

Upper Barremian-Lower Aptian Rudist Faunas From The Western Black Sea Region (Turkey)

with 12 figures

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Abstract

In the western Black Sea region of Turkey, rudist-bearing limestones from the Zonguldak-Amasra area are ascribed to the Upper Barremian-Lower Aptian. The Upper Barremian fauna consists of *Requienia* cf. *migliorinii*, *Toucasia carinata*, *T. transversa*, *Lovetchenia* sp., *Monopleura* aff. *depressa* and *Retha* sp. The Lower Aptian fauna is composed of: *Requienia* cf. *zlatarskii*, *Petalodontia* ? sp., *Caprina* cf. *douvillei* and *Ichthyosarcolites* ? sp. This assemblage is typically Mediterranean but the absence of Arabo-African components gives to the fauna a European palaeobiogeographic aspect. Moreover some elements (*Lovetchenia*, *Ichthyosarcolites* ?) show that the Pontides belonged during the early Cretaceous to the Balkanic subprovince of the European Province, in agreement with palaeotectonic regional reconstructions.

Keywords: Rudists, bivalves, Lower Cretaceous, palaeobiogeography, biostratigraphy, NW Turkey

Résumé

Les formations carbonatées à rudistes de la région de Zonguldak-Amasra sur la rive occidentale de la Mer Noire (Turquie) sont datées du Barremien supérieur-Aptien inférieur. La faune du Barrémien supérieur est constituée de: *Requienia* cf. *migliorinii*, *Toucasia carinata*, *T. transversa*, *Lovetchenia* sp., *Monopleura* aff. *depressa* et *Retha* sp. La faune de l'Aptien inférieur comprend: *Requienia* cf. *zlatarskii*, *Petalodontia* ? sp., *Caprina* cf. *douvillei* et *Ichthyosarcolites* ? sp.. En l'absence d'éléments paleobiogéographiques africains, cet assemblage faunique, méditerranéen, est d'obédience européenne. La présence de formes telles que *Lovetchenia* et *Ichthyosarcolites* ? montre que les Pontides se rattachaient, au Crétacé inférieur, à la sous-province balkanique de la Province européenne, en accord avec les reconstructions paléotectoniques.

Özet

Türkiye'nin Batı Karadeniz bölgesi'nde, Zonguldak-Amasra alanındaki rudistli kireçtaşları Üst Barremiyen-Alt Apsiyen olarak tanımlanmıştır. Üst Barremiyen faunası *Requienia* cf. *migliorinii*, *Toucasia carinata*, *T. transversa*, *Lovetchenia* sp., *Monopleura* aff. *depressa* ve *Retha* sp.; Alt Apsiyen faunası *Requienia* cf. *zlatarskii*, *Petalodontia* ? sp., *Caprina* cf. *douvillei* ve *Ichthyosarcolites* ? sp. dan oluşur. Bu topluluk tipik Akdeniz faunasıdır, fakat Arabo-Afrikan içeriğinin olmaması bu faunanın Avrupa paleobiyocoğrafyasına ait olduğu anlamına gelir. Bunun yanı sıra bazı cinsler (*Lovetchenia*, *Ichthyosarcolites* ?) Pontidlerin Erken Kretase boyunca Avrupa'nın Balkanik alt bölgesinde yereldiğini ve bu verinin de paleotektonik yapıyla aynı görüştüğüne gösterir.

Introduction

Little has been recorded on Lower Cretaceous rudists from Anatolia except from the western Black Sea region (western Pontides) (fig. 1) where Lower Cretaceous shallow water carbonates containing rudists, i.e. "Urgonian limestones", were reported by CHARLES & FLANDRIN (1929) and in unpublished reports from ARNI (1939, 1941) and ÖZER (1986). More recently DERMAN (1990) and DERMAN & SAYILI (1995) provided some new lithostratigraphic results on these Lower Cretaceous successions as well as detailed information on their regional distribution, especially in the Zonguldak area. Rudist faunas were essentially known following DOUVILLÉ (1896) who identified *Pseudotoucasia* and *Polyconites* from Ilikso, near Zonguldak, and CHARLES & FLANDRIN (1929) who mentioned *Toucasia carinata* (MATHERON), *Requienia ammonia* (GOLDFUSS) and *Matheronia gryphoides* MATHERON. ASTRE (1931) figured from Tarla-Agzi (Amasra region) *Toucasia carinata* var. *euxina*. Finally ÖZER (1986), in unpublished regional reports, also found some Barremian-Aptian forms.

The objective of the present paper is to describe rudist faunas found in this region during a field survey of the Zonguldak-Amasra region. This study will focus on Barremian-Lower Aptian faunas whose description is complemented by litho- and biostratigraphic data mainly based upon preliminary micropalaeontological investigations on the rudist bearing limestones. The biostratigraphic and palaeobiogeographic significance of the rudist fauna will also be discussed.

Geographic and stratigraphic setting

The studied region pertains to the western, outer Pontides, corresponding to the eastern part of the Rhodope-Pontide segment of the East European platform (GÖRÜR 1988). Two areas were investigated, the Zonguldak and Amasra areas (fig. 1).

Previous works

In Zonguldak two types of succession were reported by CHARLES & FLANDRIN (1929), named "Facies nord" and "Facies sud". "Facies nord" consists of a tripartite succession: "Calcaires inférieurs", "Assise d'Indjvez" and "Calcaires supérieurs à faciès urgoniens", well represented on the Black Sea coast from Zonguldak to Kozlu and Ilikso. The "Calcaires inférieurs" start with conglomerates overlying Palaeozoic (mainly Carboniferous) rocks and consist of fossil-poor fine grained limestones. The "Assise d'Indjvez" is a 80 m thick unit showing interbedded limestones, sandstones, marls and conglomerates; cephalopods found in the marly beds were ascribed to *Silesites* gr. *S. seranonis* (d'ORBIGNY) and *Hibolites minaret* (RASPAIL), indicating the upper Barremian (BUSNARDO 1965a, b, DELANOY 1994). The "Calcaires

supérieurs à faciès urgoniens" are characterized by rudists: *Requienia ammonia*, *Toucasia carinata*, *Matheronia gryphoides* and Orbitolinidae ascribed to "*Orbitolina conoidea*" GRAS. The upper part of this unit is dominated by corals. This carbonate succession is capped by marls ("Marnes violacées") ascribed to the Lower Aptian, an age based on the presence of: *Deshayesites consobrinus* (d'ORBIGNY), *Ancyloceras matheroni* (d'ORBIGNY) and *Cheloniceras seminodosum* (SINZOW). "Facies sud" consists of Urgonian limestones overlying Carboniferous rocks, with a "basal conglomerate"; the limestones contain *Toucasia carinata*, brachiopods and corals, and are overlain by black marls, in turn overlaid by sandstones: Grès de Veli-Bey. DERMAN (1990) regarded the upper carbonate unit as the Öküsmedere Formation, extending along the Black Sea coastal zone from the vicinity of Ilikso up to Kilimli. This formation was considered, Barremian-Albian in age. He interpreted the Incigez (= Indjvez) beds as continental, notwithstanding the presence of cephalopods, and referred the "Calcaires inférieurs" to the Inalti Formation, placed in the Upper Jurassic-Lowermost Cretaceous capping Carboniferous rocks (SAYILI et al. 1992). DERMAN (1990) noticed that the Öküsmedere Formation is equivalent to the so-called Cengellidere formation outcropping southward.

In Amasra, CHARLES & FLANDRIN (1929) reported the presence of Urgonian facies correlated to those of Zonguldak.

In conclusion the work of CHARLES & FLANDRIN documents the presence of Urgonian limestones, with a Late Barremian age, capped by Lower Aptian marls, running from Zonguldak to Amasra.

