*. In terms of nature of the dental plates inside the ventral valve, *Sicelia* shows intermediate characters between *Ombonia* Caneva, 1906 and *Perigeyerella* Wang, 1955. *Ombonia* has an elevated spondylium that remains always raised on a septum until its anterior termination (Grant 1995). *Perigeyerella* has dental plates which initially form an elevated spondylium, but then pass to a sessil spondylium and finally extend separate and parallel along the floor of the valve (Angiolini & Bucher 1999). *Sicelia* has plates which do not join to the median septum and which, in transverse section through the umbonal region, show a "V" shape, that remains uniform anteriorly; when the plates diverge slightly, the floor of the valve in between then is thickened. Other differences between *Sicelia* and *Ombonia* were emphasized by Greco (1942, p. 139), who indicated that *Sicelia* has a higher interarea, a flat dorsal valve, and a more developed cardinal process. The cardinal process of *Canavaria acropedion* was described by Merla (1928, p. 15) as having a bifurcate end, like *Geyerella* Schellwien, 1900; in *Ombonia* the cardinal process is bilobed too, but it is much shorter.

Meekella White & St. John, 1867 differs from *Sicelia* by having parallel plates never converging to form a spondylium and a plicate shell.

Sicelia merlai Greco, 1938

Pl. 1, fig. 36

1932 *Streptorhynchus pelargonatus* - Ruiz, p. 12 (not pl. 1, figs. 4a-4c, 5).
1932 *Meekella evanescens* - Ruiz, p. 15 (not pl. 1, figs. 9a, 9b).
1932 *Meekella uncitoides* - Ruiz, p. 16, pl. 1, figs. 10a, 10b.
1938 *Sicelia merlai* Greco, p. 23, pl. 1, figs. 15-17.
1942 *Sicelia merlai* - Greco, p.144, pl. 19 [13], figs. 6-11.

Material: One figured fragment of ventral valve: MPUM10162 (TS15-20).
Occurrence: Tunisia, Souinia section (THJ8).

Description. Slightly convex ventral valve, with long and narrow shape and pointed umbo; interarea high, concave, subtriangular, striated and tilted towards one side so that one flank is convex, the other concave; its base is straight, 19 mm wide and ~22 mm long; a

pseudodeltidium clearly visible, 3.5 mm wide, with a median, longitudinal ridge. Ornamentation of numerous, poorly expressed costellae, whose number at the anterior margin is 14 per 5 mm; irregular, concentric rugae cross the costellae.

Interior of ventral valve with almost straight dental plates meeting at the floor of the valve with a thickening in between, forming neither a septum nor a spondylium and showing a "V" shape near umbo.

Discussion. According to Greco (1938, p. 23; 1942, p. 145) *Sicelia merlai* is similar to *Sicelia acropedion* (Merla, 1928), but *S. merlai* has a more irregular and more slender shape, a shorter cardinal margin and a narrower and higher ventral interarea. Because of its shape and of the features of the ventral interarea, the present specimen is assigned as *Sicelia merlai*.

According to Greco (1947), *Megalorhynchus minimus* De Gregorio, 1930 is a junior synonym of *Sicelia merlai*. However, as it is figured by hand drawings only, it si impossible to confirm this synonymy.

Stratigraphic and geographic occurrence. *Sicelia merlai* Greco, 1938 is also known from the allochthonous limestones of Pietra di Salomone of Sosio Valley, Sicily, Italy.

Sicelia sp. ind.

Pl. 1, fig. 37

Material: One figured ventral valve: MPUM10163 (MI201-1).
Occurrence: Tunisia, Mine section (MI201).

Description and discussion. The single available ventral valve shows a considerable longitudinal convexity; subtriangular shape; 35 mm wide and >29 mm long. Maximum width anteriorly to the midlength. Ornamentation of the ventral valve consists of numerous, fine costellae, whose number at anterior margin is 19 per 5 mm; irregular, concentric rugae can cross the costellae.

Interior of ventral valve with almost straight dental plates meeting at the floor surface, forming neither a septum nor a spondylium, and showing a "V" shape near umbo, so that they divide the interior in three subtriangular chambers. Where the plates join, the floor is thickened.

Interior of dorsal valve showing a long cardinal process.

The state of preservation does not allow a specific determination.

Subfamily Omboniinae Sokolskaya, 1960

Genus *Ombonia* Caneva, 1906

Type species: *Streptorhynchus tirolensis* Stache, 1878, from the Lopingian of the Dolomites, Italy.

Remarks. *Ombonia* Caneva, 1906 is characterized by its ventral interior with dental plates that connect above the valve floor to form an elevated spondylium with "Y" shape that remains elevated to its anterior termination. *Geyerella* Schellwien, 1900 and *Perigeyerella* Wang, 1955 also have a spondylium in the ventral valve, but differ from *Ombonia* by the following characters: *Geyerella* has a spondylium with "Y" shape which remains similar during the ontogenetic development, but differs from *Ombonia* in having plication on the shell surface; *Perigeyerella* is characterized by the elevated spondylium in the umbonal region like *Ombonia*, but this passes anteriorly to a sessile spondylium, like *Sicelia* Gortani & Merla, 1934, and then ends with parallel plates along the floor of the valve, like *Meekella* White & John, 1867.

Ombonia differs from *Sicelia* because the latter can be irregularly plicated and shows dental plates meeting at the valve floor at the umbo, diverging only slightly forward, and a longer and stouter bilobed cardinal process; from *Streptorhynchus* King, 1850 because the latter lacks internal plates in the ventral valve.

Ombonia magna Greco, 1938

Pl. 1, figs 38-43; Pl. 3, figs 20-23

1928 *Canavaria acropedion* Merla, p. 72, pl. 2 [1], fig. 1 (not figs. 2-4, 8-10, 13-15).
1932 *Streptorhynchus pelargonatus* - Ruiz, p. 12, pl. 1, figs. 4a-4c (not fig. 5).
1932 *Streptorhynchus pseudopelargonatus* - Ruiz., p. 13, pl. 1, figs 6a-6c.
1932 *Derbya buchi* - Ruiz, p. 14.
1932 *Orthotetes guadalupensis* - Ruiz, p. 14, pl. 1, figs. 7a-7c.
? 1932 *Orthotetes distortus* - Ruiz, p. 15, pl. 1, figs. 8a, 8b.
1932 *Meekella evanescens* - Ruiz, p. 15 (not pl. 1, figs. 9a, 9b).
1932 *Meekella uncitoides* - Ruiz, p. 16 (not pl. 1, figs. 10a, 10b).
? 1932 *Geyerella distorta* - Ruiz, p. 20.
1932 *Gemmellaria acropedion* - Ruiz, p. 20, pl. 2, figs. 7a, 7b.
1938 *Ombonia magna* Greco, p. 9-13, 24, pl. 1, figs. 18-20; pl. 2, figs. 1-7.
1942 *Ombonia magna* - Greco, p. 147-150, pl. 19 [13], figs. 12-16.

Material: Three figured articulated specimens: MPUM10164 (TS10-5); MPUM10168 (TS12-1); MPUM10254 (TS10-2); one articulated specimen: MPUM10169 (MO205-2); two figured ventral valves: MPUM10166 (MO205-1); MPUM10165 (TS12-7); one ventral valve: MPUM10170 (MO205-3); one figured dorsal valve: MPUM10167 (TS12-9); two dorsal valves: MPUM10171 (LTS2D-3; TS14-10); three fragments: MPUM10172 (TS10-3; TS12-2(a- b)).
Occurrence: Tunisia, Souinia section (LTS2D, TS10, TS12, TS14); Merbah el Oussif section (MO205).

Description. Small to medium sized, strongly inequivalve, biconvex to convex-plane, with subconical or suboval outline and slightly uniplicate anterior commissure; cardinal margin straight.

Ventral valve subconical, usually convex with the maximum convexity at the posterior region, sometimes

nearly flat, or more rarely concave MPUM10168 (TS12-1); it shows a convex to flat, high interarea. Ornamentation parvicostellate with fine, neat costellae with rounded tops and irregular concentric rugae; the number of costellae per 5 mm is 17 at 5 mm from the umbo and 20 at the anterior margin.

Dorsal valve convex, with transversely suboval outline; it shows a shallow sulcus becoming wider anteriorly. Ornamentation similar to the one of ventral valve, except for the rugae which are absent or weaker. The number of costellae per 5 mm is 16 at 5 mm from the umbo and 17 at the anterior margin.

Interior of ventral valve with dental plates fused to the median septum to form a spondylium, which remains constant during ontogenetic development and shows a "Y" shape in cross section. Interior of dorsal valve with a bilobed cardinal process which extends to half the depth of the ventral valve and lies between the dental plates in the articulate specimens.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness	Cardinal margin length	Ventral interarea height
MO205-1	31.5	>32	<1	/	/	/
TS10-2	~17	/	/	>9	/	/
TS10-5	15	12	1.25	10	14	7
TS12-1	30	>25	/	/	>28	>17
TS12-7	26	29	0.89	/	/	/
TS12-9	27	>20	/	/	~17	/
TS14-10	~22	19	>1	/	/	/

Discussion. The specimens from Tunisia belong to *Ombonia magna* Greco, 1938 because of its "Y" shaped spondylium which remains elevated up to its anterior termination, the absence of plicae, and the ornamentation.

Based on the study of internal characters, Greco (1938; 1942) suggested that the specimen illustrated by Merla (1928, pl. 2[1], fig. 1) as *Canavaria acropedion* is in fact an *Ombonia magna*.

Ombonia antalyensis Angiolini, Carabelli, Nicora, Crasquin-Soleau, Marcoux & Rettori, 2007 from the Lopingian of Turkey has a smaller size, a transversely suboval and flabellate outline, absence of rugae and a slightly greater number of costellae per 5 mm. *Ombonia tirolensis* (Stache, 1878), described by Posenato et al. (2005) from the Dolomites, has a smaller size, a low conical shell and no rugae.

Stratigraphic and geographic occurrence. *Ombonia magna* Greco, 1938 has been previously found in the allochthonous limestones of Pietra di Salomone of Sosio Valley, Sicily, Italy.

Family Schuchertellidae Williams, 1953

Subfamily Streptorhynchinae Stehli, 1954

Genus *Streptorhynchus* King, 1850

Type species: *Terebratulites pelargonatus* von Schlotheim, 1816, from the Guadalupian of Germany.

Remarks. *Streptorhynchus pelargonatus* (von Schlotheim, 1816) is a subconical and non-plicated schuchertellid without plates in the ventral valve, with a bilobed cardinal process and deep sockets supported by divergent crural plates (Grant 1976).

Streptorhynchus sp. ind.

Pl. 2, fig. 1; Pl. 3, fig. 24

Material: One figured ventral valve: MPUM10173 (TS15bis-8).
Occurrence: Tunisia, Souinia section (TS15bis).

Description. Convex, subconical ventral valve, >25 mm long and ~26 mm wide. The valve surface is non-plicate and covered by coarse, widely spaced costellae with different thickness and undulating near the anterior margins, crossed by irregular rugae; at 5 mm from the umbo the costellae number six per 5 mm, whereas at anterior margin they number seven per 5 mm.

Interior of ventral valve characterized by the absence of any plates.

Discussion. The Tunisian specimen may be ascribed to the genus *Streptorhynchus* for the absence of any plates in the ventral interior, the ornamentation and the general shape. The undulating costellae recurved at the anterior margin are a typical feature of the genus. However, the poor state of preservation does not allow a specific determination.

Class **Rhynchonellata** Williams et al., 1996

Order **Orthida** Schuchert & Cooper, 1932

Suborder **Dalmanellidina** Moore, 1952

Superfamily Enteletoidea Waagen, 1884

Family Enteletidae Waagen, 1884

Genus *Enteletes* Fischer de Waldheim, 1825

Type species: *Enteletes* glabra Fischer de Waldheim, 1830, from the Namurian of Russia.

Remarks. The genus *Enteletes* Fischer de Waldheim, 1825 is characterized by its uniplicate anterior commissure which differentiates it from the genera *Peltichia* Jin & Liao in Jin & Sun, 1981, *Enteletina* Schuchert & Cooper, 1931 and *Mapintichia* Li in Li, Yang & Feng, 1986 According to Shen & Shi (2007), the genus *Parenteletes* King, 1931 is similar, but bears an unisul-

cate anterior commissure and a -shaped chamber under the anterior extension of the ventral median septum.

Enteletes waageni Gemmellaro, 1892

Pl. 2, figs 2-7

1892 *Enteletes waageni* Gemmellaro, p. 23.
1897 *Enteletes tschernyscheffi* Diener, p. 67, pl. 5, fig. 11 (not figs 7-10).
1899 *Enteletes waageni* - Gemmellaro, p. 280, pl. 28, figs. 13-15; pl. 29, figs 16-27.
1899 *Enteletes contractus* Gemmellaro, p. 274, pl. 28, figs. 16-23.
1903 *Enteletes waageni* - Diener., p. 28-29.
1930 *Enteletes waageni* - De Gregorio, p. 19, not p. 21, pl. 4, figs. 8-10 (var. *nudum*); not pl. 4, figs. 1-4 (var. *imperans*).
1934 *Enteletes contractus* - Solignac, p. 10 and 21.
1942 *Enteletes waageni* - Greco, p. 129, pl. 17 [11], figs. 3-5.
1944 *Enteletes waageni* - Reed, p. 15, pl. 2, figs. 6-7.

