

# Berriasian rudist faunas and micropalaeontology of Stramberk type carbonate exotics from the Lycian nappes, Bodrum Peninsula, southwest Turkey



Jean-Pierre Masse <sup>a,\*</sup>, Mükerrerem Fenerci-Masse <sup>a</sup>, Sacit Özer <sup>b</sup>, Talip Güngör <sup>b</sup>, Cüneyt Akal <sup>b</sup>

<sup>a</sup> CEREGE, Aix-Marseille University, Centre Saint-Charles, 13331 Marseille Cedex 3, France

<sup>b</sup> Dokuz Eylül University, Engineering Faculty, Geological Engineering Department, Tinaztepe Campus, Buca, 35160 İzmir, Turkey

## ARTICLE INFO

### Article history:

Received 15 December 2014

Accepted in revised form 23 March 2015

Available online

### Keywords:

Rudist bivalves  
Micropalaeontology  
Palaeogeography  
Palaeobiogeography  
Lower Cretaceous  
Turkey

## ABSTRACT

Megablocks of coral-rudist bearing platform limestone, of Stramberk type, are present as exotics in upper Santonian–Campanian flysch-like deposits of the Karabörtlen formation, near Bodrum. These beds belong to the Lycian nappes and the palaeogeographic origin of the megablocks is unclear. The micropalaeontological assemblage of benthic foraminifera, calcareous green algae and problematica of the blocks indicates a Berriasian age, and has a Mediterranean character. Rudists are essentially represented by *Heterodicerias luci* (Epidiceratidae) and *Hypelasma salevensis* (Requieniidae), commonly found in the Upper Tithonian–Berriasian of the European margin of the Mediterranean Tethys. The Lycian specimens of *Hypelasma* represent the first record of this taxon on the southern Tethyan margin whereas *Heterodicerias* has been reported from the peri-Adriatic regions but is identified for the first time in Turkey.

© 2015 Elsevier Ltd. All rights reserved.

## 1. Introduction

Cretaceous rudists from Turkey are present on both the northern, European (Pontides), and southern Tethyan margins including the Anatolia-Taurides and the Arabic promontory regions of Anatolia (Fig. 1) (Collins and Robertson, 1998; Okay and Tuysuz, 1999). Late Cretaceous faunas encompass the Cenomanian–Maastrichtian interval, they are highly diverse, widely distributed, and well-documented (Karacabey, 1970; Karacabey-Öztemür, 1980; Fenerci, 1999; Özer, 1983, 1998, 2002, 2010a,b; Özer et al., 2009). Early Cretaceous faunas are less diverse, they are currently only partially known, and have been essentially documented from the Pontides but have been recorded punctually in central and western Turkey. Lower Cretaceous records are restricted to the Barremian–Aptian of the Amasra-Zonguldak region, western Pontides (Douvillé, 1896; Masse et al., 2002, 2004), the Albian of the Bey Dağları, western Taurides (Fenerci-Masse, 2006) and the Karaburun Peninsula, İzmir region, western Turkey (Masse et al., 2010). In addition, in Lower Cretaceous limestones of the Bursa-Bilecik area sparse diceratids

and requieniids have been mentioned (Altner et al., 1991; Masse and Özer, unpublished observations).