Special attention must be paid to the stratigraphy of Tarla-Agzi, near Amasra, where ASTRE & CHARLES (1931) provided contrasting results based on rudist palaeontology on the one hand and regional stratigraphy on the other hand. While *Toucasia carinata* var. *euxina* was considered by Astre as a reliable marker of the Upper Barremian (p. 700), CHARLES (p. 701 and fig. 3) claimed that the corresponding beds may be of Hauterivian age.

New data

In the Zonguldak area, we investigated the following sections (fig. 1 b-c)

- N.E. of Cengelli village, along the Ilikso river,
- Incirleryüzü sirtlari and Kizilcakilise damlari, close to Öküsmedere, west to Kozlu,
- Kozlu,
- closer to the city of Zonguldak, the Devlet Mühendislik Mimarlik Akademisi outcrop on the north of Bahçelievler Mahallesi, and the Deniz Kulübü outcrop on the eastern of the Yayla Mahallesi.

In the Amasra area we examined the "Urgonian limestones" sensu CHARLES & FLANDRIN (1929), considered equivalent to the Öküsmedere Formation of Zonguldak. At Tarla Agzi the corresponding carbonate beds, overly-

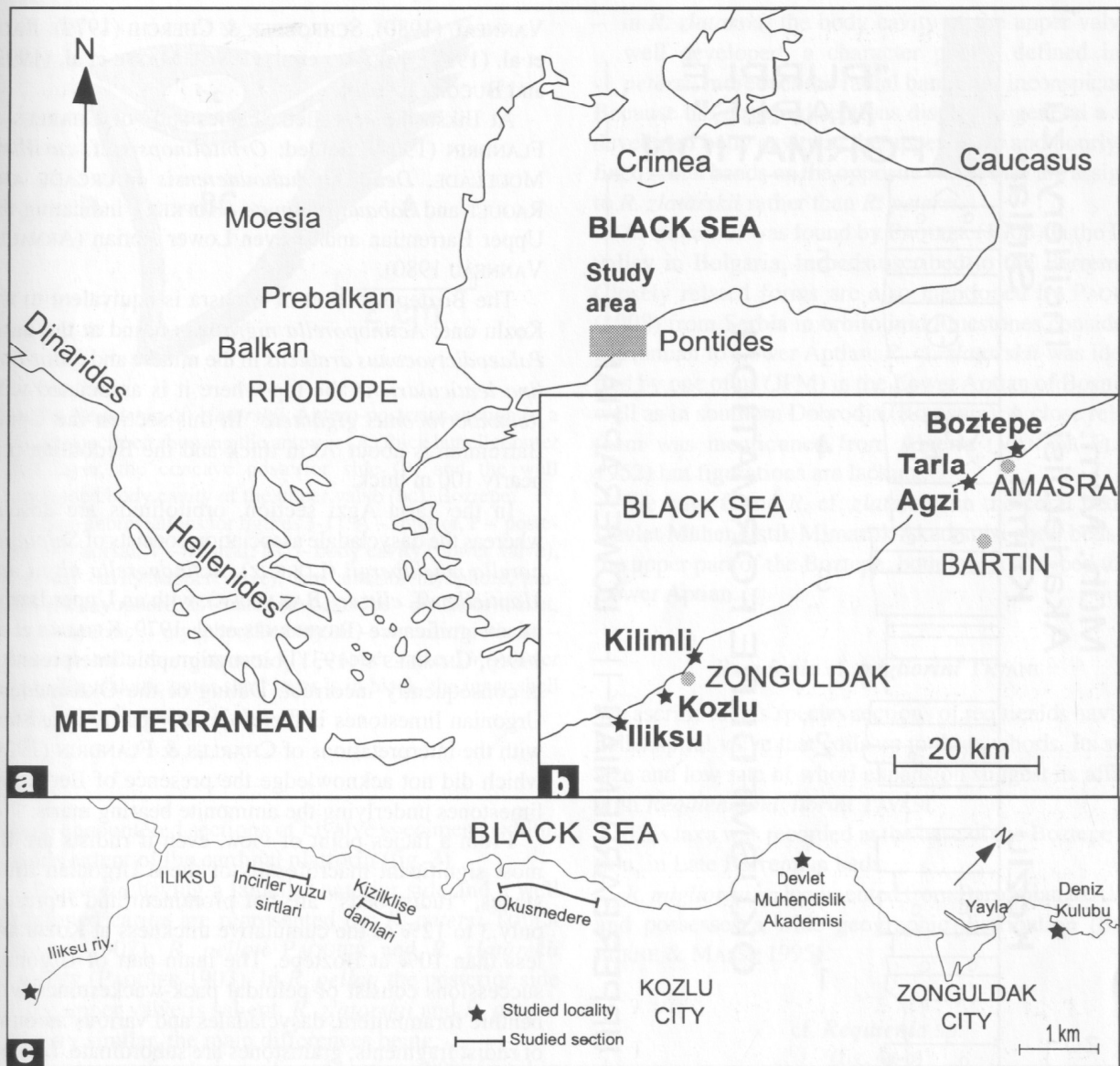


Fig. 1: Geographic situation of the study area (a) and investigated localities on the western Black Sea region of Turkey (b) (c).

ing Carboniferous beds, were studied on the eastern side of the bay. At Amasra we investigated the Boztepe Island succession with some additional observations on the topmost part of the section, along the road from Amasra to Bartın.

The micropalaeontologic content of the Urgonian Öküsmedere limestones in the vicinity of Kozlu (fig. 2) is marked by the following assemblages:

- the basal part of segment 1 contains *Actinoporella nigra* (CONRAD & PEYBERNÈS) and *Palaeodictyoconus arabicus* (HENSON), the middle part of this segment is marked by the FO of *Palorbitolina lenticularis* (BLUMENBACH) coupled with the LO of *Actinoporella nigra*,
- segment 2 still records *Palaeodictyoconus arabicus* and the FO of *Sabaudia capitata* ARNAUD VANNEAU, these species and *Palorbitolina lenticularis* are per-

sisting in segment 3, marked by the FO of *Rectodictyoconus giganteus* SCHROEDER and the presence of *Caprina* cf. *douvillei* PAQUIER.

Coral beds found at Devlet Mühendislik Mimarlık Akademisi, and Deniz Kulübü yielded *Palorbitolina lenticularis*, while in the Inceleryüzü sirtlari and Kizilcakilise damlari beds *Orbitolina (Mesorbitolina) parva* (DOUGLASS) and *Hensonella urladanasi* (CONRAD et al.) were found.