PLATE 2

Fig. 1 - *Streptorhynchus* sp. ind. Ventral valve. MPUM10173 (TS15bis-8), x1.
Fig. 2 - *Enteletes waageni* Gemmellaro, 1892. Ventral view of an articulated specimen. MPUM10174 (TS15bis-39), x1.
Fig. 3 - *Enteletes waageni* Gemmellaro, 1892. Anterior view of an articulated specimen. MPUM10174 (TS15bis-39), x1.
Fig. 4 - *Enteletes waageni* Gemmellaro, 1892. Postero-dorsal view of an articulated specimen. MPUM10174 (TS15bis-39), x1.
Fig. 5 - *Enteletes waageni* Gemmellaro, 1892. Lateral view of an articulated specimen. MPUM10174 (TS15bis-39), x1.
Fig. 6 - *Enteletes waageni* Gemmellaro, 1892. Ventral valve. MPUM10175 (LTS2D-1), x1.
Fig. 7 - *Enteletes waageni* Gemmellaro, 1892. Anterior view of an articulated specimen. MPUM10176 (TS13-20), x1.
Fig. 8 - *Enteletes imperans* De Gregorio, 1930. Ventral view of an articulated specimen. MPUM10181 (LTS1-40), x1.
Fig. 9 - *Enteletes imperans* De Gregorio, 1930. Anterior view of an articulated specimen. MPUM10181 (LTS1-40), x1.
Fig. 10 - *Enteletes imperans* De Gregorio, 1930. Postero-dorsal view of an articulated specimen. MPUM10181 (LTS1-40), x1.
Fig. 11 - *Enteletes imperans* De Gregorio, 1930. Ventral view of an articulated specimen. MPUM10182 (LTS3D-1), x1.
Fig. 12 - *Enteletes tschernyschewi* Gemmellaro, 1892. Ventral valve. MPUM10183 (TS13-13), x1.
Fig. 13 - *Enteletes* sp. ind. Internal mould of a ventral valve. MPUM10185 (MI201-7), x1.
Fig. 14 - *Enteletes* sp. ind. Interior of a ventral valve. MPUM10186 (Dmine), x1.
Fig. 15 - *Stenoscisma* sp. ind. Ventral view of an articulated specimen. MPUM10189 (TS12-19), x2.
Fig. 16 - *Stenoscisma* sp. ind. Dorsal view of an articulated specimen. MPUM10189 (TS12-19), x2.
Fig. 17 - *Cleiothyridina* sp. ind. Ventral view of an articulated specimen. MPUM10190 (TS12-15), x2.
Fig. 18 - *Cleiothyridina* sp. ind. Dorsal view of an articulated specimen. MPUM10190 (TS12-15), x2.
Fig. 19 - *Cleiothyridina* sp. ind. Ventral view of an articulated specimen. MPUM10191 (LTS1-13), x2.
Fig. 20 - *Cleiothyridina* sp. ind. Dorsal view of an articulated specimen. MPUM10191 (LTS1-13), x2.
Fig. 21 - *Composita advena* Grant, 1976. Ventral view of an articulated specimen. MPUM10193 (TS10-8), x2.
Fig. 22 - *Composita advena* Grant, 1976. Dorsal view of an articulated specimen. MPUM10193 (TS10-8), x2.
Fig. 23 - *Composita advena* Grant, 1976. Ventral view of an articulated specimen. MPUM10194 (TS10-10), x2.
Fig. 24 - *Composita advena* Grant, 1976. Dorsal view of an articulated specimen. MPUM10194 (TS10-10), x2.
Fig. 25 - *Composita advena* Grant, 1976. Ventral view of an articulated specimen. MPUM10195 (TS12-14), x2.
Fig. 26 - *Composita advena* Grant, 1976. Dorsal view of an articulated specimen. MPUM10195 (TS12-14), x2.
Fig. 27 - *Orbicoelia* sp. ind. Ventral valve. MPUM10198 (TMO2-29), x1.
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Fig. 29 - *Martinia* aff. *M. semiplana* Waagen, 1883. Ventral view of an articulated specimen. MPUM10200 (TS10-13), x2.
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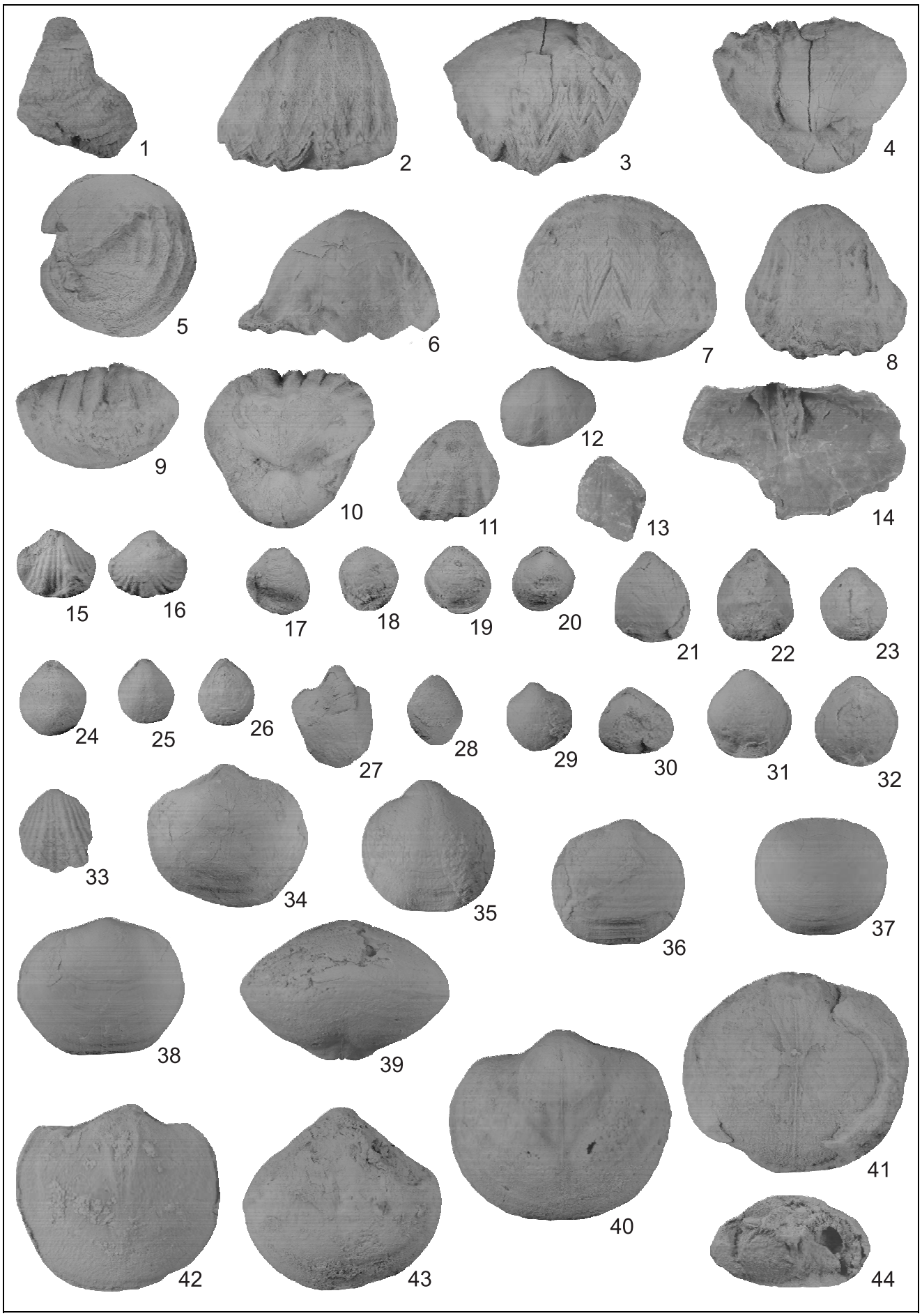
Fig. 31 - *Martinia* aff. *M. semiplana* Waagen, 1883 Ventral view of an articulated specimen. MPUM10201 (TS13-11), x2.
Fig. 32 - *Martinia* aff. *M. semiplana* Waagen, 1883. Dorsal view of an articulated specimen. MPUM10201 (TS13-11), x2.
Fig. 33 - *Bamberina* sp. ind. Ventral valve. MPUM10205 (TS13-25), x2.
Fig. 34 - *Permophricodothyris affinis* (Gemmellaro, 1899). Ventral view of an articulated specimen. MPUM10207 (THJ4-1), x1.
Fig. 35 - *Permophricodothyris affinis* (Gemmellaro, 1899). Ventral view of an articulated specimen. MPUM10208 (THJ5-125), x1.
Fig. 36 - *Permophricodothyris affinis* (Gemmellaro, 1899). Dorsal view of an articulated specimen. MPUM10208 (THJ5-125), x1.
Fig. 37 - *Permophricodothyris affinis* (Gemmellaro, 1899). Dorsal view of an articulated specimen. MPUM10209 (THJ5-106), x1.
Fig. 38 - *Permophricodothyris affinis* (Gemmellaro, 1899). Dorsal view of an articulated specimen. MPUM10210 (THJ4-2), x1.
Fig. 39 - *Permophricodothyris affinis* (Gemmellaro, 1899). Anterior view of an internal mould of an articulated specimen. MPUM10211 (THJ7-3), x1.
Fig. 40 - *Permophricodothyris affinis* (Gemmellaro, 1899). Ventral view of an internal mould of an articulated specimen. MPUM10211 (THJ7-3), x1.
Fig. 41 - *Permophricodothyris affinis* (Gemmellaro, 1899). Ventral view of an internal mould of an articulated specimen. MPUM10212 (THJ7-4), x1.
Fig. 42 - *Permophricodothyris affinis* (Gemmellaro, 1899). Dorsal view of an internal mould of an articulated specimen. MPUM10212 (THJ7-4), x1.
Fig. 43 - *Permophricodothyris affinis* (Gemmellaro, 1899). Dorsal view of an internal mould of an articulated specimen. MPUM10213 (THJ7/3-1), x1.
Fig. 44 - *Permophricodothyris affinis* (Gemmellaro, 1899). Anterior view of an internal mould of an articulated specimen showing the spiralia. MPUM10214 (THJ7/2-38).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1957 *Enteletes contractus* - Termier & Termier, p. 197, pl. Ig-j.
1957 *Enteletes waageni* - Termier & Termier, p. 197, pl. Ia-e.
1977 *Enteletes waageni* - Termier, Termier & Vachard, p. 51.

Material: Two figured articulated specimen: MPUM10174 (TS15bis-39), MPUM10176 (TS13-20); four articulated specimens: MPUM10177 (LTCP2-2, LTS1-3, LTS1-7, TS15bis-6); one figured ventral valve: MPUM10175 (LTS2D-1); one ventral valve: MPUM10178 (TS13-23); two dorsal valves: MPUM10179 (TS13-4, TS13-21); five fragments: MPUM10180 (LTCP2-1, LTCP2-3, LTS1-19, TS13-8, TS13-22).

Occurrence: Tunisia, Souinia section (TS13, TS15bis, LTS1, LTS2D); Djebel Tebaga section, LTCP2 loose block in Unit III.

Description. Medium to large sized, dorsi-biconvex, with subcircular to subtriangular outline. Cardinal margin curved; anterior commissure uniplicate and zigzag. The convexity of the ventral valve is significant, but lower than that of the dorsal valve. Ventral median sulcus becoming wider and deeper anteriorly. Ventral valve plicate, with radial plicae whose number and width are not constant and which do not start directly from the umbo. Ornamentation of fine and numerous costellae. Dorsal valve large and very convex with maximum convexity near the umbo; umbo wide, prominent and pointed; dorsal fold with sharp crest, becoming higher and wider anteriorly. Dorsal valve as plicate as the ventral valve and ornamented by fine and numerous costellae. Growth lamellae, parallel to the zigzag anterior commissure, can be present near the commissure.

Interior of ventral valve with two long and thin dental plates and a long medium septum.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
LTCP2-1	44	/	/	/
LTCP2-2	32	35	0.91	36
LTS1-3	>35	/	/	35
LTS1-7	>32	~29	>1	~30
LTS2D-1	31	/	/	>28
TS13-4	24	~32	~0.75	/
TS13-20	40	/	/	>35
TS15bis-6	~34	~22	~1.54	31
TS15bis-39	38	32	1.18	32

Discussion. The Tunisian specimens are ascribed to the species *Enteletes waageni* Gemmellaro, 1892 because of their large size, their dorsi-biconvex shape with very weakly convex ventral valve and the number and nature of the plicae. *Enteletes tschernyschewi* Gemmellaro, 1892 is similar to *Enteletes waageni,* but differs by having a transversely oval and slightly asymmetrical shell, and a sulcus on the ventral valve which diverts from the median line.