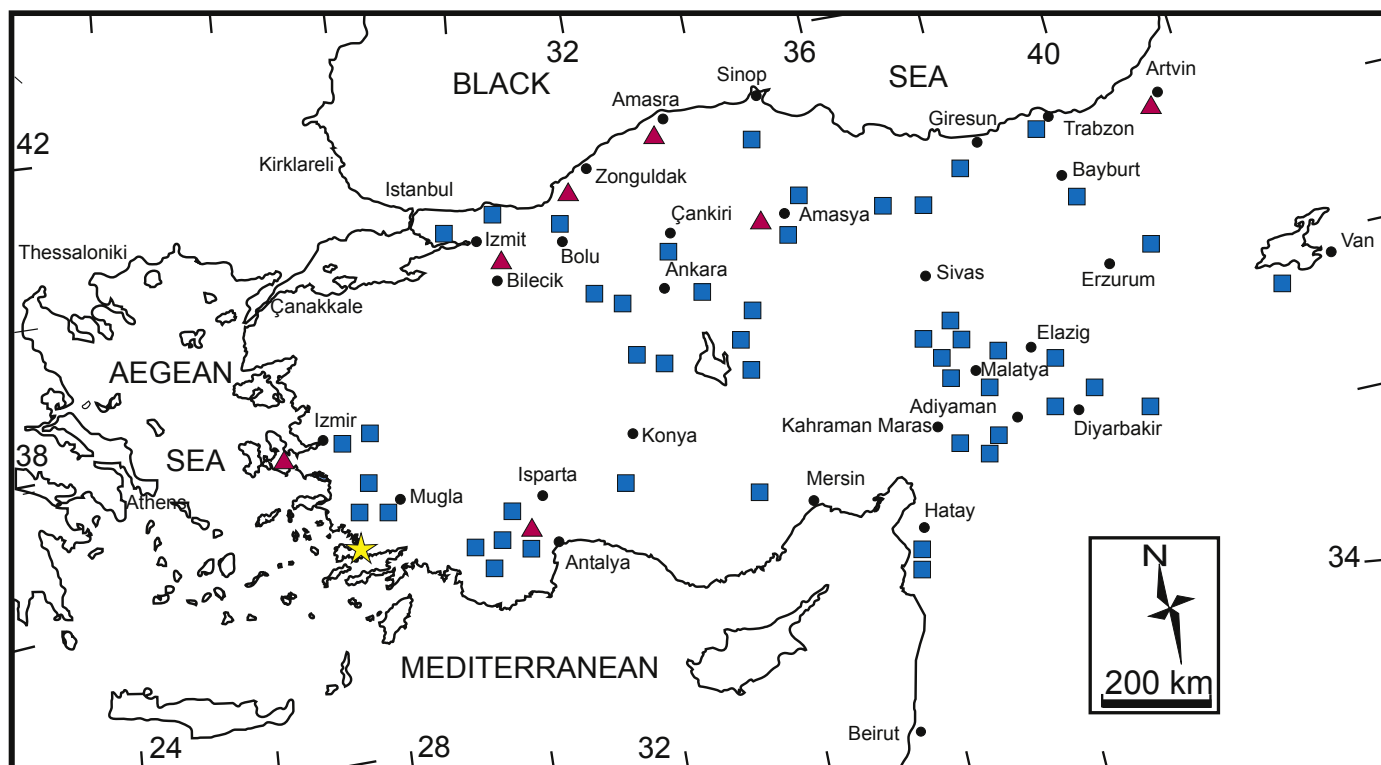
The present paper provides the first report of the occurrence of Berriasian rudists in Turkey and includes the description of representatives of diceratids and requieniids. The rudist fauna and associated platform carbonates of Stramberk type, have been investigated in the Bodrum Peninsula, within the Lycian Nappes (Brunn et al., 1971) of the Lycian Taurus, in southwestern Turkey (Fig. 2). Dating of the platform carbonates is mainly based on the identification and stratigraphic significance of benthic foraminifera, calcareous algae and some problematica, whereas rudists are also used concurrently for this purpose. We discuss the palaeoecological and paleobiogeographical significance of the faunal assemblage.

## 2. Geological setting

The Lycian Taurus constitutes the eastern branch of the Dinaric-Hellenic arc which crosses the Aegean sea and consists of three main tectonic units (Bernoulli et al., 1974; Gutnic et al., 1979; Şengör and Yılmaz, 1981; Poisson, 1985; Collins and Robertson, 1998; Güngör and Erdoğan, 2001; Arslan et al., 2013) (Fig. 2): 1- An “autochthonous” basement mainly known in the Bey Dağları, made of a thick (more than 1000 m) succession of platform carbonates of

\* Corresponding author.

E-mail address: [masse@cerege.fr](mailto:masse@cerege.fr) (J.-P. Masse).



**Fig. 1.** Distribution of Cretaceous rudist localities in Turkey. Upper Cretaceous sites marked by squares, Lower Cretaceous sites by triangles, the study site near Bodrum a star (modified and complemented from Özer, 2002).

Jurassic to Late Cretaceous p.p. age (Poisson, 1974). 2-The Lycian Nappes. 3-The Menderes metamorphic complex, the core of which consists of Proterozoic-Paleozoic rocks overlain by Mesozoic metasediments including mainly marbles with emery, which contain late Cretaceous rudists, the topmost of the cover rocks is characterized by reddish pelagic marbles and flysch type rocks (Dürr, 1975; Konak et al., 1987; Özer, 1998; Özer et al., 2001; Dora et al., 2001).