Segment 1 of Kozlu is considered Upper Barremian; the Barremian-Bedoulian boundary is tentatively placed in segment 2, while segment 3 and the overlying coral beds are ascribed to the Bedoulian p.p. The *O.(M.) parva* bearing beds are considered upper Bedoulian p.p. These biostratigraphic interpretations are based on the works of: PEYBERNÈS (1976), CONRAD and PEYBERNÈS (1978), PEYBERNÈS, CONRAD & CUGNY (1979), ARNAUD-

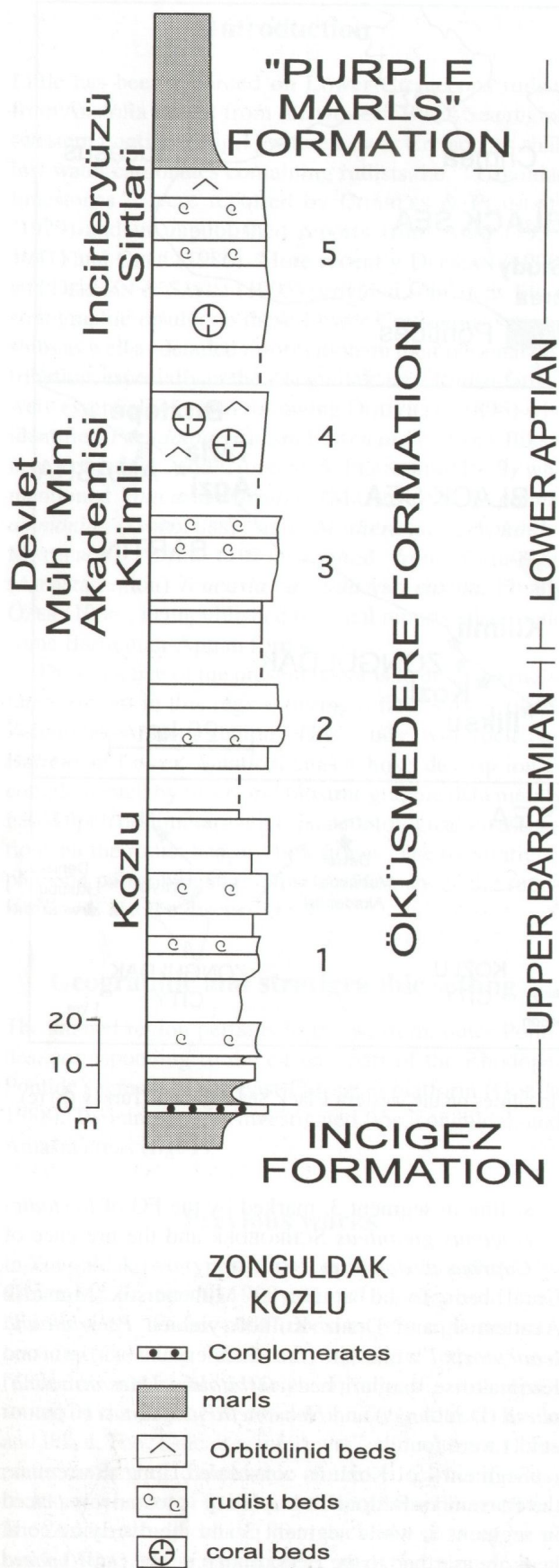


Fig. 2: Stratigraphic sketch of the Öküsmedere section, at Kozlu, near Zonguldak showing the position of the rudist beds and associated facies.

VANNEAU (1980), SCHROEDER & CHERCHI (1979), BAUD et al. (1994), KIRMACI et al. (1996), MASSE et al. (1992) and BUCUR (1993).

At Iliku the so called "Facies sud" of CHARLES & FLANDRIN (1929) yielded: *Orbitolinopsis* cf. *cuwillieri* MOULLADE, *Debarina hahounerensis* FOURCADE AND RAOULT and *Sabaudia minuta* (HOFKER), indicating the Upper Barremian and/or even Lower Aptian (ARNAUD-VANNEAU 1980).

The Boztepe section of Amasra is equivalent to the Kozlu one: *Actinoporella nigra* was found at the base, *Palaeodictyoconus arabicus* in the middle and *Palorbitolina lenticularis* at the top where it is associated with *Rectodictyoconus giganteus*. In this section the Upper Barremian is about 70 m thick and the Bedoulian p.p. nearly 100 m thick.

In the Tarla Agzi section, orbitolinids are absent, whereas the dasycladale association consists of *Salpingoporella muehlbergii* (LORENZ), *Actinoporella nigra* and *Montiella* aff. *elitzae* (BAKALOVA), with an Upper Barremian significance (PEYBERNÈS et al. 1979, KIRMACI et al. 1996), CHARLES's (1931) biostratigraphic interpretation is consequently incorrect. Dating of the Öküsmedere/Urgonian limestones is therefore only partly consistent with the interpretations of CHARLES & FLANDRIN (1929) which did not acknowledge the presence of Bedoulian limestones underlying the ammonite bearing marls.

From a facies point of view, even if rudists are the most significant macrofossils of these Urgonian limestones, "rudist beds" are not prominent and represent only 3 to 12% of the cumulative thickness at Kozlu and less than 10% at Boztepe. The main part of Urgonian successions consist of peloidal pack-wackestones with benthic foraminifera, dasycladales and various amounts of rudist fragments; grainstones are subordinate. In coral beds rudists are rare or absent. Large orbitolinids are in general scattered in muddy or even grainy facies and mixed with other, smaller, benthic foraminifera and dasycladales.

Systematic Palaeontology

Family Requieniidae DOUVILLE

Genus *Requienia* MATHERON

Requienia cf. *zlatarskii* PAQUIER
(fig. 3)

1903 *Requienia zlatarskii* PAQUIER, pl. V, fig. 1-3.

We tentatively ascribe to *Requienia zlatarskii* Paquier sections showing:

- a lower valve having a lamellar anterior side and a smooth posterior side, with a pronounced, acute, ventral carina,
- a flat, slightly convex, upper valve, with a small posterior myophoral plate, whereas a myophoral plate is lacking on the lower valve.

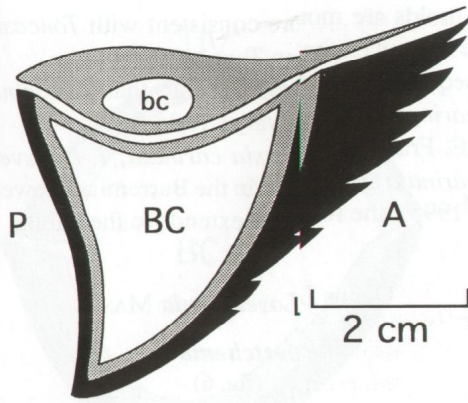


Fig. 3: *Requienia* cf. *zlatarskii*. Antero-posterior section of a bivalve specimen showing the anterior (A) thick lamellar outer shell layer, the concave posterior (P) side and the well developed body cavity of the upper valve (bc). Boztepe. Common abbreviations for figures 3-11. A – anterior, P – posterior, D – dorsal, V – ventral, BC – body cavity (lower valve), bc – body cavity (upper valve), am – anterior myophore, pm – posterior myophore, as – anterior socket, ps – posterior socket, s – socket, mc – myophoral cavity, at – anterior tooth, pt – posterior tooth, m – myophore, UV – upper valve, LV – lower valve. The calcitic outer shell layer is in black, the inner shell layer, formerly aragonitic is in grey.

Some encountered sections of bivalve specimens exhibit a wide extent of the cardinal platform (fig. 3).

Requienia having a lamellar anterior side and a well developed carina are represented by: *R. petersi* TOULA (TOULA 1902), *R. pellati* PAQUIER and *R. zlatarskii* PAQUIER (PAQUIER 1903). In *R. pellati* the posterior side of the upper valve is salient. *R. zlatarskii* and *R. petersi* are very similar, the main differences being:

- the abrupt change in coiling direction (90°) found in *R. zlatarskii*,
- the rapid shell expansion of *R. petersi*, which is still trochospiral at the adult stage while it tends to be helicospiral in *R. zlatarskii*,

– in *R. zlatarskii* the body cavity of the upper valve is well developed, a character poorly defined in *R. petersi*, moreover the radial bands are inconspicuous. Because the observed sections display in general a well developed body cavity in the upper valve and poorly defined radial bands on the opposite valve, they are assigned to *R. zlatarskii* rather than *R. petersi*.

R. zlatarskii was found by PAQUIER (1903) in the Lom valley in Bulgaria, in beds ascribed to the Barremian. Closely related forms are also mentioned by PAQUIER (1908) from Serbia in orbitolinid limestones considered Barremian to Lower Aptian. *R. cf. zlatarskii* was identified by one of us (JPM) in the Lower Aptian of Bosnia as well as in southern Dobrodja (Romania). A close related form was mentioned from Algeria (VAN DE FLIERT 1952) but figurations are lacking.