Stratigraphic and geographic occurrence. *Enteletes waageni* Gemmellaro, 1892 has been previously found in the allochthonous limestones of Pietra di Salomone and Rocca di San Benedetto of Sosio Valley, Sicily, Italy (Gemmellaro 1892; Greco 1942), in the Chitichun Limestone (Diener 1897), in the Middle and Upper Productus Limestone of Salt Range (Reed 1944) and in the Bateun Beni Zid and Djebel Seikra sections of Djebel Tebaga (Termier et al. 1977).

Enteletes imperans De Gregorio, 1930

Pl. 2, figs 8-11

1930 *Enteletes waageni* Gemmellaro var. *imperans* De Gregorio, p. 21, pl. 4, figs 1-4.
1942 *Enteletes imperans* - Greco, p. 135, pl. 17, figs 15-16.

Material: Two figured articulated specimens: MPUM10181 (LTS1-40), MPUM10182 (LTS3D-1).

Occurrence: Tunisia, Souinia section (LTS1, LTS3D (scree of LTS3)).

Description. Medium sized, biconvex shell, with subtriangular outline. Cardinal margin curved, anterior commissure zigzag. Flat ventral valve with pointed and wide umbo; ventral sulcus absent. Ventral valve plicate, with plicae starting from the umbo. Ornamentation of numerous, fine costellae and of growth lamellae anteriorly. Dorsal valve more convex and with wiser umbo than the ventral one. Dorsal valve distinctly plicate, ornamented by numerous and fine costellae.

Interior of ventral valve with two long parallel dental plates bisected by a long, thin median septum. Interior of dorsal valve showing two long and divergent brachiophore plates.

Dimensions (in mm)

Specimens	Width	Length	W/L
LTS1-40	32	31	1.03
LTS3D-1	20	22	0.90

Discussion. *Enteletes imperans* was erected by De Gregorio (1930) as a variety of the species *Enteletes waageni* Gemmellaro, 1892 based on one single specimen from his private collection. Subsequently Greco (1942) considered it distinct from *E. waageni*, because of the absence of a median sulcus and the presence of evident plicae starting directly from the umbo; therefore, he renamed the single specimen of De Gregorio (1930) *Enteletes imperans*.

E. imperans is similar to *Enteletes elegans* Gemmellaro, 1899, but the latter shows a smaller size and sharper costae.

Stratigraphic and geographic occurrence. *E. imperans* has been found in the allochthonous limestones of Pietra di Salomone of Sosio Valley, Sicily, Italy (Greco 1942).

Enteletes tschernyschewi Gemmellaro, 1892

Pl. 2, fig. 12

1892 *Enteletes tschernyschewi* Gemmellaro, p. 24.
1899 *Enteletes tschernyschewi* - Gemmellaro, p. 270 and 305, pl. 27, figs 48-57, pl. 28, figs 1-9 and text-figs 14-15.
1930 *Enteletes tschernyschewi* - De Gregorio, p. 19.
1930 *Enteletes waageni nudum* De Gregorio, p. 21, pl. 4, figs 8-10.
1942 *Entetetes tschernyschewi* - Greco, p. 126, pl. 16, figs 17-20; pl. 17, figs 1-2.
2009 *Entetetes tschernyschewi* - Shen & Clapham, p. 721, pl. 2, figs 2-6.

Material: One figured ventral valve: MPUM10183 (TS13-13); one dorsal valve: MPUM10184 (TS15bis-32).
Occurrence: Tunisia, Souinia section (TS13, TS15bis).

Description. Convex ventral valve with the maximum convexity near the wide umbo; oval outline and uniplicate anterior commissure. Ventral sulcus slightly diverts from the median line and starts from the umbo, where it is 1 mm wide and shallow; it reaches the anterior commissure, where it is 5 mm wide and deeper. The ventral sulcus is bounded by two low, but distinct plicae; on one flank a lateral insubstantial plica is also present. Ornamentation of numerous and fine costellae and thin zigzag growth lamellae anteriorly. Dorsal valve convex with subtriangular outline and a low median fold; on each flank there is another very low plica. Ornamentation of numerous costellae and coarse growth lamellae anteriorly.

Interior of ventral valve with thin and parallel dental plates separated by a thin septum. Interior of dorsal valve with two divergent brachiophore plates.

Dimensions (in mm)

Specimens	Width	Length	W/L
TS13-13	21	19	1.10
TS15bis-32	14	15	0.93

Discussion. *Enteletes tschernyschewi* differs from *E. waageni* in having smaller dimensions, less marked and less numerous plicae on the flanks, and a slightly different commissure, which is not zigzagged as in *E. waageni*; from *E. imperans* because of the occurrence of a ventral sulcus, fewer and lower plicae and a more convex ventral valve. *Enteletes tschernyscheffi* Diener, 1897 differs by having a smaller size, stronger and more numerous plicae and a lower convexity.

Stratigraphic and geographic occurrence. *Enteletes tschernyschewi* has been reported from the allochthonous limestones of Pietra di Salomone and Rocca di S. Benedetto of Sosio Valley, Sicily (Gemmellaro 1899; Greco 1942) and from the Lopingian of Hydra, Greece (Shen & Clapham 2009).

Enteletes sp. ind.

Pl. 2, figs 13-14

Material: Two figured ventral valves: MPUM10186 (Dmine), MPUM10185 (MI201-7); five fragments: MPUM10187 (LTS1-11, TS10-6, TS13-6, TS13-24, TS14-2).
Occurrence: Tunisia, Souinia section (LTS1, TS10, TS13, TS14); Mine section (MI201, Dmine (scree of the section)).

Description and discussion. The examined specimens can be ascribed to the genus *Enteletes*, because of the presence of costae and sharp plicae, numerous and fine costellae, the zigzag anterior commissure and the interior of ventral valve showing two thin and subparallel dental plates separated by a thin septum. However, their state of preservation and the incompleteness of diagnostic characters do not allow a specific determination.

Several fragments from LTCP3 indicate the probable occurrence of *Enteletes* sp. ind. in Unit III of Djebel Tebaga section.

Order **Rhynchonellida** Kuhn, 1949

Superfamily Stenoscismatoidea Oehlert, 1887 “1883”

Family Stenoscismatidae Oehlert, 1887 “1883”

Subfamily Stenoscismatinae Oehlert, 1887 “1883”

Genus *Stenoscisma* Conrad, 1839

Type species: *Terebratula schlottheimii* von Buch, 1834, from the Guadalupian of Germany.

Remarks. *Stenoscisma* is similar to *Coledium* Grant, 1965, from which it differs because of the developed stolidium and the lower number of costae in the sulcus.

Stenoscisma sp. ind.

Pl. 2, figs 15-16

Material: One figured articulated specimen: MPUM10189 (TS12-19); one articulated specimen: MPUM 10461 (TS12-16); one external cast of ventral valve: MPUM10188 (TS10-9).
Occurrence: Tunisia, Souinia section (TS10, TS12).

Description. Small shell, with subpentagonal to subcircular outline and equally biconvex profile; umbonal flanks appear concave beside the pointed, small and suberect umbo; anterior commissure uniplicate; presence of a well developed stolidium. Ventral sulcus widening and deepening anteriorly. Ornamentation of neat and thin costae, starting from the umbo and reaching the stolidium; the number of the costae on the sulcus is three, on the flanks at least three to four. Dorsal valve with fold anteriorly; ornamentation of costae numbering three to four on the fold and six to seven on the flanks.

Interior of ventral valve with "V" shaped spondylium.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
TS10-9	6.2	5	1.24	/
TS12-16	7.2	6.1	1.18	3.7
TS12-19	7.4	6.3	1.17	4.8

Discussion. The present specimens resemble *Stenoscisma* species B described by Grant (1976, p. 186, pl. 50, figs. 29-33) from Southern Thailand, but the latter differs in having a greater number of costae in the sulcus and greater dimensions. It is also similar to *Stenoscisma amoenum* Cooper & Grant, 1976, from the Guadalupian of West Texas (p. 2084, pl. 554, figs 1-14), but *S. amoenum* shows no clear stolidium and it has greater dimensions and more numerous costae in the sulcus. *Stenoscisma bellatulum* Cooper & Grant, 1976, from the Cisuralian of West Texas (p. 2086, pl. 556, figs 34-54) is also similar, but it is larger and wider and has less distinct costae, not always starting from the umbonal region.

The Tunisian specimens are similar to *Camarophoria acuminata* Gemmellaro, 1899 (p. 265, pl. 27, figs 8-13) from Sosio, Sicily, but the Sicilian species has a wider sulcus, more numerous and thinner costae in the sulcus, a larger size and a triangular outline; *Camarophoria paronae* (Gemmellaro, 1894a) from Sosio, Sicily, differs for the lower width/length ratio, the more numerous and slightly fine costae, the unequally convex valves (Gemmellaro 1899, p. 266, figs 14-19).

The specimens coming from Chios Island, Greece (Guadalupian), named *Stenoscisma* sp. ind. by Angiolini et al. (2005) are different from the Tunisian species because they show a sulciplicate anterior commissure and weaker and fewer costae.

Termier et al. (1977, p. 57) reported from Tunisia a specimen of *Stenoscisma* sp., which is described as having two costae on the dorsal fold. Being very poorly figured only in Termier & Termier (1957, pl. 5, figs a-b) it is impossible to establish if it belongs the same species as our material.

Order **Athyridida** Boucot, Johnson & Staton, 1964

Suborder **Athyrididina** Boucot, Johnson & Staton, 1964

Superfamily Athyridoidea Davidson, 1881

Family Athyrididae Davidson, 1881

Subfamily Cleiothyridininae Alvarez, Rong & Boucot, 1998

Genus *Cleiothyridina* Buckman, 1906

Type species: *Atrypa pectinifera* de Sowerby, 1840 in 1840-1846, from the Guadalupian of Durham, United Kingdom.

Remarks. According to Cooper & Grant (1976, p. 2134), the surface spines and concentric lamellae of *Cleiothyridina* Buckman, 1906 resemble those of *Permoprhicodothyris* Pavlova, 1965, but differ in their single rather than double bases, and their apparent solidity. *Cleiothyridina* differs further in its lack of interarea, its apical foramen, and possession of dental and hinge plates. *Cleiothyridina* differs from *Composita* Brown, 1845 by its concentric spinose lamellae, and internally by its perforated hinge plate.

Cleiothyridina sp. ind.

Pl. 2, figs 17-20

1957 *Cleiothyridina* sp. - Termier & Termier, p. 211, pl. 7, figs h-j.

Material: Two figured articulated specimens: MPUM10191 (LTS1-13), MPUM10190 (TS12-15); one ventral valve: MPUM10192 (TS15bis-19b).

Occurrence: Tunisia, Souinia section (LTS1, TS12, TS15bis).

Description. Small sized, weakly to moderately strongly biconvex shell, with maximum degree of convexity posteriorly and with subequally convex valves; subcircular to subtriangular outline; maximum width near midlength; slightly uniplicate anterior commissure. Ventral valve, with small, pointed umbo, slightly larger than the dorsal one; ventral sulcus shallow, visible anteriorly. Dorsal valve with a low fold anteriorly. Ornamentation of coarse, imbricate growth lamellae, bearing irregularly arranged solid spines.

Interior of ventral valve with dental plates.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
LTS1-13	6.3	6.6	0.95	3.9
TS12-5	6	6.5	0.92	3.4
TS15bis-19b	6.2	6.1	1.01	/

Discussion. The specific determination of this material is left in open nomenclature as it shows the

external characters of *Cleiothyridina*, but does not display diagnostic specific features.

Subfamily Spirigerellinae Grunt, 1965

Genus *Composita* Brown, 1845

Type species: *Spirifer ambiguus* Sowerby, 1822 in 1821-1822, from the Visean of Derbyshire, England.

Remarks. The longer, more erect beak, larger foramen, more elongate outline, and lack of external spines distinguish *Composita* from *Cleiothyridina* Buckman, 1906. Poorly preserved specimens might be confused with *Martinia* M'Coy, 1844, but they can be distinguished when the oval foramen of *Composita* is visible (Cooper & Grant 1976).

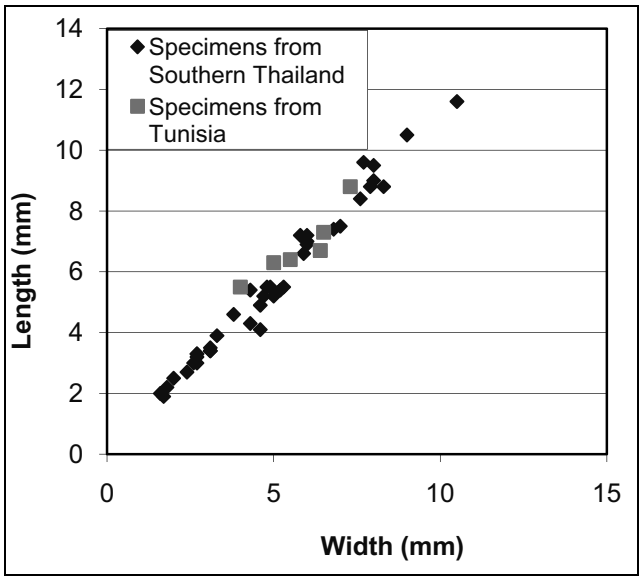


Fig. 6 - Width vs. length relationship of *Composita advena.*

Composita advena Grant, 1976

Pl. 2, figs 21-26; Fig. 6

1976 *Composita advena* Grant, p. 205, pl. 56, figs. 1-60.