The study area of Bodrum is located in the Lycian Nappes (Fig. 3) which were divided by Senel (1997) into five tectonic units which are, in ascending order: the Tavas, Bodrum, Gülbahar, Domuzdağ and the Marmaris ophiolite. Alternative views were then envisaged by Collins and Robertson (1998), who recognized three main tectonic units showing an imbricated structure, from base to top, the “Lycian Thrust Sheets” comprising Permo-Triassic to Tertiary low grade metamorphic sediments with subordinate volcanics and consisting of four thrust sub-units (Karadağ, Yavuz, Teke Dere and Köyceğiz nappes), the thick “Lycian Mélange” consisting of chaotic ocean-related sedimentary and igneous lithologies and two sub-units, namely the Layered Tectonic Mélange and the Ophiolitic Tectonic Mélange and the “Lycian Peridotite Thrust Sheet” consisting of serpentinized peridotite with an amphibolitic metamorphic sole.

### 3. Stratigraphic context

The overall Jurassic–Cretaceous stratigraphic succession of the Bodrum area, has been described by Graciansky et al. (1967) and Bernoulli et al. (1974) (Fig. 4). Some of the former stratigraphic hypothesis concerning the Cretaceous are re-interpreted or refined herein, in the light of newly established biostratigraphic schemes. The lowermost part of the succession is represented by

the Gereme Formation which consists of platform limestones and dolomites of early Jurassic age. This shallow water formation is followed by calcareous talus and basinal deposits, with *Aptychus*, ascribed to the Middle and Upper Jurassic, corresponding with the lower Çal Dağ Formation. The overlying unit, the upper Çal Dağ Formation, consists of well bedded basinal micritic limestones with cherts and episodic calcarenites (turbidites). The basal part yield calpionellids: *Remaniella cadischiana* and *Calpionella alpina*, and the upper part *Favusella washitensis* and *Rotalipora appenninica*; the age of the upper Çal Dağ beds therefore encompasses the Berriasian-Albian interval. The presence of *Rotalipora cushmani* in the uppermost part of the formation indicates the latest Cenomanian (Huber et al., 1999) and suggests that the capping major sedimentary discontinuity (locally marked by breccias, namely the “Sirna breccia”) may correspond to the Cenomanian–Turonian boundary. The overlying Karabörtlen formation is a shaly-sandy one and contains *Globotruncana convexa*, *G. linneiana*, *G. lapparenti* and *G. coronata*. The range of these species (Sarı, 2006; Elamri and Zaghbib-Turki, 2014) supports a Coniacian/Santonian–Campanian age. The Karabörtlen formation is characterized by the presence of limestones breccias, including megablocks reworked from the underlying basement, essentially the Çal Dağ cherty limestones, whereas blocks of diabase, radiolarites and metamorphic rocks are present at the topmost part of the formation in beds of Maastrichtian age with *Abatomphalus cf. mayaorensis*. One of the biggest megablocks, here labelled the “Bitez block”, originally recognized by Monod (in Bernoulli et al., 1974) and made of platform limestones with rudists, forms the Bitez promontory. Different types of limestone blocks, with a smaller size, are present within and in the vicinity of the city of Bodrum, one of them with coral and diceratids supports the old castle.