We have found *R. cf. zlatarskii* in the coral beds of Devlet Mühendistik Mimarlik Akademisi coral beds and the upper part of the Boztepe, both levels ascribed to the Lower Aptian.

***Requienia* cf. *migliorini* TAVANI**

We ascribe to this species sections of requienids having a helicospiral valve that coils up to three whorls. Its small size and low rate of whorl expansion suggest its affinity with *Requienia migliorini* TAVANI.

This taxa was recorded at the base of the Boztepe section, in Late Barremian beds.

R. migliorini is documented from Barremian to Albian and possesses a wide geographic distribution (SWINBURNE & MASSE 1995).

cf. ***Requienia* sp.**
(fig. 4a-b)

Small size requienids (less than 2 cm) forming dense assemblages, associated with a muddy matrix are frequent, especially in the Barremian of Kozlu. The rounded shell outline and the absence of a myophoral plate on the

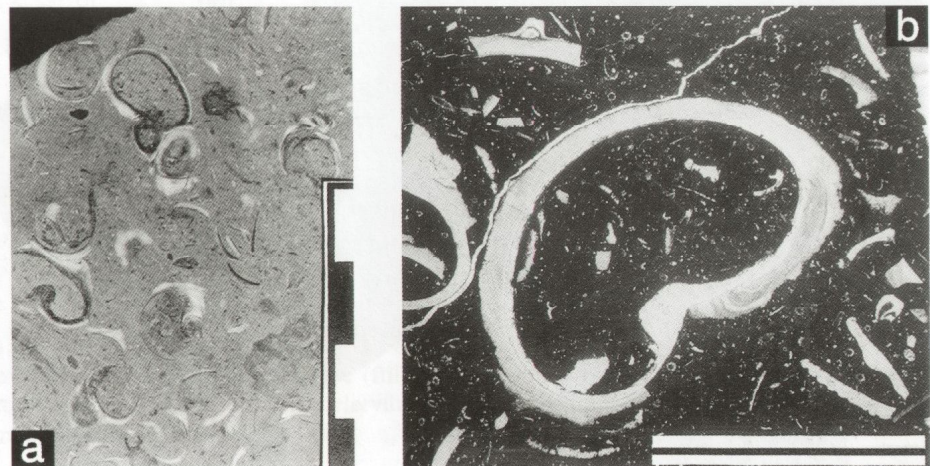


Fig. 4a: cf. *Requienia* sp. Assemblage of small size Requieniidae in a muddy sediment. Kozlu. This facies conforms to the typical requienid dominated “Urgonian facies” from SE France.
4b: Corresponding microfacies showing the shell microstructure and the micritic matrix. Scale bar 1 cm.

lower valve suggest *Requienia* whereas *Matheronia* cannot be excluded. The scarcity of upper valves and the absence of appropriate sections preclude a more specific taxonomic identification.

Genus *Toucasia* MUNIER CHALMAS

Toucasia transversa PAQUIER
(fig. 5a)

This form is characterized by the offset of the posterior flank of the upper valve onto the commissure (PAQUIER 1903) a character well defined in our material. Isolated specimens from Ilikso, have a relatively modest size: width (W) fluctuates from 1.5 to 2 cm, and length (L) from 2 to 2.5 cm. The W/L ratio is higher than 0.5, and more frequently fluctuates from 0.7 to 0.8 which means that the antero-posterior compression of the shell is limited. Coiling is well developed, external grooves marking the myophoral posterior plates are poorly defined and the ventral carina on both valves are acute and well defined.

Toucasia carinata (MATHERON)
(fig. 5b)

We ascribe to this species a collection of specimens found at Tarla Agzi. The length fluctuates from 1 to 3 cm. The posterior side of the upper valve is moderately salient above the commissure without offset. Ventral carina is well marked. This locality was sampled by CHARLES (in ASTRE & CHARLES 1931) and the specimens studied by ASTRE who recognized a special type considered as a variety: *Toucasia carinata* var. *euxina*. This form was regarded more advanced than the typical *Toucasia carinata* because of a higher angle between the commissure and the posterior myophoral plate of the upper valve, and appears peculiar owing to the oval shape, high and non carinate upper valve, looking like those of *Apricardia* (ASTRE 1931). Notwithstanding the sound description given by ASTRE, the corresponding illustrations, based on

internal molds are more consistent with *Toucasia praecarinata* DOUVILLE than *Toucasia carinata*.

Consequently we can assume that *T. carinata* and *T. praecarinata* are coeval at Tarla Agzi.

In S.E. France *Toucasia carinata*, *T. transversa* and *T. praecarinata* are found in the Barremian-Lower Aptian (MASSE 1995), the former extends to the Albian p.p.

Genus *Lovetchenia* MASSE

Lovetchenia sp.
(fig. 6)

We assigned to this genus longitudinal sections of bivalve specimens showing a bulge-shape rounded upper valve, the development of which is near equal to those of the lower valve whereas the thickness of the outer calcitic shell layer is far more limited. Myophores parallel the commissure and lie on the extension of the cardinal platform. These characters conform to the descriptions given by PAQUIER (1903), MASSE (1993) and MASSE et al. (1998) for the genus *Lovetchenia* MASSE. The specific attribution of our material is more problematic. It differs from *Lovetchenia lovetchensis* (ZLATARSKI) by the absence of strong lamellar anterior growth bands, a character which could justify a close relationship with *Lovetchenia drinovi* (ZLATARSKI) described from the Barremian-Aptian of Bulgaria (ZLATARSKI 1886) and later on documented by TZANKOV (1960) and ATANASOVA-DELTCHEVA (1978). The size is also significantly smaller. PAQUIER (1903) considered *L. drinovi* as a variety of *L. lovetchensis*, an interpretation based on specimens from S.E. France, having an Hauterivian age. Because the French material belongs to a distinctive group of taxa we do not acknowledge PAQUIER's opinion (MASSE et al. 1998).

We observed the best specimens in segment 1 of the Kozlu section, that is to say in Upper Barremian beds. This stratigraphic position is different from those of the *Lovetchenia* beds from the Lovetch group in Bulgaria,

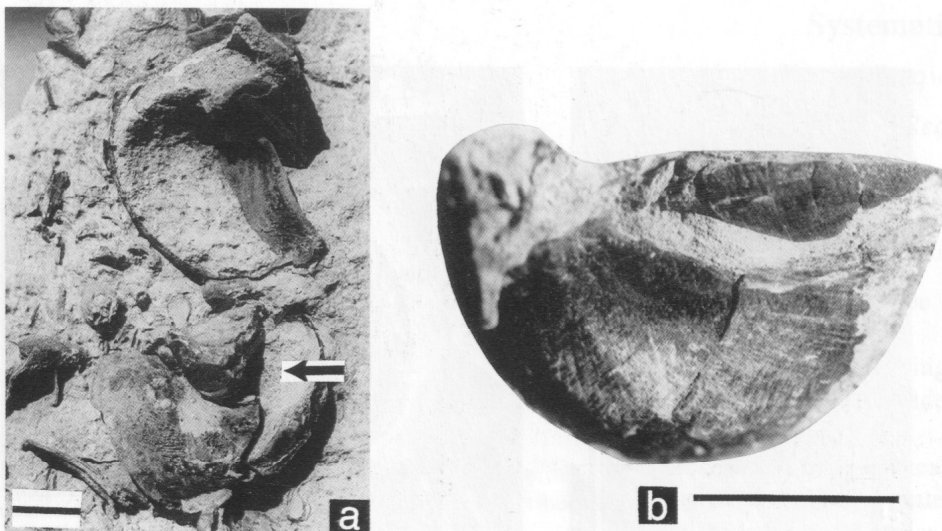


Fig. 5a: *Toucasia transversa*. Partly isolated bivalve specimen showing the offset of the posterior flank of the upper valve (arrow). Ilikso.
5b: *Toucasia carinata*. Posterior view of a partly isolated bivalve specimen showing the elevation of the upper valve above the commissure. Tarla Agzi. Scale bar 1 cm.