Material: Three figured articulated specimens: MPUM10193 (TS10-8), MPUM10194 (TS10-10), MPUM10195 (TS12-14); four articulated specimens: MPUM10196 (LTS1-10 (a, b), TS11-9, TS12-21); one external cast of ventral valve: MPUM10197 (LTS1-10c).

Occurrence: Tunisia, Souinia section (LTS1, TS10, TS11, TS12).

Description. Moderately strongly biconvex shell, with subovate to subpentagonal outline. Shell substance thin. Cardinal margin curved; anterior commissure weakly uniplicate. Ventral valve with small, pointed umbo and a transversally oval foramen; presence of a very shallow sulcus anteriorly. Dorsal valve smaller, less convex than the ventral one. Ornamentation of weak, irregularly spaced growth lamellae anteriorly.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
LTS1-10a	5.5	6.4	0.85	5
LTSI-10b	/	6.5	/	6
LTS1-10c	4	5.5	0.72	/
TS10-8	7.3	8.8	0.82	5.4
TS10-10	6.5	7.3	0.89	4.8
TS11-9	4	6	0.6	5
TS12-14	5	6.3	0.79	3.1
TS12-21	6.4	6.7	0.95	4.2

Discussion. The Tunisian specimens have been assigned to *Composita advena* Grant, 1976 based on their small size (Fig. 6), moderate to high degree of convexity, oval foramen, weakly uniplicate commissure, very shallow sulcus, and ornamentation of poorly developed growth lamellae. Grunt (1986) relocated *Composita advena* into here new genus *Posicomta*. However, neither the Thai specimens nor the Tunisian ones have the unusually thick shell substance which characterizes *Posicomta*. Grant (1986, p. 204) is very clear in this respect, writing that the Thai *Composita* have not a thick shell substance.

Composita advena is similar to *Composita pilula* Cooper & Grant, 1976, from the Road Canyon Formation of West Texas, but differs because the latter has a weakly parasulcate to uniplicate commissure and a slightly asymmetric sulcus. *C. advena* also resembles *Composita affinis* Girty, 1909, from the Pinery, Rader, Lamar and Capitan members of West Texas, but the latter differs in having a rectimarginate commissure and moderately strong and numerous growth lamellae.

Stratigraphic and geographic occurrence. *Composita advena* has been found in the Wordian Rat Buri Limestone from Southern Thailand (Grant 1976).

Order **Spiriferida** Waagen, 1883

Superfamily Ambocoelioidea George, 1931

Family Ambocoeliidae George, 1931

Subfamily Ambocoeliinae George, 1931

Genus *Orbicoelia* Waterhouse & Piyasin, 1970

Type species: *Orbicoelia fraterculus* Waterhouse & Piyasin, 1970, from the Guadalupian of South Thailand.

Remarks. *Orbicoelia* Waterhouse & Piyasin, 1970 resembles *Cruricella* Grant, 1976, but it differs by its narrower umbo, a lower interarea, an ornamentation of spinules and a larger size. Waterhouse & Piyasin (1970) described the microornament of *Orbicoelia* as formed

by dense uniramous spinules over 1 mm long where well preserved, 12-15 per millimetre, more or less concentrically arranged in close-set rows on both valves. According to Grant (1976, p. 193), the wide outline of *Orbicoelia* suggests a spire with several volutions in contrast to one or two in *Cruricella*, although the spires of *Orbicoelia* have not been observed in the USNM specimens of Grant (1976) or by Waterhouse & Piyasin (1970).

Orbicoelia is also similar to *Crurithyris* George, 1931, but the latter shows a median sulcus on both valves and a low ventral interarea. According to Chen et al. (2006, p. 316), *Orbicoelia* differs from *Crurithyris* by its relatively more strongly inflated dorsal valve and more rounded cardinal extremities. Furthermore, *Crurithyris* includes forms with distinct, concentrically arranged spines (George 1931; Veevers 1959; Waterhouse & Piyasin 1970).

Orbicoelia sp. ind.

Pl. 2, figs 27-28

1957 *Crurithyris* sp. ind. - Termier & Termier, p. 211, pl. 6, figs *i-n*.

1977 *Crurithyris opalinus* Termier, Termier & Vachard, p. 59, pl. 14, fig. 9; text-fig. 9.

Material: Two figured ventral valves: MPUM10199 (THJ8-100), MPUM10198 (TMO2-29).

Occurrence: Tunisia, Merbah el Oussif section (TMO2); Halq Jemel section (THJ8).

Description. Convex ventral valve, with maximum longitudinal convexity posteriorly; drop-like outline; maximum width: 10.7-20 mm, the length 13.3-19.5 mm. Cardinal extremities rounded; anterior commissure rectimarginate. Ventral umbo narrow and pointed, with lateral slopes curved over a triangular, narrow and slightly concave interarea which is rather high; median sulcus absent. Microornamentation of very fine growth lamellae, 0.1-0.2 mm wide, and of very tiny, elongate spinules, roughly concentrically arranged on the growth lamellae (specimen MPUM10198 (TMO2-29)); the observed maximum length of the spinules is 0.35 mm.

Discussion. The specimens described as *Crurithyris* sp. ind. by Termier & Termier (1957, p. 210, pl. 6, figs. i-n) belong to *Orbicoelia*, based on their rather high interarea, the narrow umbo, the absence of the sulcus and the presence of fine growth lamellae and spinules. In 1977, Termier et al erected the new species *Crurithyris opalinus* Termier, Termier & Vachard, 1977, without adequately describing and re-illustrating the material. We think that there are not the conditions for considering valid this species and the determination is left open.

Superfamily Martinioidea Waagen, 1883

Family Martiniidae Waagen, 1883

Subfamily Martiniinae Waagen, 1883

Genus *Martinia* M'Coy, 1844

Type species: *Spirifer glaber* Sowerby, 1820 in 1818-1821, from the Visean of England.

Remarks. *Martinia* differs from *Spinomartinia* Waterhouse, 1968 from the Cisuralian of Thailand and eastern Australia and the Lopingian of New Zealand, because *Martinia* lacks a microornament of fine erect spines; from *Postmartinia* Wang & Yang, 1993 from the Sakmarian of China (Xinjiang) it differs by the lack of three to four smooth, low, broad plicae on the lateral slopes.

Martinia aff. **M. semiplana** Waagen, 1883

Pl. 2, figs 29-32

Material: Two figured articulated specimens**:** MPUM10200 (TS10-13), MPUM10201 (TS13-11); six articulated specimens: MPUM10202 (TS10-7, TS10-12, TS11-11, TS11-12, TS12-20, TS13-12); four ventral valves: MPUM10203 (TS11-4, TS12-5 (a, c), TS12-12); one dorsal valve**:** MPUM10204 (TS12-5b).

Occurrence: Tunisia, Souinia section (TS10, TS11, TS12, TS13).

Description. Small sized biconvex shell, with rounded to subpentagonal profile, usually longer than wide. Ventral umbo elongated, pointed and can be extended beyond the hinge; cardinal extremities sometimes slightly alate; anterior commissure rectimarginate to weakly uniplicate. Interarea subtriangular and flat to concave; ventral sulcus absent or very shallow. Dorsal fold absent or very weakly evident. Ornamentation of fine growth lamellae.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
TS10-7	5.5	6	0.91	3.5
TS10-12	5.5	7	0.78	4
TS10-13	6	6.5	0.92	3.5
TS11-4	6	7	0.85	/
TS11-11	7	7	1	5
TS11-12	9	7	1.28	5
TS12-5a	4.5	5.5	0.81	/
TS12-5b	4	4.5	0.88	/
TS12-5c	5.5	6.5	0.84	/
TS12-12	6.5	7	0.92	/
TS12-20	9	10	0.9	6
TS13-11	7	9	0.77	5
TS13-12	8	7.5	1.06	5.5

Discussion. The Tunisian specimens resemble *Martinia semiplana* Waagen, 1883 (p. 536, pl. 43, fig. 4) from the Wargal Formation of Salt Range because of its absent or very shallow sulcus, the outline and the small size of the shell. However, the characteristic unequal convexity of the two valves of Waagen's species is not seen in the present specimens. The specimens described by Campi et al. (2005) as *Martinia semiplana* Waagen, 1883 are close to those from Tunisia, but show more alate cardinal extremities.

Of the species of *Martinia* from Sosio, Sicily, the most similar to the Tunisian specimens are *Martinia pusilla* Gemmellaro, 1899, which differs in having an anteriorly uniplicate commissure and fine radial striae on its peripheral region; and *Martinia ceres* Gemmellaro, 1899 which differs in having a larger size and a clear and evident sulcus, which appears as a long linear depression in the juveniles.

Finally the Tunisian specimens resemble those described by Grabau (1934) from China (Lower Permian) as *Martinia incerta* Tschernyschew, 1902, for their dimensions and the absence of sulcus, but the latter shows a high interarea and a subtriangular profile with a ventral convexity almost double than that of the dorsal valve and a higher interarea.

Stratigraphic and geographic occurrence. *Martinia semiplana* has been recorded from the Guadalupian of Peninsular Malaysia and from the Guadalupian-Lopingian of South China, Japan, the Salt Range and the Chitichun Limestone in India (Campi et al. 2005).

Superfamily Spiriferoidea King, 1846

Family Spiriferellidae Waterhouse, 1968

Genus *Bamberina* Waterhouse, 2004

Type species: *Elivina? annectens* Cooper & Grant, 1976 from the Guadalupian of Texas, USA.

Remarks. *Bamberina* Waterhouse, 2004 is similar to *Spiriferella* Tschernyshev, 1902, but the latter differs for the greater dimensions, the wider hinge line and the delthyrium partially or completely covered by stegidia.

Bamberina sp. ind.

Pl. 2, fig. 33

Material: One figured ventral valve: MPUM10205 (TS13-25); one fragment of articulated shell: MPUM10206 (TS12-17).

Occurrence: Tunisia, Souinia section (TS12, TS13).

Description. Small sized, biconvex shell, 6.6 mm wide and 8 mm long. Subpentagonal to oval outline; short hinge line; anterior commissure uniplicate. Ventral valve more convex, with small umbo recurved over the dorsal one; sulcus starting from the umbo, becoming wider and deeper anteriorly ornamented by two costae starting from the umbo and separated by a groove; the flanks are ornamented by evident costae starting from the umbo and numbering at least five on each flank; they are 0.2-0.4 mm wide at 1 mm from the umbo and 0.4-1 mm wide anteriorly; irregularly spaced growth lamellae.

Discussion. The present specimens are very similar to that of the type species of *Bamberina*, *Elivina? annectens* Cooper & Grant, 1976 (p. 2242, pl. 633, figs 21-37); in fact, the sole important differences concern the number of the costae on the flanks, which is greater in *B. annectens*, and the pustules and the fine radial ornamentation, confined to intercostal troughs which characterize *B. annectens*.

The collocation of the Tunisian form in the genus *Bamberina* is supported by the observation of shared characteristics, including their small dimensions, short hinge line, sulcus that is deeper anteriorly, with a median trough confined by two costae, and flanks with low, simple costae. However, the specific determination remains open, due to the scarcity of material.

The specimen reported by Termier et al. (1977, p. 59) as *Cancellospirifer* sp. probably belongs to *Bamberina* as the ones here described. However, they do not describe the morphology of their specimen and do not adequately illustrate it.

Suborder **Delthyridina** Ivanova, 1972

Superfamily Reticularioidea Waagen, 1883

Family Elythidae Fredericks, 1924

Subfamily Phricodothyridinae Caster, 1939

Genus *Permophricodothyris* Pavlova, 1965

Type species: *Permophricodothyris ovata* Pavlova, 1965, p. 134. Lopingian, Transcaucasia

Remarks. When Pavlova (1965) erected *Permophricocothyris,* the type species of *Neophricadothyris* Licharew, 1934, namely *Squamularia asiatica* Chao, 1929 from the Lower Permian Wangchiapa Limestone of Guizhou, was imperfectly known and unavailable for re-study, even if this is no longer the case (Shi et al. 2002). Most importantly, the direction of the axes of the brachial cones was unknown and undeterminable, so there was no way to distinguish *Neophricadothyris* from *Phricodothyris* George, 1932, which has the axes directed laterally. Pavlova (1965) therefore, established the genus *Permophricodothyris* to include Permian forms that have the spiral axes pointing diagonally backward toward the hinge line, no internal plates and micrornament of double-barreled spines (Grant 1976). The presence of bifid spines is a characteristic of the family Elythidae, to which *Permophricodothyris* belongs. How-

ever, personal observation by SEM (Pl. 4, figs. 3-10) of several specimens of *Permophricodothyris* suggests that it is difficult to base the taxonomic diagnosis on the spine bases, both because a very detailed analysis is required, and because the shell may be abraded.

Shi et al. (2002) revised the Permian reticularioids from South China, showing that *Permophricodothyris* is very abundant in the Guadalupian and Lopingian of this region. They also clarified its relationships with allied genera, as *Squamularia* Gemmellaro, 1899, *Neophricadothyris* and *Phricodothyris* indicating as critical features for their distinctions the type of spines, presence/absence of adminicula, and the direction of coiling axis.