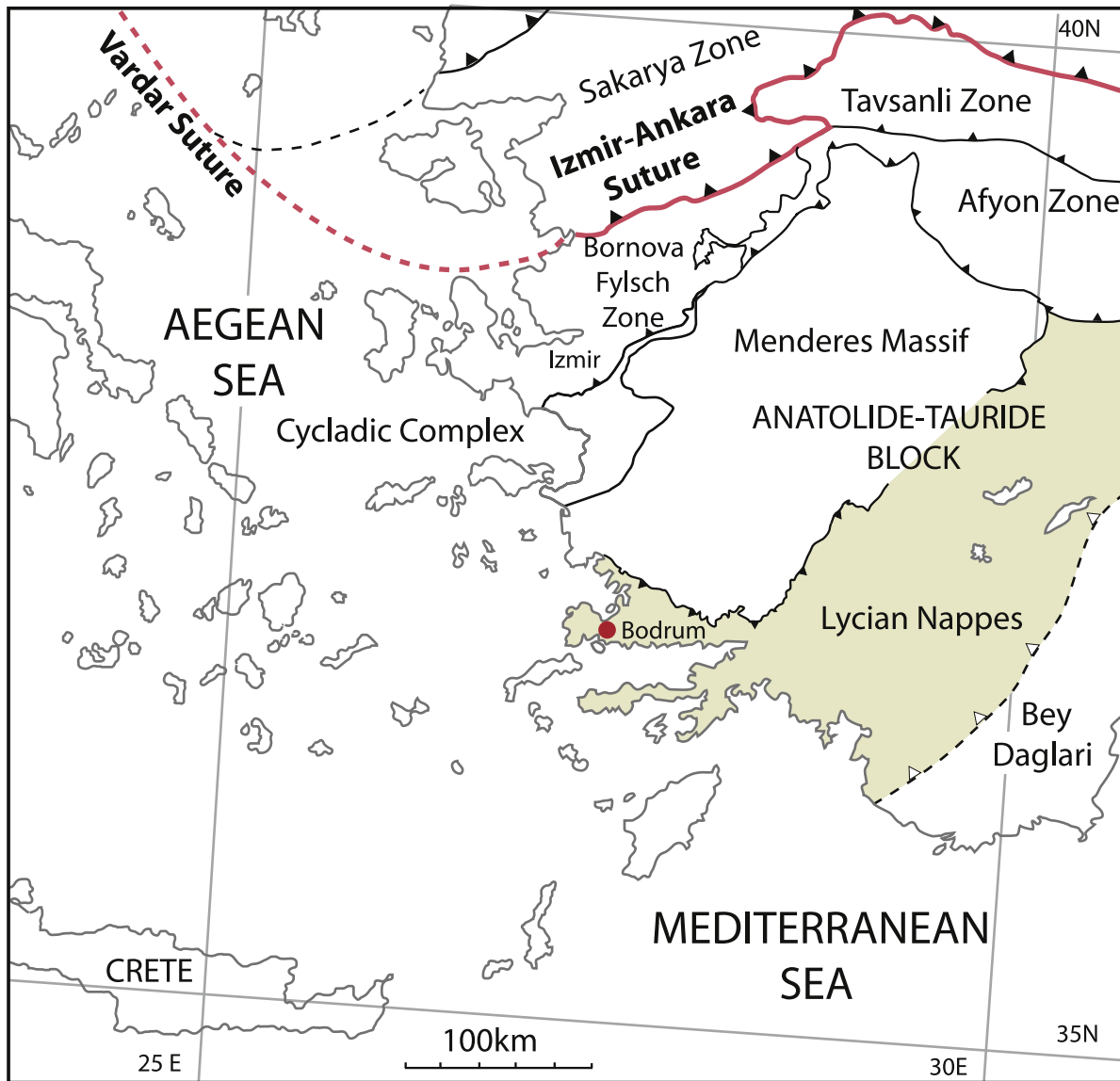


Fig. 2. Structural map of SW Turkey, with location of the Lycian Nappes in between the Menderes and the Bey Daglari autochthons (after Collins and Robertson, 1998; Okay and Tuysuz, 1999).

### 3.1. The Bitez block: lithology and micropaleontology

#### 3.1.1. Stramberk type facies

The Bitez block, in the range of 100 m thick, consists of massive limestones (Fig. 5A) with rudists, essentially diceratids, and corals (Fig. 5B). Microencrusters including the *Bacinella-Lithocodium* consortium, *Crescentiella*, rivulariacean algae and sessile foraminifera, are associated with microbial-pelletoidal or porostromatic structures, supporting or supported by large fragments of corals, stromatoporoids, nerineids or rudists, pointing to shallow water settings. Wackestones—packstones are subordinate but commonly found with the foregoing bioaggregations, grainstones are rare and essentially peloidal. The micro-skeletal fraction represents a limited portion of the sediment but its diversity is relatively high (see below the description of foraminifera and calcareous algae). This lithology matches the characters of Stramberk type limestones originally described from Moravia by Boehm (1883), and mainly documented from the outer Carpathians (Housa, 1975; Vasicek and