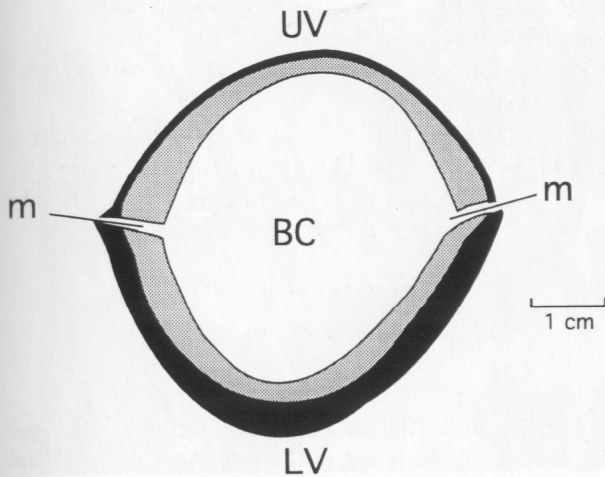


Fig. 6: *Lovetchenia* sp. Antero-posterior section of a bivalve specimen showing the bulge shape upper valve (UV) and the myophore (m) located on a widened extent of the cardinal platform. Kozlu.

which are mainly Lower Aptian (MASSE 1993). It is also older than the Italian findings of this genus (Lower Aptian, MASSE 1992).

Family Monopleuridae MUNIER-CHALMAS

Genus *Monopleura* MATHERON

Monopleura aff. *depressa* MATHERON
(fig. 7)

We attribute to this genus two kinds of sections:

- antero-posterior sections of bivalve specimens (fig. 7a) showing that the valves are near equal, with a triangular outline, the thickened, flat area is interpreted as the posterior myophoral zone, while the opposite side where valves thin out is regarded as the anterior myophore,

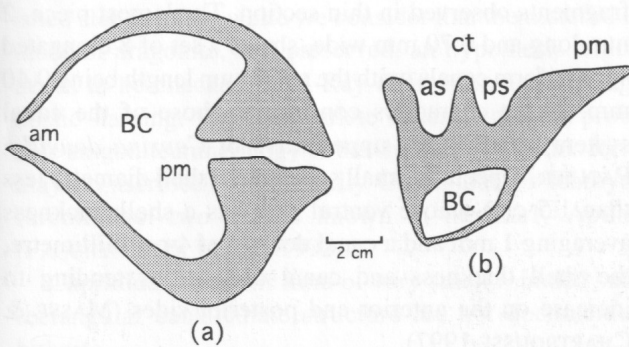


Fig. 7: *Monopleura* aff. *depressa*. (a) anterior-posterior section of a bivalve specimen showing the overall shell habit and the myophores. (b) antero-posterior section of a lower valve, cut near the dorsal side, showing the myocardial organisation. Boztepe.

- antero-posterior sections (fig. 7b) of the lower valve, cut near the dorsal side, displaying a low triangular habit, the anterior and posterior sockets and the central tooth; the section is strongly asymmetrical, with a thin vertical side, regarded anterior, and a thick inclined, thickened side, regarded posterior.

The overall configuration and dimensions of the sections are consistent and indicative of the genus *Monopleura* MATHERON. *Monopleura depressa* MATHERON shows very similar sections (MASSE, personal observations) and dimensions are also similar, though the lower valve is shorter than those of our material. As in the Orgon limestones where *Monopleura* species tend to have a very thin outer calcitic shell layer, the calcitic shell layer of the investigated sections is hardly visible.

Monopleura aff. *depressa*. was found at Boztepe, associated with *Retha* sp. and poorly preserved requienids, in beds close to the Barremian-Aptian boundary.

Genus *Petalodontia* (?) POCTA

Petalodontia ? sp.
(fig. 8)

This form is illustrated by a set of transverse sections of the lower valve, found in thin sections, showing the following characters:

- the calcitic outer shell layer shows two sublayers, a radial fibrous outer part (fibres are 0.02 mm in diameter), and a coarse prismatic inner part (prisms are

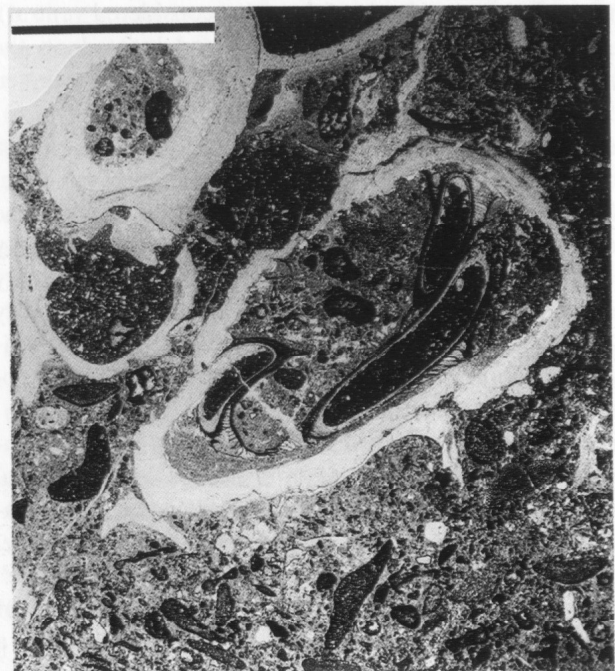


Fig. 8: *Petalodontia* ? sp. Oblique thin section of the lower valve (filled with worm tubes) belonging to a small cluster. Inceleryüzü Sirtlari. Scale bar 5 mm.

0.10 to 0.20 mm wide); outer layer has rounded, obtuse ribs: there is a triangular ligamentary crest, – the inner shell layer, initially aragonitic is very thin; – sockets and teeth are not preserved.

Because of the thin inner shell layer we can exclude *Monopleura*, the posterior side of which, having a myophoral function, is thickened; this form is therefore tentatively ascribed to *Petalodontia*?. This name was proposed by DOUVILLÉ (1918) for Barremian-Lower Aptian tubular monopleurids having a vertical myophoral plate on the upper valve, protruding in the lower valve and facing the posterior inner flank.

The taxonomic attribution of this form is open to revision because the myophoral organisation of the upper valve is unknown, moreover the so called Barremian-Lower Aptian *Petalodontia* cannot pertain to this genus (MASSE, work in progress).

This form was found at the Inceleryüzü sirtlari section in beds of Lower Aptian age, (*Orbitolina (Mesorbitolina) parva* interval).

Family Caprinidae d'ORBIGNY emend.

Genus *Retha* COX

Retha sp.
(fig. 9)

We assigned to this genus two different types of sections.

- Longitudinal oblique sections (fig. 9a) that show an arcuate shape and two elongated cavities, one of which is regarded as the body cavity (it flanks the convex outward side of the valve considered ventral), and the other (relatively wide and located on the straight/concave outward side of the shell) interpreted as the myocardial cavity.
- Transverse oblique sections (fig. 9b) that display a subtriangular shape, with a flat depressed ventral zone; the body cavity has also a subtriangular outline and is flanked laterally by a smaller elongated cavity displaying ventrally a rounded termination; this cavity is interpreted as a myocardial cavity, that is to say connecting the central (dorsal) socket and the perimyophoral depression (postero-ventral) (= endomyophoral cavity sensu SKELTON & SMITH 2000).