Three species of *Permophricodothyris, Permophricodothyris affinis* (Gemmellaro, 1899), *Permophricodothyris caroli* (Gemmellaro, 1894a), *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a), have been found in the Guadalupian of Tunisia in this study. However, some specimens from beds LTS1, LTS3, THJ4, THJ5, THJ7, TMO1, TMO2, TMO3, TS10, TS13, TS14, and TS15 have been left in open nomenclature as *Permophricodothyris* sp. ind., because of their poor state of preservation.

Permophricodothyris affinis (Gemmellaro, 1899)

Pl. 2, figs 34-44; Pl. 3, fig. 25; Pl. 4, figs 8-10; Fig. 7

1899 *Reticularia affinis* Gemmellaro, p. 330, pl. 34, figs 5-8.
1934 *Reticularia lineata* var. *affinis* - Solignac, p. 13.

PLATE 3

Fig. 1 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Ventral view of an articulated specimen. MPUM10226 (THJ5-93), x1.

Fig. 2 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Dorsal view of an articulated specimen. MPUM10226 (THJ5-93), x1.

Fig. 3 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Ventral valve. MPUM10227 (THJ5-86), x1.

Fig. 4 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Internal mould of a ventral valve. MPUM10228 (THJ7/2-39), x1.

Fig. 5 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Internal mould of a ventral valve. MPUM10229 (THJ7/2-41), x1.

Fig. 6 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Internal mould of a ventral valve. MPUM10230 (THJ7/3-51a), x1.

Fig. 7 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Ventral valve. MPUM10236 (THJ5-100), x1.

Fig. 8 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Internal mould of a ventral valve. MPUM10237 (THJ7/2-32), x1.

Fig. 9 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Ventral valve. MPUM10238 (TS11-5), x1.

Fig. 10 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Dorsal view of an articulated specimen. MPUM10239 (THJ7-21), x1.

Fig. 11 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Dorsal valve. MPUM10240 (THJ5-81), x1.

Fig. 12 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Ventral view of an articulated specimen. MPUM10249 (TS11-7), x2.

Fig. 13 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Dorsal view of an articulated specimen. MPUM10249 (TS11-7), x2.

Fig. 14 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Anterior view of an articulated specimen. MPUM10249 (TS11-7), x2.

Fig. 15 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Ventral view of an articulated specimen. MPUM10250 (TS12-13), x2.

Fig. 16 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Dorsal view of an articulated specimen. MPUM10250 (TS12-13), x2.

Fig. 17 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Anterior view of an articulated specimen. MPUM10250 (TS12-13), x2.

Fig. 18 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Ventral view of an articulated specimen. MPUM10251 (TS12-18), x2.

Fig. 19 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Dorsal view of an articulated specimen. MPUM10251 (TS12-18), x2.

Fig. 20 - *Ombonia magna* Greco, 1938. Transverse section of the umbonal region of an articulated specimen showing the spondylium. MPUM10254 (TS10-2), x3.

Fig. 21 - *Ombonia magna* Greco, 1938. Transverse section of the umbonal region of an articulated specimen showing the spondylium and the cardinal process. MPUM10254 (TS10-2), x3.

Fig. 22 - *Ombonia magna* Greco, 1938. Transverse section of the umbonal region of an articulated specimen showing the spondylium. MPUM10168 (TS12-1), x3.

Fig. 23 - *Ombonia magna* Greco, 1938. Transverse section of the umbonal region of a ventral valve showing the septum of the spondylium. MPUM10165 (TS12-7), x3.

Fig. 24 - *Streptorhynchus* sp. ind. Transverse section of the umbonal region of a ventral valve showing no internal plates. MPUM10173 (TS15bis-8), x2.

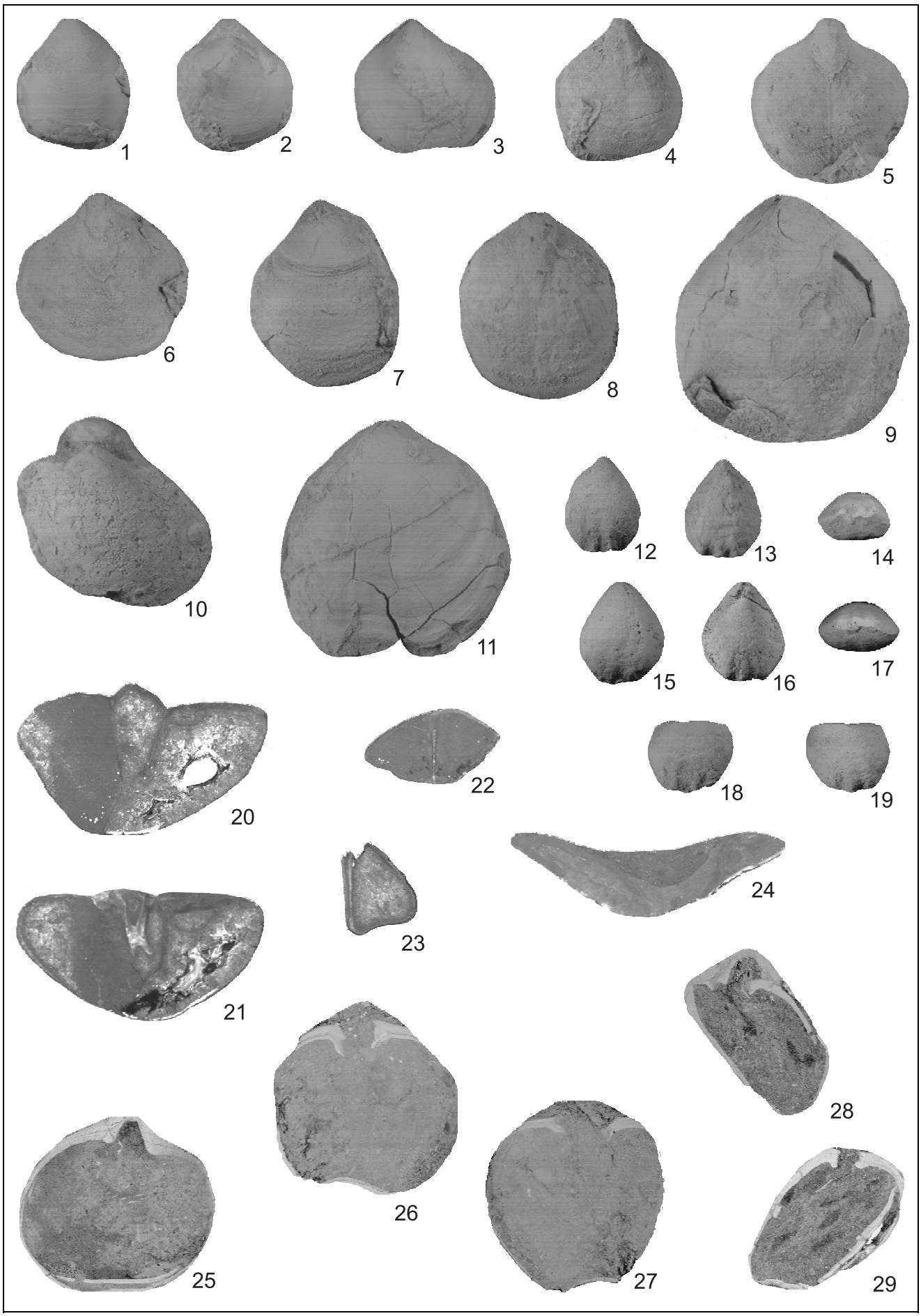
Fig. 25 - *Permophricodothyris affinis* (Gemmellaro, 1899). Longitudinal section near the commissure plane of an articulated specimen, showing spiralia. MPUM10255 (THJ5-53), x1.

Fig. 26 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Longitudinal section near the commissure plane of a ventral valve, showing spiralia. MPUM10256 (LTS1-14), x1.

Fig. 27 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Longitudinal section near the commissure plane of a dorsal valve, showing spiralia. MPUM10256 (LTS1-14), x1.

Fig. 28 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Longitudinal section near the commissure plane of an articulated specimen, showing spiralia. MPUM10257 (THJ5-11), x1.

Fig. 29 - *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a). Longitudinal section near the commissure plane of an articulated specimen, showing spiralia. MPUM10257 (THJ5-11), x1.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1957 *Reticularia affinis* - Termier & Termier, p. 209, pl. 5i-k, 6a-f.

1977 *Permophricodothyris affinis* - Termier, Termier & Vachard, p. 59.

Material: Seven figured articulated specimens: MPUM10207 (THJ4-1); MPUM10210 (THJ4-2); MPUM10209 (THJ5-106); MPUM10208 (THJ5-125); MPUM10255 (THJ5-53); MPUM10260 (THJ5-83); MPUM10261 (THJ5-99); eleven articulated specimens: MPUM10215 (MI200-3; THJ4-4; THJ5-5; THJ5-18; THJ5-41; THJ5-67; THJ5-72; THJ5-84; THJ5-91; THJ7-18; TMO3-5); four figured internal moulds of articulated specimens: MPUM10211 (THJ7-3); MPUM10212 (THJ7-4); MPUM10214 (THJ7/2-38); MPUM10213 (THJ7/3-1); sixteen internal moulds of articulated specimens: MPUM10216 (dHJ-2; MI201-5; THJ7-1; THJ7-7; THJ7-11; THJ7-19; THJ7/2-19c; THJ7/2-34; THJ7/2-36; THJ7/3-10; THJ7/3-35; THJ7/3-36; THJ7/3-37; THJ7/3-38; THJ7/3-41; THJ7/3-58); forty-two ventral valves: MPUM10217 (HJ104a; dHJ-1; dHJ-3; MO203-7; LTCP1-8; LTCP2-4; LTcP2-5a; LTCP2-6; LTS1-18;

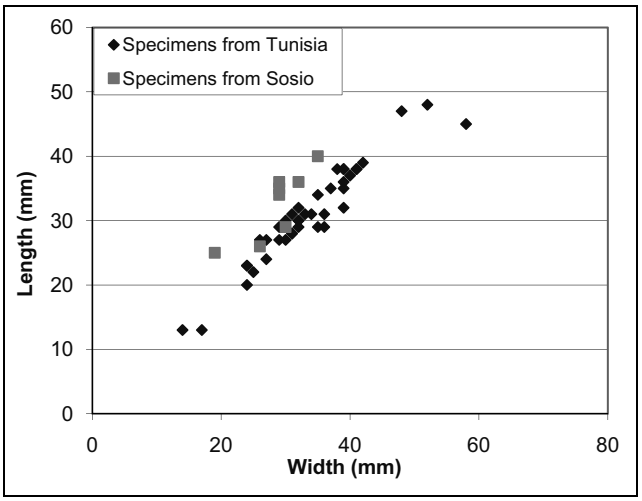


Fig. 7 - Width vs. length relationship of *Permophricodothyris affinis.*

THJ3-2; THJ4-3; THJ4-6; THJ4-9; THJ5-13; THJ5-23; THJ5-26; THJ5-33; THJ5-44; THJ5-56; THJ5-57; THJ5-70; THJ5-87a; THJ5-92; THJ5-95; THJ5-98; THJ5-104; THJ5-107; THJ5-121(a-b); THJ7/3-4a; THJ7/3-43; TS13-1; TS13bis-1; TS14-5; TS15-32; TS15-48; TS15-59; TS15-64; TS15bis-16; TS15bis-18; TS15bis-37; TS15bis-42); twenty-three internal moulds of ventral valves: MPUM10218 (THJ7-6; THJ7/2-1c; THJ7/2-4a; THJ7/2-8a; THJ7/2-9a; THJ7/2-10b; THJ7/2-44a; THJ7/2-46; THJ7/2-47a; THJ7/2-48a; THJ7/2-51(a- c); THJ7/2-55e; THJ7/3-3; THJ7/3-16; THJ7/3-11; THJ7/3-20; THJ7/3-31; THJ7/3-34a; THJ7/3-40; THJ7/3-48a; THJ7/3-50b; TS15-30); four external casts of ventral valves: MPUM10219 (THJ7/2-1b; THJ7/2-19b; THJ7/2-20(c-d)); 41 dorsal valves: MPUM10220 (LTCP2-5b; LTS1-17; THJ4-6bis; THJ4-8; THJ4-11; THJ4-14; THJ4-15; THJ5-20; THJ5-39; THJ5-42; THJ5-54; THJ5-58; THJ5-59; THJ5-79a; THJ5-82; THJ5-85; THJ5-101; THJ5-112; THJ5-116; THJ5-123; TMO2-22; TMO3-4; TS13-16; TS13bis-2; TS13bis-4a; TS13bis-11; TS15bis-1; TS15bis-4; TS15bis-9; TS15bis-14; TS15bis-21; TS15bis-31; TS15bis-34; TS15bis-35; TS15-25; TS15-33; TS15-37; TS15-51; TS15-53; TS15-61; TS15-70); forty internal moulds of dorsal valves: MPUM10221 (THJ5-35; THJ7-15b; THJ7/2-1a; THJ7/2-2a; THJ7/2-8d; THJ7/2-9b; THJ7/2-10a; THJ7/2-11a; THJ7/2-12a; THJ7/2-13(a-e-f); THJ7/2-14(a- d); THJ7/2-15a; THJ7/2-18; THJ7/2-19a; THJ7/2-20(a-b); THJ7/2-25; THJ7/2-26; THJ7/2-42(a-b); THJ7/2-45a; THJ7/2-48b; THJ7/2-50; THJ7/2-53; THJ7/2-55I; THJ7/2-56; THJ7/3-6; THJ7/3-15; THJ7/3-5b;THJ7/3-14; THJ7/3-39; THJ7/3-44; THJ7/3-47a; THJ7/3-49b; THJ7/3-50a; THJ7/3-52; THJ7/3-61); five external casts of dorsal valves: MPUM10222 (THJ3-1; THJ7-15a; THJ7-17a; THJ7/2-14H; THJ7/2-51d); fifty-seven fragments: MPUM10223 (HJ104b; LTCP1-4; LTCP2-5c; LTS1-8; LTS1-16; LTS3d-4; THJ4-13; THJ4-17; THJ4-19; THJ5-12; THJ5-19; THJ5-48; THJ5-69; THJ5-71; THJ5-77; THJ5-90; THJ5-108; THJ5-117; THJ5-123; THJ5-131; THJ7/2-55d; THJ7/3-17; THJ7/3-26; THJ7/3-28; THJ7/3-34b; THJ7/3-49(a-c); THJ7/3-53; TMO2-35; TMO3-1; TS13bis-4b; TS13bis-5; TS13bis-8(a-b); TS13bis-9; TS14-6; TS15-4; TS15-5; TS15-8; TS15-9; TS15-15; TS15-18; TS15-19; TS15-27(a-b); TS15-28; TS15-34; TS15-35; TS15-38; TS15-40; TS15-47; TS15-52; TS15-62; TS15-67b; TS15-72; TS15bis-25; TS15bis-28); twelve fragments of internal moulds: MPUM10224 (THJ7/2-2(b-c); THJ7/2-3; THJ7/2-8(c-f); THJ7/2-31; THJ7/2-44b; THJ7/2-47b; THJ7/2-51(b, e); THJ7/3-9; THJ7/3-32a; nine fragments of external casts: MPUM10225 (THJ7-10; THJ7-17b; THJ7/2-8g; THJ7/2-20e; THJ7/3-48b; THJ7/3-50c; TS13-18; TS15-67a; TS15bis-7).