Skupien, 2013; Eliasova, 2008), the western Carpathians (Sotak, 1987), the northern calcareous Alps (Schlagintweit and Ebli, 1999); the Apuseni Mountains (Bucur and Sasaran, 2005), the outer Carpathians and foreland (Ivanova and Kolodziej, 2010), and Transylvania (Serban et al., 2004; Bucur et al., 2014a). The Stramberk limestones are lithologically and stratigraphically equivalent to the so-called *Ellipsactinia* limestones (Canavari, 1893; Parona, 1905) from Italy (e.g. Barattolo and Pugliese, 1987; Russo and Morsilli, 2007), the Dinarides, and the Hellenides (Carras, 1989). The physiognomic importance of macro-benthic elements and a rich and diversified microbiota are the prominent characters of the Stramberk limestones. *Ellipsactinia* and *Sphaeractinia*, i.e. “stromatoporoids” presently assigned to the Demospongia, have long been used as facies markers, (Russo and Morsilli, 2007), whereas scleractinian corals are highly diversified (Eliasova, 2008). Traditionally seen as “reefal” the Stramberk limestones represent the distal, marginal parts of Tithonian-Berriasian carbonate platforms. Stramberk type limestones are frequently found as exotics either in

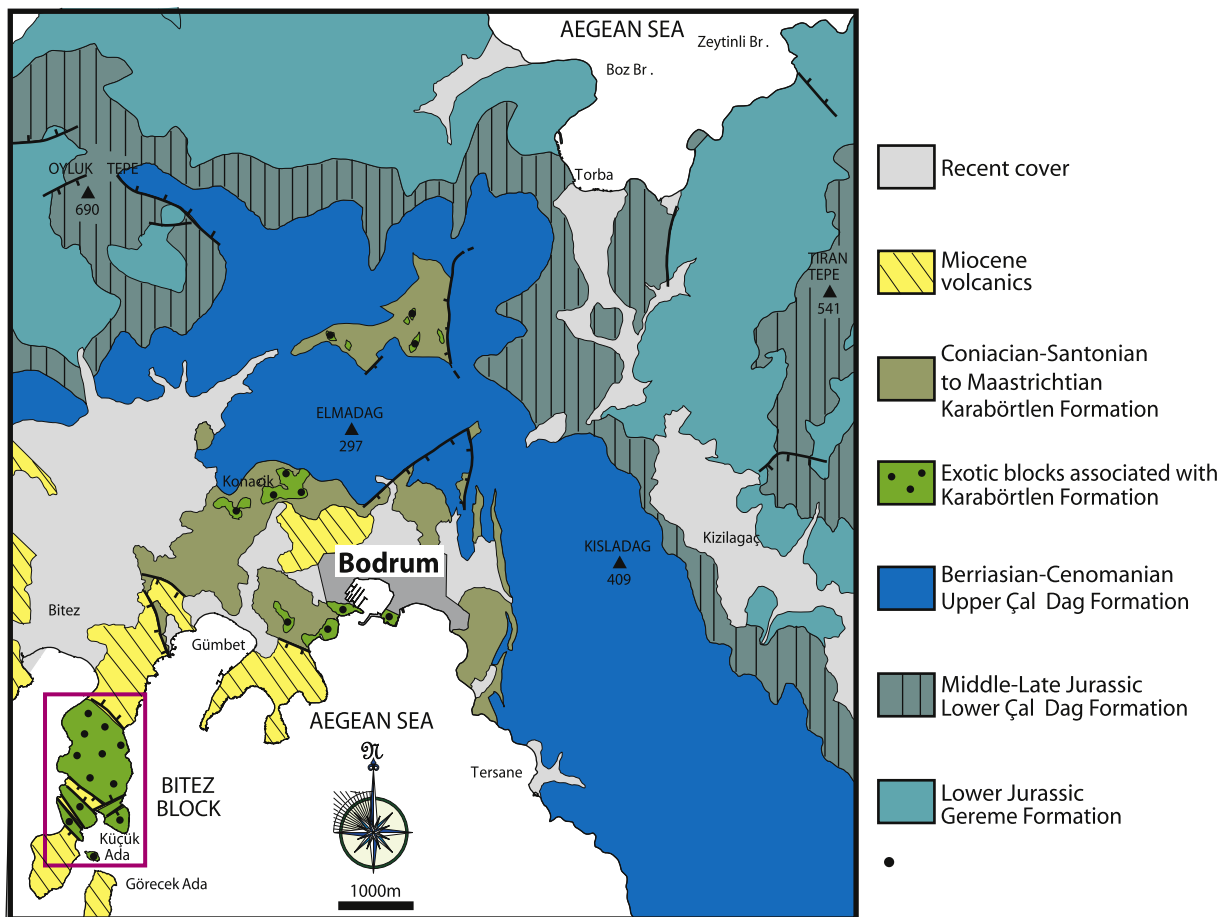


Fig. 3. Geological map of the Bodrum area (after Bernouilli et al., 1974).

pencontemporaneous or younger deposits (e.g. Housa, 1975; Sotak, 1987; Bucur et al., 2005; Ivanova and Kolodziej, 2010), a situation recorded in the Lycian Nappes.