Both sections which exhibit the same size (5 cm in diameter), are essentially made of sparitic calcitic material suggesting an originally aragonite dominated shell mineralogy. The outer calcitic shell layer was not visible, i.e. probably diagenetically altered. The “caprinid type” myophoral organisation illustrated by the characters of the upper valve and the lack of pallial canals suggest a close affinity with primitive Caprinidae such as *Pachytraga tubiconcha* ASTRE or *Retha munieri* (MATHERON). Because evidence for an anterior myophoral cavity (a typical feature of *Pachytraga*, even if sections far from the commissure do not show this trait) is lacking we consider *Retha* a more appropriate designation than *Pachy-*

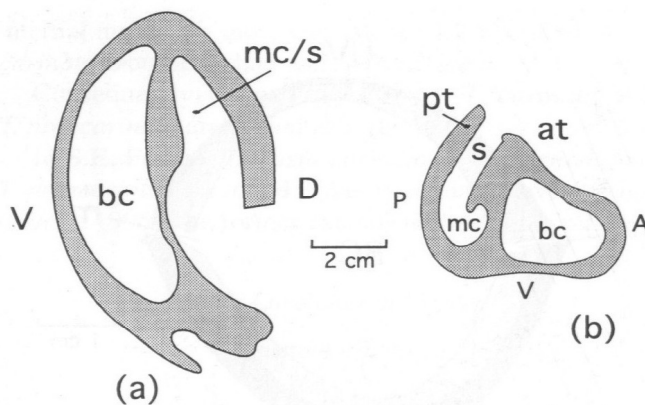


Fig. 9: *Retha* sp. (a) Oblique longitudinal section of the upper valve showing the body cavity (bc) and the endomyophoral (mc) – socket (s) cavity. (b) Transverse section of the upper valve showing the myocardial cavity (mc/s) and the location of anterior (at) and posterior (pt) teeth. Boztepe.

traga. The size of our sections conforms to those of *Retha munieri* (see SKELTON & MASSE 1998) as well as the apparent coiling of the upper valve, whereas the typical anterior carina and the flattened antero-dorsal side of *R. munieri* were not observed. Our sections also differ from *Retha tulae* (FELIX) by the absence of a carina, their larger size and their subtriangular transverse outline. The finding of new material is needed to clarify the specific status of this form which was observed at Boztepe in beds close to the Barremian-Aptian boundary.

Genus *Caprina* d'ORBIGNY

Caprina cf. *douvillei* PAQUIER
(fig. 10)

This form is represented by millimetre size shell fragments observed in thin section. The largest piece, 2 mm long and 0.70 mm wide, shows a set of 8 elongated subpyriform canals, with the maximum length being 0.40 mm. These characters conform to those of the canal system found in the upper valve of *Caprina douvillei* PAQUIER, especially small specimens (shell diameter less than 1.5 cm) whose ventral side has a shell thickness averaging 1 mm and a canal density of 4 per millimetre, the shell thickness and canal dimensions tending to increase on the anterior and posterior sides (MASSE & CHARTROUSSE 1997).

Elongated canals are also found in *Caprina parvula* DOUVILLE and *Offneria nicolinae* (MAINELLI) but the dimensions are far higher (MASSE & CHARTROUSSE 1997).

This material was found in segment 3 of the Kozlu section, of early Aptian age.

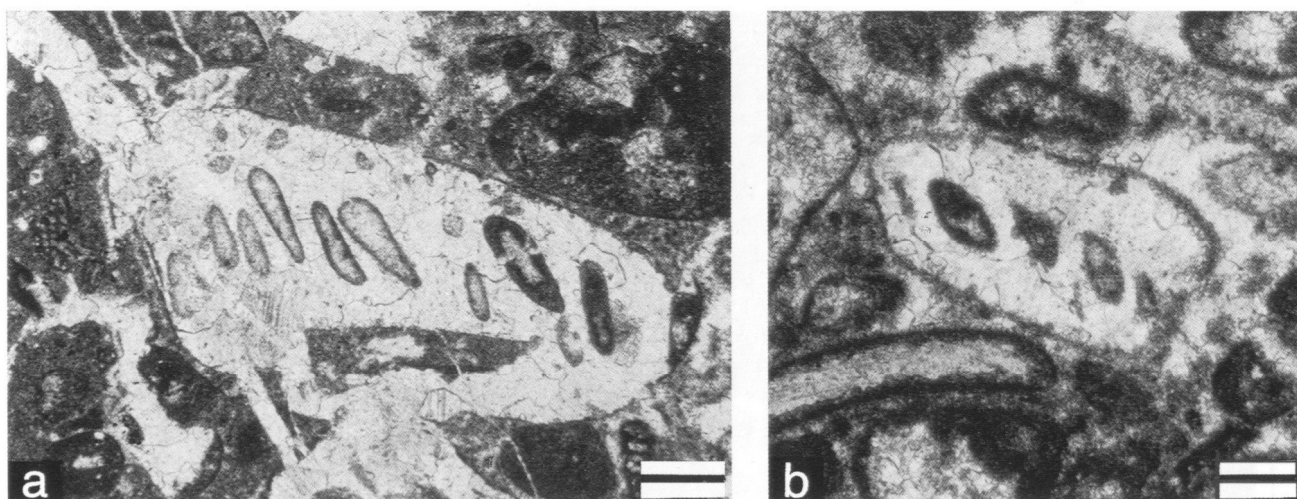


Fig. 10: *Caprina cf. douvillei*. Thin sections showing canaliculate fragments with elongated subpyriform (a) or elliptical canals (b). Kozlu. Scale bar 0.20 mm.

Family Ichthyosarcolitidae DOUVILLE emend.

Ichthyosarcolites ? sp.
(fig. 11)

This form is represented by millimetre size shell fragments observed in thin section. The basic architecture is small rounded subrectangular canals having 0.15-0.25 mm transverse dimensions. Shell fragments having one row of canals are very frequent while those with two rows are rare. Longitudinal oblique sections show that the canals, are at least 2 to 3 mm long. In transverse sections each canal is inscribed in a square shaped structure, delineated by a thin micritic line, with a T termination, making the boundary between the canals. Triangular canals are locally observed within the rounded ones, clearly bounded too by micritic lines.

Owing to the bending of some shell fragments:

- the shell diameter is probably less than 1 cm,
- the T foot is directed towards the shell cavity.

The microstructure of the shell is pale yellow with a fine fibrous habit. Because the corresponding aspect on polished slab is milky white we consider that the material is made of aragonite, still preserved, an hypothesis which needs to be checked by X-Ray diffraction and/or diagnostic staining. The canaliculate structure and the probable aragonite mineralogy of the shell show that this form may be ascribed to the family Caprinidae or Ichthyosarcolitidae: two groups known in the Early Aptian (PAQUIER 1905, MASSE 1992).

Caprinidae with this kind of very small rounded subrectangular canaliculate structure are not documented hitherto.

Detailed studies on the canal architecture of *Ichthyosarcolites* are few. Descriptions and figures on the microstructural aspect point out a rounded or polygonal pattern (CARBONE et al. 1971, PHILIP et al. 1978, CESTARI & SARTORIO 1995) but data on the microstructural pattern

of the canal organisation (i.e. canal boundaries) from aragonite preserved specimens are lacking. Of special interest are the figures provided by PLENIČAR (1965) of *Ichthyosarcolites rogi* showing some monocanaliculate portions of the shell and fragments of these resembling our material. Unpublished figures from BOUCHARD (1986) dealing with the shell microstructure of *Ichthyosarcolites cf. triangularis* from the Cenomanian of Provence (SE France) display subrounded canals bounded by polygonal micritic lines. The size of the canals is about 0.5 mm on average.