Occurrence: Tunisia, Halq Jemel section base (THJ3, THJ4, THJ5, THJ7, THJ7/2, THJ7/3, DHJ, HJ); Djebel Tebaga section, LTCP1 loose block in Unit III, LTCP2 loose block in Unit III; Merbah el Oussif section (TMO2, TMO3, MO203); Souinia section (LTS1, LTS3D, TS13, TS13bis, TS14, TS15, TS15bis); Mine section (MI200, MI201).

Description. Medium to large sized, biconvex shell with subcircular to oval outline; maximum width at mid-length; anterior commissure uniplicate with valves meeting forming a variable angle; in two specimens (MPUM10223 (THJ5-90), MPUM10215 (THJ5-91)) they nearly meet in a plane. Shell substance with fibrous fabric of the secondary layer with flattened fibers. Many specimens show a general tendency to reduce the convexity with growth. Ventral valve slightly larger and deeper than the dorsal one, convex and more curved in the umbonal region. Umbo large, recurved and pointed; ventral interarea can be high, large and concave, but the delthyrium is not preserved. Median sulcus starting near the umbo, widening and deepening towards the anterior margin. Dorsal valve convex and slightly less curved than ventral valve; presence of almost inappreciable fold anteriorly. Ornamentation of regular concentric growth lines 0.4-0.5 mm thick, bearing two orders of long, dense spine bases, concentrically arranged (Pl. 4, figs 8-10): 1) bifid spine bases, 55-85 μm wide, 2) simple spine bases, 14-22 μm wide. Radial striae of respectable length occasionally cross the growth lines.

Interior of ventral valve without dental plates; lanceolate muscle scars divided by a septum reaching the anterior commissure; mantle canals are presents. Interior of dorsal valve with spiral brachidium, with spiral axes directed postero-laterally towards the cardinal region. A median septum starts posteriorly and reduces anteriorly until to disappear; mantle canals are observed.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness	Specimens	Width	Length	W/L	Thickness
LTCP1-8	30	30	1	/	THJ5-121a	39	38	1.02	/
LTCP2-4	40	>45	<1	/	THJ5-121b	33	31	1.06	/
LTCP2-5a	29.5	32.5	0.90	/	THJ5-125	25.5	26	0.98	17.5
LTCP2-5b	>29	30.5		/	THJ7-1	51	52	0.98	29
LTS1-16	48	47	1.02	/	THJ7-3	42	37.5	1.12	29
THJ3-1	30	32.5	0.92	/	THJ7-4	41	38	1.07	24
THJ3-2	32	30	1.06	/	THJ7-7	27.5	27	1.01	18
THJ4-1	33	29,5	1.11	19.5	THJ7-15a	36	29	1.24	/
THJ4-2	32.5	28	1.16	19	THJ7-18	41	>35		26
THJ4-4	28	29	0.96	/	THJ7-19	58	45	1.28	37
THJ4-6	30	27	1.11	/	THJ7/2-12a	39	41	0.95	/
THJ4-8	>26	30		/	THJ7/2-14D	14	13	1.07	/
THJ4-9	25	>20		/	THJ7/2-19b	44	>38		/
THJ4-14	>24	20	>1	/	THJ7/2-19C	19	16.5	1.15	11
THJ4-15	17	16.5	1.03	/	THJ7/2-36	37	35	1.05	/
THJ4-17	24	20	1.2	/	THJ7/2-47a	27	24	1.12	/
THJ4-19	24	23	1.04	/	THJ7/2-48a	27.5	24.5	1.12	/
THJ5-5	36	31	1.16	16.5	THJ7/3-1	39	38	1.02	24
THJ5-18	26	27	0.96	11	THJ7/3-14	32	29	1.10	/
THJ5-20	17	13	1.30	/	THJ7/3-31	40	47.5	0.84	/
THJ5-41	>17	18.5		1	THJ7/3-34a	41	38	1.07	18
THJ5-44	39	35	1.11	/	THJ7/3-35	>44	47.5		23
THJ5-53	40	37	1.08	/	THJ7/3-36	39	36	1.08	25
THJ5-56	>34	33.5	>1	/	THJ7/3-38	35	30.5	1.14	20
THJ5-58	31	28	1.10	/	THJ7/3-41	>33	34		23
THJ5-59	>30	28	>1	/	THJ7/3-43	34	37	0.91	/
THJ5-67	24	>25	<1	17.5	THJ7/3-47	35	34	1.02	/
THJ5-70	34	33.5	1.01	/	THJ7/3-50b	32	30	1.06	/
THJ5-72	31	31	1	11	THJ7/3-52	39	32	1.21	/
THJ5-77	32	32	1	/	TS13-1	33.5	31	1.08	/
THJ5-79	31	38	0.81	/	TS13-16	~48	49	/	/
THJ5-82	31	28	1.10	/	TS13bis-1	>44	39	/	/
THJ5-84	38	38	1	22	TS13bis-11	42	36	1.16	/
THJ5-85	34	33.5	1.01	/	TS15-5	26	23	1.13	/
THJ5-87a	34	31	1.09	/	TS15-25	47	/	/	/
THJ5-91	25	22	1.13	19.5	TS15-30	37.5	36.5	1.02	/
THJ5-95	22	>27	<1	/	TS15-33	42	39	1.07	/
THJ5-98	29	29	1	/	TS15-70	47	43	1.09	/
THJ5-101	35	29	1.20	/	TS15bis-1	52	48	1.08	/
THJ5-106	27	27	1	18	TS15bis-9	29	27	1.07	/
THJ5-108	33	35	0.94	/	TS15bis-16	29	30	0.96	/
THJ5-112	28	26.5	1.05	/	TS15bis-35	20	18	1.11	/
THJ5-116	>53	40	>1	/	TS15bis-37	/	37	/	/
THJ5-127	24	23	1.04	/					

Discussion. The examined specimens are very similar to *Permophricodothyris affinis* (Gemmellaro, 1899), having the same equally biconvex shell, subcircular to oval outline, ventral valve larger and deeper than the dorsal valve, with a large umbo, pointed and very recurved, the sulcus starting from umbo and widening and deepening anteriorly, the dorsal valve meeting the ventral valve anteriorly at a variable angle. Small differences are 1) the width/length ratio (Fig. 7), considered lower than one by Gemmellaro (1899), but more variable from lower than one to greater than one in the Tunisian specimens, and 2) the direction of the spiral axes. In fact, Gemmellaro (1899) considered the spiral cones of brachidium as having extremities directed towards the lateral regions, whereas the Tunisian specimens show spiral cones extremities directed towards the cardinal extremities. However, direct observation of the collection comprising six specimens studied by Gemmellaro (1899) at the "G. Gemmellaro Museum" of Palermo showed that none of them has been sectioned to see the direction of the spiral cones.

Gemmellaro (1899), in the description of this species, refers to his plate 46, figs 10-11 which does not exist in his text. This is the plate in which he illustrates the spiralia of *P. affinis*. A search in several Italian universities and museum libraries shows that none of the 1899 volumes written by Gemmellaro contain a plate 46.

Stratigraphic and geographic occurrence. *Permophricodothyris affinis* (Gemmellaro, 1899) has been found in the allochthonous limestones of Pietra di Salomone, of Rocca di San Benedetto and of Rupe del Passo del Burgio of Sosio Valley, Sicily, Italy (Gemmellaro 1899), and in the Bellerophon limestone of Oudjah el Rhar, Tunisia (Termier et al. 1977).

Permophricodothyris caroli
(Gemmellaro, 1894a)

Pl. 3, figs 1-6; Pl. 4, figs 1-5; Fig. 8

1894a *Reticularia caroli* Gemmellaro, p. 3.

1899 *Reticularia caroli* - Gemmellaro, p. 334, pl. 34, fig. 11-20, pl. 35, fig. 1.

1969 *Permophricodothyris caroli* - Pavlova, p. 103, pl. 10, fig. 1.

Material: One figured articulated specimen: MPUM10226 (THJ5-93); two articulated specimens: MPUM10231 (THJ5-97; THJ7/2-35); four internal moulds of articulated specimens: MPUM10232 (THJ7-5; THJ7/3-33; THJ7/3-45; THJ7/3-54); two figured ventral valves: MPUM10227 (THJ5-86); MPUM10258 (THJ5-37); sixteen ventral valves: MPUM10233 (LTCP1-2; LTCP1-7a; LTS1-2; THJ5-8; THJ5-16; THJ5-29; THJ5-47; THJ5-65; THJ5-102; THJ5-129; TMO2-5; TMO2-6; TS13-10; TS15-23a; TS15-49; TS15bis-38); three figured internal moulds of ventral valves: MPUM10228 (THJ7/2-39); MPUM10229 (THJ7/2-41); MPUM10230 (THJ7/3-51a); sixteen internal moulds of ventral valves: MPUM10234 (THJ7-9; THJ7-12; THJ7-14a; THJ7-16a; THJ7/2-4b; THJ7/2-5; THJ7/2-6; THJ7/2-7; THJ7/2-24(a-b); THJ7/2-55(E, H); THJ7/3-8a; THJ7/3-25; THJ7/3-55; THJ7/3-56); five dorsal valves: MPUM10235 (THJ5-60; THJ5-78; THJ7/3-29; TS15-63; TS15bis-15).

Occurrence: Tunisia, Halq Jemel section base (THJ5, THJ7, THJ7/2, THJ7/3); Djebel Tebaga section, LTCP1 loose block in Unit III; Souinia section (LTS1, TS13, TS15, TS15bis); Merbah el Oussif section (TMO2).

Description. Medium to large sized, biconvex shell with subtriangular outline; maximum width at mid-length; cardinal extremities usually weakly angular; anterior commissure uniplicate with valves meeting anteriorly at different angles. Shell substance with fibrous fabric of the secondary layer with flattened fibers. Ventral valve, with subtriangular outline, narrow in the cardinal region; umbo prominent, narrow, recurved and strongly pointed; it is not symmetric but slightly tilted sideways especially in the adults. Ventral interarea very high, large and concave; median sulcus shallow, starting near umbo, widening and deepening towards the anterior margin. Dorsal valve with oval-subtriangular outline, smaller than the ventral one. Ornamentation of narrow, imbricate lamellae, 120-250 µm wide, bearing two series of bifid, capillary and densely arranged spine bases, about 35-50 µm wide (Pl. 4, figs 1-5); long radial striae cross the concentric lamellae.

Interior of ventral valve without dental plates; lanceolate muscle scars present, usually reaching the mid-length of valve and divided by a septum extending to the anterior commissure. Interior of dorsal valve with median septum starting posteriorly and reducing anteriorly. In the posterior region the septum divides the muscle scars which are lanceolate and extend beyond mid-length.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness	Specimens	Width	Length	W/L	Thickness
LTCP1-2	30	30	1	/	THJ7/2-24a	31	29	1.06	/
LTS1-2	~30	31	/	/	THJ7/2-35	41	41	1	/
THJ5-8	/	28	/	/	THJ7/2-39	24	28	0.85	/
THJ5-78	28	24	1.16	/	THJ7/2-41a	29	30	0.96	/
THJ5-86	27	28	0.96	/	THJ7/2-55E	35	37	0.94	/
THJ5-93	23	26	0.88	16.5	THJ7/3-25	21	21	1	12
THJ5-97	30	32	0.93	/	THJ7/3-29	42	38	1.10	/
THJ5-102	37	39	0.95	/	THJ7/3-33	41	41	1	22
THJ7-5	32	33	0.97	15.5	THJ7/3-45	25	25	1	14
THJ7-9	27	28	0.96	/	THJ7/3-51a	31	31	1	/
THJ7-12	21	22	0.95	11.5	THJ7/3-54	34	37	0.91	8
THJ7-14a	32	/	/	/	THJ7/3-55	33	36	0.91	/
THJ7-16a	29	32	0.90	/	THJ7/3-56	28	29	0.96	/
THJ7-16b	30	/	/	/	TS15-23a	33	37	0.89	/
THJ7/2-5	33	30	1.1	/	TS15-63	26	24	1.08	/
THJ7/2-7	34	33	1.03	/	TS15bis-15	28	25	1.12	/

Discussion. The present specimens fit with the diagnosis of *Permophricodothyris caroli* (Gemmellaro, 1894a), based on their large and high ventral interarea, narrow, prominent and asymmetric ventral umbo, shallow sulcus, ornamentation of two series of capillary and dense spine bases. *Permophricodothyris caroli* differs from *Permophricodothyris affinis*, by its asymmetric umbo, the slightly longer outline (Figs 7, 8) and the high and wide ventral interarea. *P. caroli* is similar to *P. pulcherrima* (Gemmellaro, 1899), but the latter differs because it is more elongate, has a lower interarea and a more convex dorsal valve.

Stratigraphic and geographic occurrence. *Permophricodothyris caroli* has been found in the allochthonous limestones of Pietra di Salomone and of Rocca di San Benedetto of Sosio Valley, Sicily, Italy (Gemmellaro 1899).

Permophricodothyris inaequilateralis (Gemmellaro, 1894a)

Pl. 3, figs 7-11, 26-29; Fig. 8

1894a *Reticularia inaequilateralis* Gemmellaro, p. 3.

1899 *Reticularia inaequilateralis* - Gemmellaro, p. 336, pl. 35, fig. 2-21.

1911 *Spirifer (Reticularia) inaequilateralis* - Frech, p. 169, pl. 28, fig. 1.

1913 *Reticularia inaequilateralis* - Mansuy, p. 120, text-fig. 12, pl. 13, fig. 7.

1933 *Squamularia inaequilateralis* - Huang, p. 31, pl. 4, figs 10-11.

1934 *Reticularia dieneri* - Solignac, p. 10.

1944 *Squamularia (Neophricodothyris) inaequilateralis* - Reed, p. 240, pl. 31, fig. 5.

1957 *Reticularia inaequilateralis* - Termier & Termier, p. 209, text-pl. 5d-h.

1977 *Permophricodothyris inaequilateralis* - Termier, Termier & Vachard, p. 58.

Material: Three figured articulated specimens: MPUM10239 (THJ7-21); MPUM10256 (LTS1-14); MPUM10257 (THJ5-11); three articulated specimens: MPUM10241 (THJ7-8; THJ7-20; TMO3-2); one internal mould of articulated specimens: MPUM10242 (THJ7/2-55g); two figured ventral valves: MPUM10236 (THJ5-100); MPUM10238 (TS11-5); sixteen ventral valves: MPUM10243 (LTS1-20; THJ5-2; THJ5-32; THJ5-38; THJ5-64; THJ5-66; THJ5-96; THJ5-110; THJ5-118; THJ7/2-21b; THJ7/3-27a; TMO1-1; TMO1-2; TS15-26; TS15-58; TS15bis-11); one figured internal mould of ventral valve: MPUM10237 (THJ7/2-32); one internal mould of ventral valve: MPUM10244 (THJ7/3-22); one external cast of ventral valves: MPUM10245 (THJ5-75a); one figured dorsal valve: MPUM10240 (THJ5-81); eleven dorsal valves: MPUM10246 (THJ5-6; THJ5-27; THJ5-88; THJ5-89a; THJ5-119; THJ7-2; THJ7/3-13; THJ7/3-19; TS15-29a; TS15-31; TS15bis-41); three internal moulds of dorsal valves: MPUM10247 (THJ7/2-21a; THJ7/2-55n; THJ7/3-46); ten fragments: MPUM10248 (THJ4-12; THJ5-4; THJ5-74(a-b); THJ5-89b; THJ7/3-27b; TS15-12; TS15-42; TS15-50; TS15-69).

Occurrence: Tunisia, Halq Jemel section (THJ4, THJ5, THJ7, THJ7/2, THJ7/3); Merbah el Oussif section (TMO1, TMO3); Souinia section (LTS1, TS11, TS15, TS15bis).

Description. Medium to large sized biconvex shell; unequilateral and asymmetrical outline because one side is more expanded than the other and the umbo recurved to the right or the left; oval outline, sometimes

subcircular; cardinal extremities slightly angular; anterior commissure weakly uniplicate. Ventral valve with a narrow, pointed, prominent umbo, recurved towards the dorsal one; it is not symmetrical, but laterally recurved or deviated, so its sides are different lengths, one concave the other convex; ventral interarea apsacline to orthocline; median or slightly laterally displaced sulcus which is more evident anteriorly; the sulcus may be absent. Dorsal valve with a low and often asymmetrical fold anteriorly corresponding to sulcus of ventral valve; dorsal interarea nearly catacline. Ornamentation of narrow, imbricate lamellae bearing two order of long, dense spine bases, concentrically arranged; radial striae may cross the concentric lines.

Interior of ventral valve with lanceolate muscle scars extending to mid-length. Interior of dorsal valve with lanceolate muscle scars extending beyond mid-length; spiral axes directed postero-laterally towards the cardinal extremities.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness	Specimens	Width	Length	W/L	Thickness
LTS1-14	38	42	0.90	>23	THJ7-8	39	45	0.86	30
LTS1-20	37	/	/	/	THJ7-20	39	44	0.88	28
THJ5-2	30	42	0.71	/	THJ7-21	34	39	0.87	24
THJ5-6	26	32	0.81	/	THJ7/2-21a	35	31	1.13	/
THJ5-11	34	33	1.03	>19	THJ7/2-21b	25	27	0.92	/
THJ5-27	31	33	0.94	/	THJ7/2-32	33	36	0.91	/
THJ5-32	26	31	0.83	/	THJ7/2-55g	24	23	1.04	14
THJ5-64	/	40	/	/	THJ7/2-55n	24	26	0.92	/
THJ5-66	27	30	0.9	/	THJ7/3-19	39	42	0.92	/
THJ5-75a	/	32	/	/	THJ7/3-46	27	31	0.87	/
THJ5-81	44	46	0.95	/	TMO3-2	25	27	0.92	20
THJ5-88	/	46	/	/	TS11-5	44	53	0.83	/
THJ5-89a	31	32	0.96	/	TS15-26	/	47	/	/
THJ5-96	34	35	0.97	/	TS15-31	34	38	0.89	/
THJ5-100	30	37	0.81	/	TS15bis-11	33	31	1.06	/
THJ5-110	/	26	/	/	TS15bis-41	43	39	1.10	/
THJ7-2	34	30	1.13	/					

Discussion. The specimens under study belong to *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a), having an asymmetrical shape, oval outline, asymmetric ventral sulcus, narrow, pointed, prominent ventral umbo, recurved towards the dorsal umbo and not symmetrical, but distorted laterally, interareas meeting almost perpendicularly. Its asymmetrical shape have been underlined by the same Gemmellaro (1899, p. 336), who wrote: "*... more or less inequilateral and asymmetric, with one flank more extended than the other and the umbo tilted leftward or rightward*" [translated from Italian by the authors].

Permophricodothyris inaequilateralis shares the asymmetrical and unequilateral umbo and outline with *P. caroli*, but it can be distinguished from *P. caroli* by its larger and more convex dorsal valve, shorter ventral interarea, and laterally displaced sulcus.

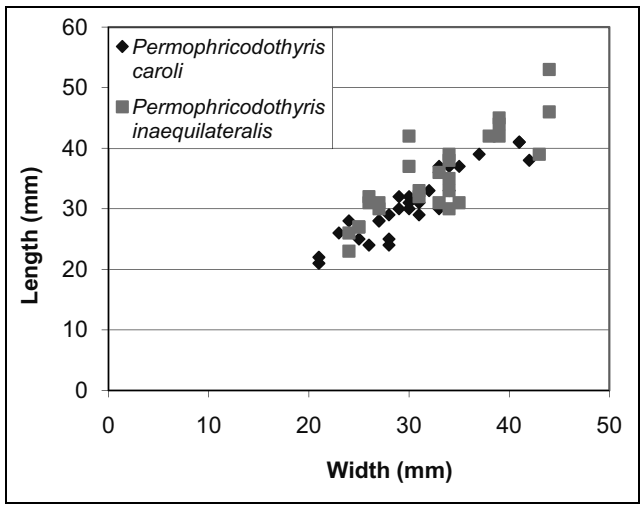


Fig. 8 - Width vs. length relationship of *Permophricodothyris caroli* and *Permophricodothyris inaequilateralis*.

Stratigraphic and geographic occurrence. *Permophricodothyris inaequilateralis* (Gemmellaro, 1894a) has been found in the allochthonous limestones of Rupe del Passo del Burgio, Rocca di San Benedetto and Pietra di Salomone of Sosio Valley, Sicily and in the Bellerophon limestone of Tunisia (Oudjah el Rhar of the Djebel Tebaga) (Termier et al. 1977). It has been also reported from the Chhiddru Formation of Salt Range (Reed 1944), the Sisiphon Limestone of Cambodia (Mansuy 1913), southern China (Yunnan) (Frech 1911) and southwestern China (Guizhou, Lopingian age) (Huang 1933).

Order **Terebratulida** Waagen, 1883

Suborder **Terebratulidina** Waagen, 1883

Superfamily Centronelloidea Waagen, 1882

Family Notothyrididae Licharew, 1960

Genus *Rostranteris* Gemmellaro, 1898

Type species: *Dielasma adrianense* Gemmellaro, 1894a, from the Guadalupian of Sicily, Italy

Remarks. Grant (1976, p. 253) discussed the genera *Notothyris* Waagen, 1882 and *Rostranteris* Gemmellaro, 1898 pointing out that Davidson's (1862, pl. 1, fig. 4) illustration of *Terebratula subvesicularis* Davidson, 1862 (the type species of *Notothyris*) from the Salt Range shows only three plications in the anterior part, although his description (Davidson 1862, p. 27) men-

tions seven. A higher number of anterior plicae seems to be the only distinctions from *Rostranteris* Gemmellaro, 1898 but, as Waterhouse & Piyasin (1970) noted, *Rostranteris* can have as many as six and *Notothyris* as few as three plications. Some of the specimens from Ko Muk (Grant 1976) have no plications, only a low fold, along with the centronelliform loop and perforated hinge plate. The presence of plicae and their number, therefore, seems variable in this group, and a poor basis for generic distinction. Examination of topotypic material of *Notothyris* from the Salt Range and *Rostranteris* from Sosio by Grant (1976) reveals no consistent external differences.

However, Jin & Lee (2006) considered them to be separate genera because of the plicosulcate anterior commissure and the acuminate loop with a high median plate in *Rostranteris*, which differ from the rectimarginate to slightly unisulcate anterior commissure and non-acuminate loop with only incipient median plate in *Notothyris*. Also the hinge plate of *Rostranteris* seems to be very characteristic, being confined posteriorly between the independent inner socket ridge (see Gemmellaro 1899, pl. 25, figs. 39 and 62, and Jin & Lee 2006, fig. 1338, *8a*) and being not perforated (see Jin & Lee 2006, fig. 1338, *4d*).

Smirnova (2007 and refs. therein) provided an exhaustive and detailed revision of the Permian Terebratulids of Eurasia in which she clarified the relationships between *Rostranteris* and allied genera, showing that *Rostranteris* differs from *Notothyris*, in having plicae which can reach also the the posterior half of the shell, more strongly curved commissures and the crural bases located ventrally on the inner hinge plates.

She also included the family Notothyridae in the Superfamily Centronelloidea Waagen, 1882, which is characterized by weakly developed or absent dental plates, entire or perforated inner hinge plate and brachidium at the centronelloid stage.

Rostranteris cf. **R. adrianense** (Gemmellaro, 1894a)

Pl. 3, figs 12-19; Pl. 5, figs 1-10

1894a *Dielasma adrianense* Gemmellaro, p. 5.
1898 *Rostranteris adrianense* - Gemmellaro, p. 306.
1899 *Rostranteris adrianense* - Gemmellaro, p. 241, pl. 25, figs. 35-39.
1934 *Rostranteris exile* - Solignac, p. 10, 25.
1957 *Rostranteris exilis* - Termier & Termier, p. 212, pl. 8, figs a-b.
1977 *Rostranteris exilis* - Termier, Termier & Vachard, p. 60.