Concerning the pre-Cenomanian forms, little is known on the canaliculate architecture of the *Ichthyosarcolites* figured by PAQUIER (1905) from the Barremian ?-Aptian from Bulgaria, nevertheless the configuration looks polygonal or rounded with average diameter near 1 mm and the overall canaliculate pattern is rather irregular. The overall size and canal arrangement of our material closely resemble those of "*Ichthyosarcolites* sp." figured by MASSE (1992) from the Lower Aptian of southern Italy. Nevertheless the actual taxonomic position of this form is still problematic.

In conclusion we can provisionally ascribe this form to *Ichthyosarcolites* (?), notwithstanding that well preserved material is needed to document its general organisation, in particular the myocardinal one. Additional information on the primitive (ante Cenomanian) Ichthyosarcolitidae, still poorly investigated, is also required.

Ichthyosarcolites ? was found at the upper part of the Boztepe section, in Lower Aptian beds.

Discussion

The Zonguldak-Amasra fauna is dominated by Requieniidae represented by *Requienia cf. migliorini*, *R. cf. zlatarskii*, *Lovetchenia* sp., *Toucasia carinata* and *Toucasia transversa*; Monopleuridae are represented by *Mono-*

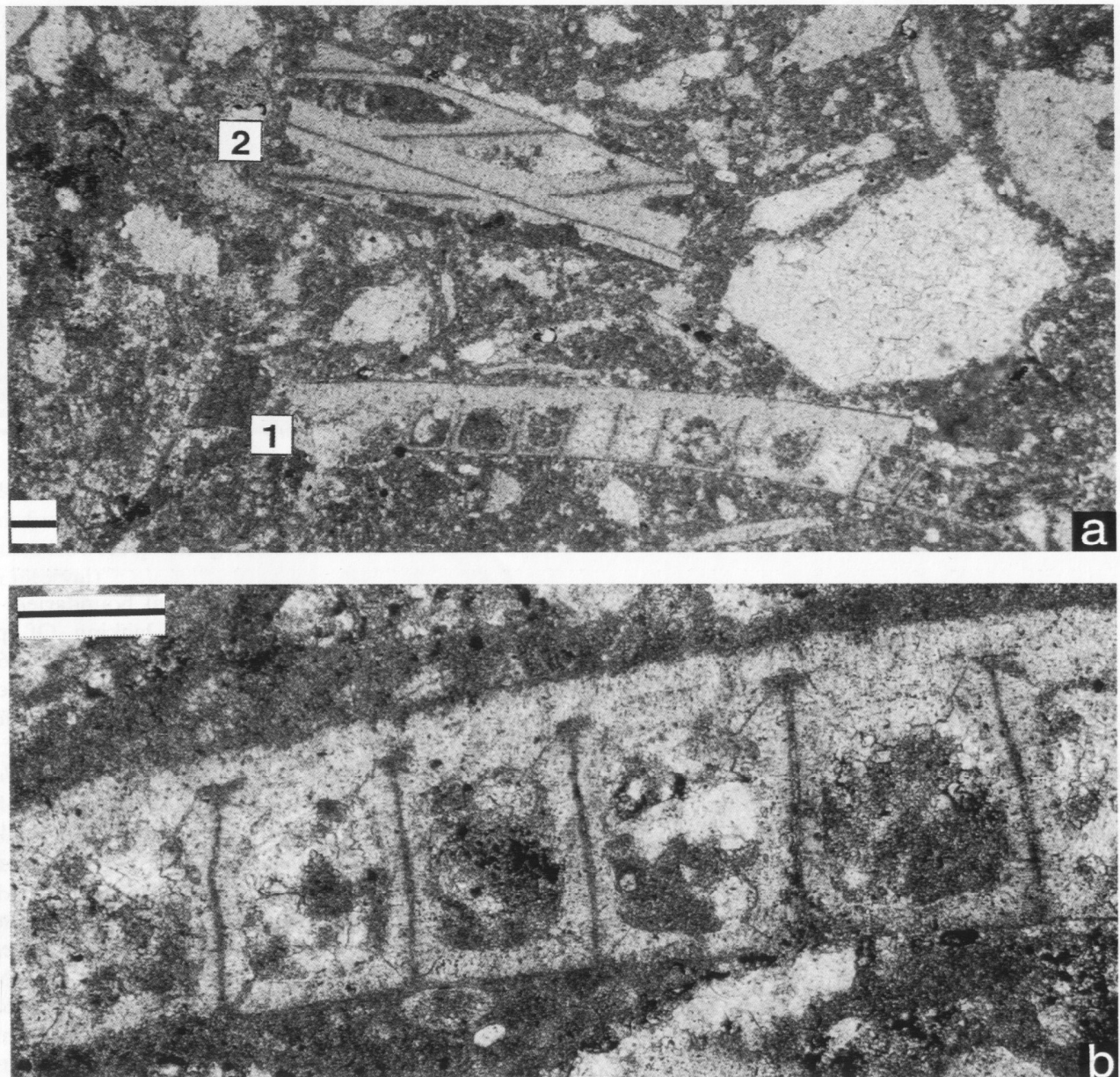


Fig. 11: *Ichthyosarcolites* ? sp. Thin sections showing the rounded subrectangular canals (a) in one (1) or two (2) rows. Close up of the canal architecture showing the bounding micritic line with a T termination (b). Boztepe. Scale bar 0.10 mm.

pleura aff. *depressa* and *Petalodontia* ?, Caprinidae are represented by *Retha* sp. and *Caprina* cf. *douvillei*, moreover a form is provisionally ascribed to *Ichthyosarcolites* ?. These taxa display a distinctive stratigraphic distribution:

- in the Upper Barremian and close to the Barremian Aptian boundary *Requienia* cf. *migliorini*, *Lovetchenia* sp., *Toucasia transversa*, *T. carinata*, *Monopleura* aff. *depressa* and *Retha* sp. were obtained,
- in the Lower Aptian *Requienia* cf. *zlatarskii*, *Caprina* cf. *douvillei*, *Petalodontia* ? sp. and *Ichthyosarcolites* ? were identified, in association with some *Toucasia* sp.

The dominance of Requieniidae both in taxonomic diversity and in number of individuals in the stratigraphic successions, is a typical trait of Barremian-Aptian Urgonian type series (MASSE 1979). Nevertheless by comparison with Urgonian formations of western Europe, southern France, Spain and Italy in particular, this fauna looks relatively poor. Comparisons with former findings (CHARLES & FLANDRIN 1929, ASTRE & CHARLES 1931) show the absence of *Requienia ammonia*, while the presence of any representatives of *Matheronia* is doubtful. The low specific diversity may result from:

- the low frequency of rudist beds, as pointed out above,
- the difficulty to obtain a good taxonomy from sections