Material: Three figured articulated specimens: MPUM10249 (TS11-7), MPUM10250 (TS12-13), MPUM10251 (TS12-18); three articulated specimens: MPUM10252 (TS11-8, TS12-22, TS13bis-6 (deformed specimen); three ventral valves: MPUM10253 (LTS1-12, TS13bis-10(a-b)).

Occurrence: Tunisia, Souinia section (LTS1, TS11, TS12, TS13bis).

Description. Ventribiconvex or biconvex shell, with maximum convexity in the posterior third part; drop-shaped or subpentagonal outline. Ventral valve with recurved umbo over the dorsal one, truncated by a circular and relatively large foramen; two plicae are limited almost always to the anterior region and are separated by a weak sulcus. Dorsal valve less convex than the ventral valve, and characterized by three weak and short plicae, separated by weak sulci.

Interior of ventral valve with pedicle collar and without dental plates; hook-like teeth. Interior of dorsal valve with a very reduced hinge plate, confined apically between well visible dental sockets and inner socket ridges which extend separately anteriorly to the hinge plate (Pl. 5, figs 1-10). The brachidium shows descending lamellae and a displaced high median plate.

Dimensions (in mm)

Specimens	Width	Length	W/L	Thickness
LTS1-12	7	8	0.87	/
TS11-7	7	8.9	0.78	5.1
TS11-8	8	9.8	0.81	4.2
TS12-13	8	9.8	0.81	4.9
TS12-18	8	/	/	5.5
TS12-22	7	7.5	0.93	5
TS13bis-10a	6	6.8	0.88	/
TS13bis-10b	3.9	4.3	0.90	/

PLATE 4

Fig. 1 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Fibers of the secondary layer with longitudinal keels (SEM). MPUM10258 (THJ5-37).

Fig. 2 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Overview of secondary layer fibers from the external surface (SEM). MPUM10258 (THJ5-37).

Fig. 3 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Bifid spine base (SEM). MPUM10258 (THJ5-37).

Fig. 4 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Concentrically arranged bifid spine bases (SEM). MPUM10258 (THJ5-37).

Fig. 5 - *Permophricodothyris caroli* (Gemmellaro, 1894a). Concentrically arranged bifid spine bases (SEM). MPUM10258 (THJ5-37).

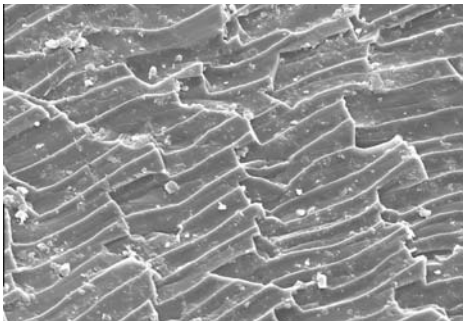
Fig. 6 - *Permophricodothyris* sp. ind. Alternation of large and small spine bases (SEM). MPUM10259 (THJ5-68).

Fig. 7 - *Permophricodothyris* sp. ind. Abraded bifid spine bases (SEM). MPUM10259 (THJ5-68).

Fig. 8 - *Permophricodothyris affinis* (Gemmellaro, 1899). Well preserved bifid spine bases (SEM). MPUM10260 (THJ5-83).

Fig. 9 - *Permophricodothyris affinis* (Gemmellaro, 1899). Bifid spine bases (SEM). MPUM10260 (THJ5-83).

Fig. 10 - *Permophricodothyris affinis* (Gemmellaro, 1899). Bifid spine bases (SEM). MPUM10261 (THJ5-99).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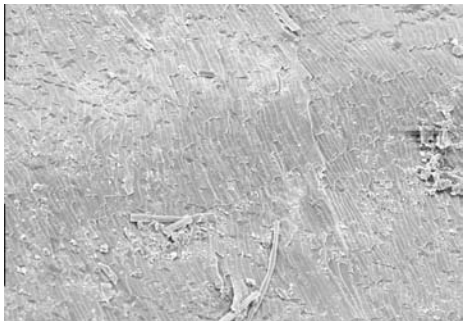
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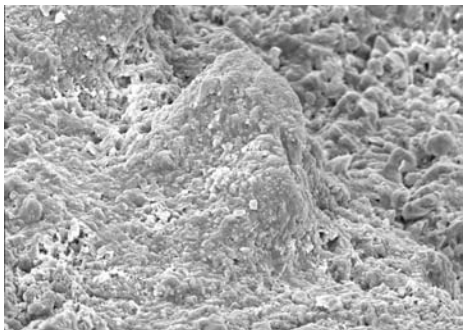
100 µm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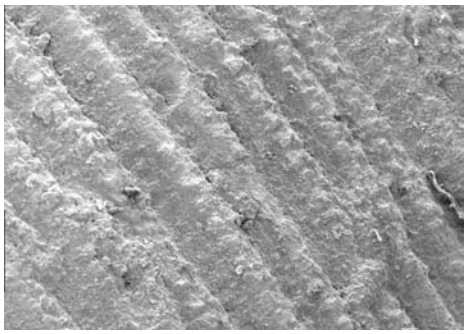
20 µm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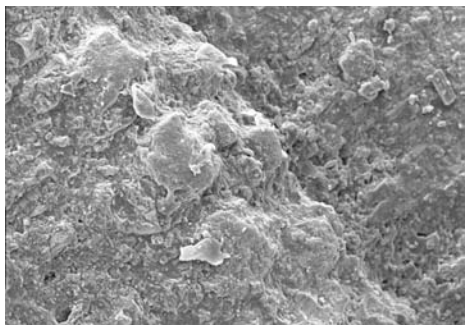
500 µm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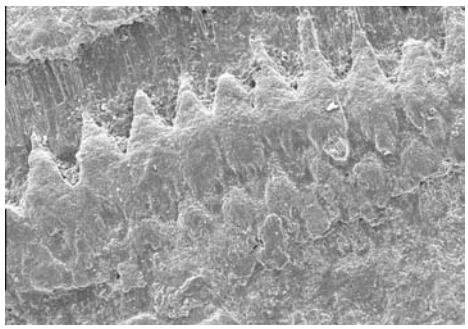
50 µm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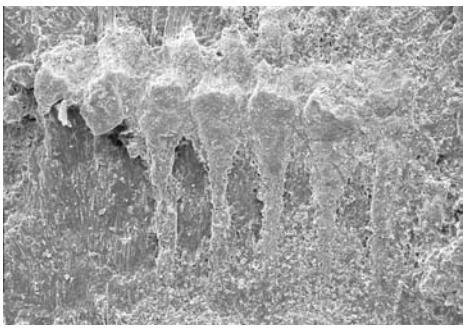
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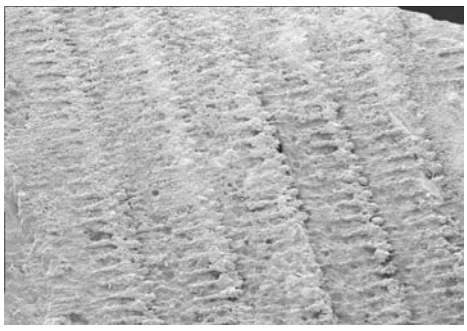
200 µm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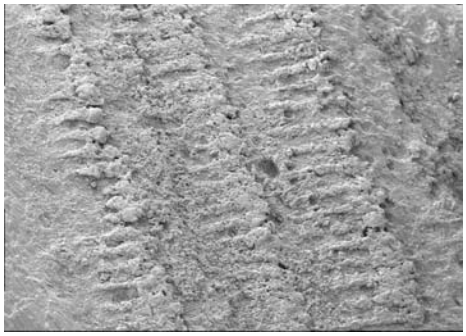
1 mm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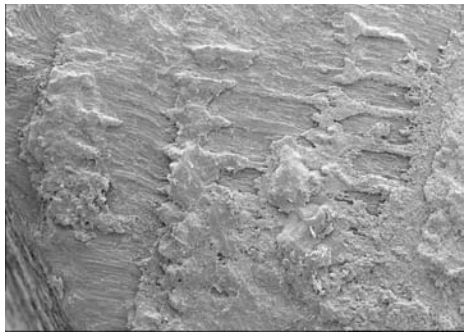
500 µm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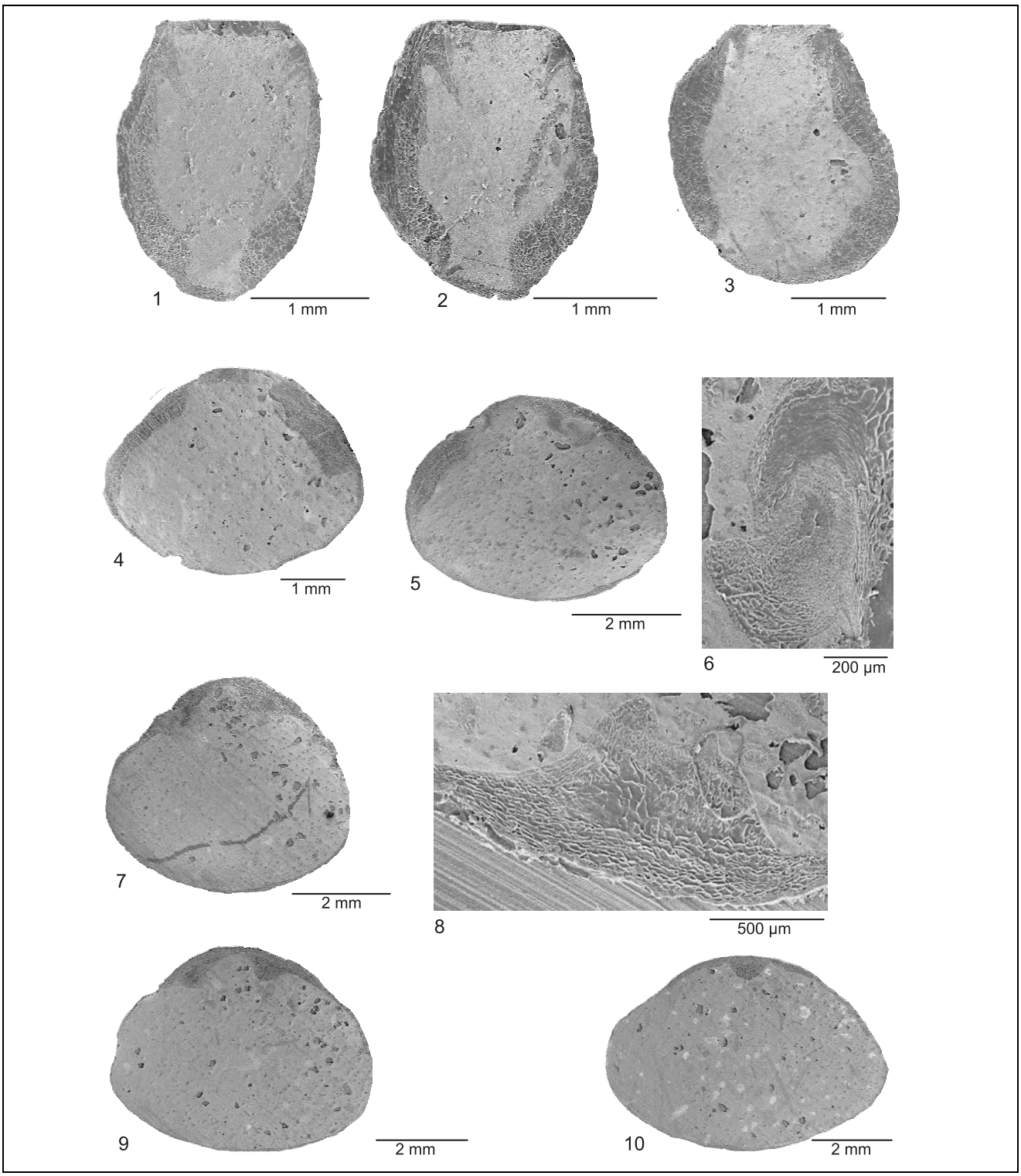

PLATE 5

Fig. 1 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 0.2 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 2 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 0.4 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 3 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 0.6 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 4 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 1.6 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 5 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 1.8 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 6 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 2.0 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 7 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 2.2 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 8 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 2.6 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 9 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 2.8 mm from the umbo (SEM). MPUM10250 (TS12-13).
Fig. 10 - *Rostranteris* cf. *R. adrianense* (Gemmellaro, 1894a). Serial section at 3.6 mm from the umbo (SEM). MPUM10250 (TS12-13).

Discussion. The present species has been placed in the genus *Rostranteris* because of the number and arrangement of plicae and the well developed median plate of brachidium. They are similar to *Rostranteris adrianense* (Gemmellaro, 1894a), but their plicae and sulci are slightly narrower. Furthermore, Gemmellaro (1899) described only two specimens of *R. adrianense*, so the determination is left open.

The Tunisian specimens are also similar to *Rostranteris exile* Gemmellaro, 1898, but the latter differs in showing a smaller width/length ratio, a median plica wider than the lateral plicae on the dorsal valve and an elliptical foramen.

Stratigraphic and geographic occurrence. *R. adrianense* has been found in the allochthonous limestones of Pietra di Salomone of Sosio Valley, Sicily, Italy.

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