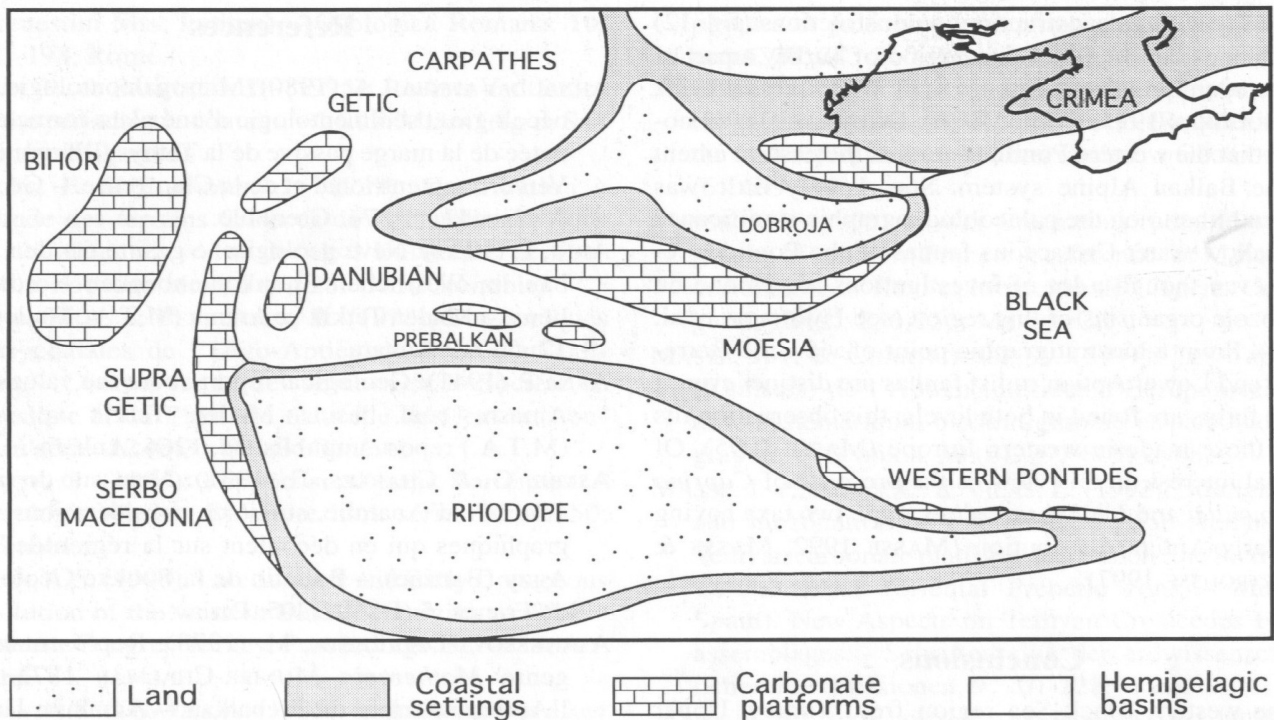


Fig. 12: Palaeogeographic reconstruction of the Carpatho-balkan and Pontides regions showing the configuration of rudist bearing carbonate platforms of Late Barremian-Early Aptian age (after MASSE unpublished). This area belongs to the Eastern European Tethyan margin.

observed in hard rocks, this is especially critical for *Requieniidae* as well as for genera like *Monopleura* and *Retha*. This difficulty also accounts for uncertainties in specific identifications, i.e. the majority of taxa are given with aff. or cf.

- the limited field survey carried out in the region: only two areas were investigated.

But we must not exclude regional ecological factors or a palaeobiogeographical control.

The Barremian fauna consists of cosmopolitan forms of *Requienia* and *Toucasia*, *Retha* has also a wide geographic distribution (SKELTON & MASSE 1998). *Monopleura depressa* was hitherto only known from SE France, while *Lovetchenia* was mainly known from the Hauterivian on one hand and the Lower Aptian on the other hand (MASSE 1993). In the Periadriatic domain and in the Balkans this genus was only recorded from Lower Aptian beds. However we must be aware about some biostratigraphic uncertainties concerning the Carpathian and Balkan regions where *Lovetchenia* was observed (MASSE 1993) allowing this genus to be possibly present in the Barremian. Its presence in well dated Barremian beds is here clearly documented and therefore remarkable. Actually this finding provides a clue for understanding the origin of the wide distribution of *Lovetchenia* in the Lower Aptian of the Periadriatic and Carpatho-Balkan regions.

In the Lower Aptian fauna, the presence of *Caprina* cf. *douvillei* gives to this species, hitherto mainly known

from western Europe, a wider palaeobiogeographic extent. If we accept the identifications given by SKELTON (1982) for Texas specimens as well as those from MASSE et al. (1998) for Oman specimens, as valid assignments to *Caprina douvillei*, this species has a cosmopolitan distribution.

Requienia cf. *zlatarskii* is a Carpatho-Balkan and Moesian form (see above) that is to say distributed on the northeastern edge of the Adria, Apulian domain, and the European northeastern Tethyan margin. Lower Aptian representatives of *Ichthyosarcolites* or close related forms are only documented from the Apulian domain (Italy) and the Prebalkan; quotations from Algeria have not been checked (MASSE 1985, 1992) while forms figured by TAVANI (1948) from Somalia are doubtful.

In conclusion some Upper Barremian-Lower Aptian elements of the Zonguldak-Amasra region such as *Requienia* cf. *zlatarskii*, are typical Carpatho-Balkan forms, while some others such as *Lovetchenia* and *Ichthyosarcolites* ? are also known from the same area but extent to Apulia. Because typical Apulian forms, i.e. Arabo-African taxa, are lacking, e.g. the “*Offneria murgensis* fauna” (MASSE 1985, MASSE et al. 1998) including *Glossomyophorus* and *Himeraelites* (BARON SZABO & STEUBER 1996), the western Black Sea fauna cannot belong to the African province but to the European one. The presence of *Lovetchenia* and *Requienia* cf. *zlatarskii* shows that this fauna belongs to the Balkan sub-province sensu MASSE (1985). This palaeobiogeographic interpre-

tation fits with palaeostructural reconstructions (fig. 12) which consider the Black Sea region of Turkey a part of the Tethyan Eurasian northern margin (FOURQUIN 1975, BERGOUGNAN 1975, GÖRÜR 1988). DOUVILLÉ (1896) noticed that the western Pontides are just the eastern extent of the Balkan Alpine system. Surprisingly little was known hitherto on the palaeobiogeographic significance of shallow water Cretaceous faunas of the Pontides region even though a lot of investigations were done on Mesozoic organisms of this region (see FARINACCI et al. 1991). From a biostratigraphic point of view the Barremian and Lower Aptian rudist faunas are distinct even if some forms are found in both levels; this observation fits with those made in western Europe (MASSE 1995). Of special interest, in this view, is the presence of *Caprina* cf. *douvillei* and *Ichthyosarcolites* ? sp., two taxa having an Early Aptian distribution (MASSE 1992, MASSE & CHARTROUSSE 1997).

Conclusions

In the western Black Sea region from Turkey, Upper Barremian-Lower Aptian shallow water platform carbonates (Öküsmedere Formation) from the Zonguldak-Amasra region were dated by micropalaeontological assemblages (benthic foraminifera and dasycladale algae). Their rudist content is dominated by Requieniidae, while Monopleuridae and Caprinidae are subordinate. The Barremian fauna consists of *Requienia* cf. *migliorini*, *Toucasia carinata*, *T. transversa*, *Lovetchenia* sp., *Monopleura* aff. *depressa* and *Retha* sp. The Lower Aptian fauna consists of *Requienia* cf. *zlatarski*, *Petalodontia* ? sp., *Caprina* cf. *douvillei* and *Ichthyosarcolites* ? sp. Compared to western Mediterranean faunas or even those of the Middle East, the recorded fauna is relatively poor, an observation which may relate to rock property contingencies, limited field survey or regional ecological and palaeobiogeographical factors. Most of the taxa are cosmopolitan whereas *Lovetchenia* and *Requienia* cf. *zlatarskii* are Carpatho-Balkan forms, the former is also recorded from Apulia. *Ichthyosarcolites* was also found in the Aptian of Bulgaria and Italy. These elements and the absence of typical Arabo-African taxa (e.g. *Offneria murgensis*, *Glossomyophorus*) show that the fauna belongs to the Balkan sub-province of the European province. This interpretation is in agreement with palaeotectonic reconstructions which show that the western Pontides were a part of the Eurasian, northern Tethyan margin during the Early Cretaceous.

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