### 3.1.2. Benthic foraminifera (Fig. 6)

*Troglotella incrustans* Wernli and Fookes (Fig. 6A) is usually found imbedded into or associated with *Bacinnella-Lithocodium* bodies. Its range is Kimmeridgian–Berriasian (Bucur et al., 1996; Krajewski and Olszewska, 2007; Kolodziej, 1997). Sections of *Verneuilinoides polonicus* (Cushman and Glazewski) (Fig. 6B) match the attributes of the species, known to have a Tithonian–lower Valanginian range (Krajewski and Olszewska, 2007). *Belussiella taurica* Gorbachik (Fig. 6C) conforms the characters of the Crimean species described from the Berriasian by Gorbachik (1971). *Charentia* cf. *evoluta* (Gorbachik) (Fig. 6D, E) shows the microgranular/micritic wall observed in pre-Cenomanian *Charentia*, it lacks the canalicate microstructure characteristic of advanced forms of the genus. It differs from the pre-Cenomanian forms of *Charentia cuvillieri* Neumann by a more limited number of whorls preceding the rectilinear, terminal stage, and a more rounded axial outline (Kuznetsova and Gorbachik, 1985; Altner, 1991; Morycowa and Moryc, 2011). Its age ranges from the upper Kimmeridgian to lower Valanginian (Krajewski and Olszewska, 2007). We ascribe to *Bramkampella arabica* Redmond longitudinal sections showing the septal structure (Fig. 6F). This form, first described from the Middle East (Redmond, 1964), has been also recognized in the Tithonian–Berriasian of the Trascau Mts (Romania) and the Berriasian of Crimea (Bucur and Sasaran, 2005;

Gorbachik and Mohamad, 1997). *Pseudocyclammina lituus* (Yokoyama) (Fig. 6G) is a classical member of the Kimmeridgian–early Valanginian foraminiferal assemblages (e.g. Bucur et al., 1995, among others). *Coscinochragma cribrosum* (Reuss) (Fig. 6H) belongs to the group of microencrusters which plays a significant role as binding agents of the Bitez limestones. As so it has been frequently reported from Stramberk type limestones of Tithonian–Berriasian age (e.g. Radoicic, 2005; Ivanova and Kolodziej, 2010) but it has been recorded up to the Barremian (Masse, 1976; Arnaud-Vanneau, 1980).

We tentatively ascribed to *Buccicrenata* aff. *primitiva* BouDagher-Fadel sections (Fig. 6I) of a coarsely agglutinated lituolid with 4–5 low chambers, somewhat similar to the “*Everiticyclammina*” figured by Altner (1991) from the Kimmeridgian of the Pontides. Considering that the Bitez limestones are Berriasian, this form may fall in the Tithonian–?Berriasian evolutionary gap identified in the Middle East (and assumed to be due to hypersaline conditions), in between *Buccicrenata primitiva* BouDagher-Fadel (Kimmeridgian) and *Buccicrenata italica* (Dieni and Massari) (Valanginian) (Boudagher-Fadel, 2001). *Coscinoconus alpinus* Leupold (Fig. 6J) and *Coscinoconus elongatus* Leupold, formerly attributed to *Trocholina* then to *Andersenolina* (see Arnaud-Vanneau et al., 1988; Neagu, 1994), have been reappraised by Rigaud et al. (2013), and are presently assigned to *Coscinoconus*. They are quite common and considered as Tithonian to early Valanginian forms (e.g. Arnaud-Vanneau et al., 1988; Altner, 1991; Bucur and Sasaran, 2005, among others). *Coscinoconus cherchiai* (Arnaud-Vanneau et al., 1988) (Fig. 6K) is restricted to the Berriasian–lower Valanginian

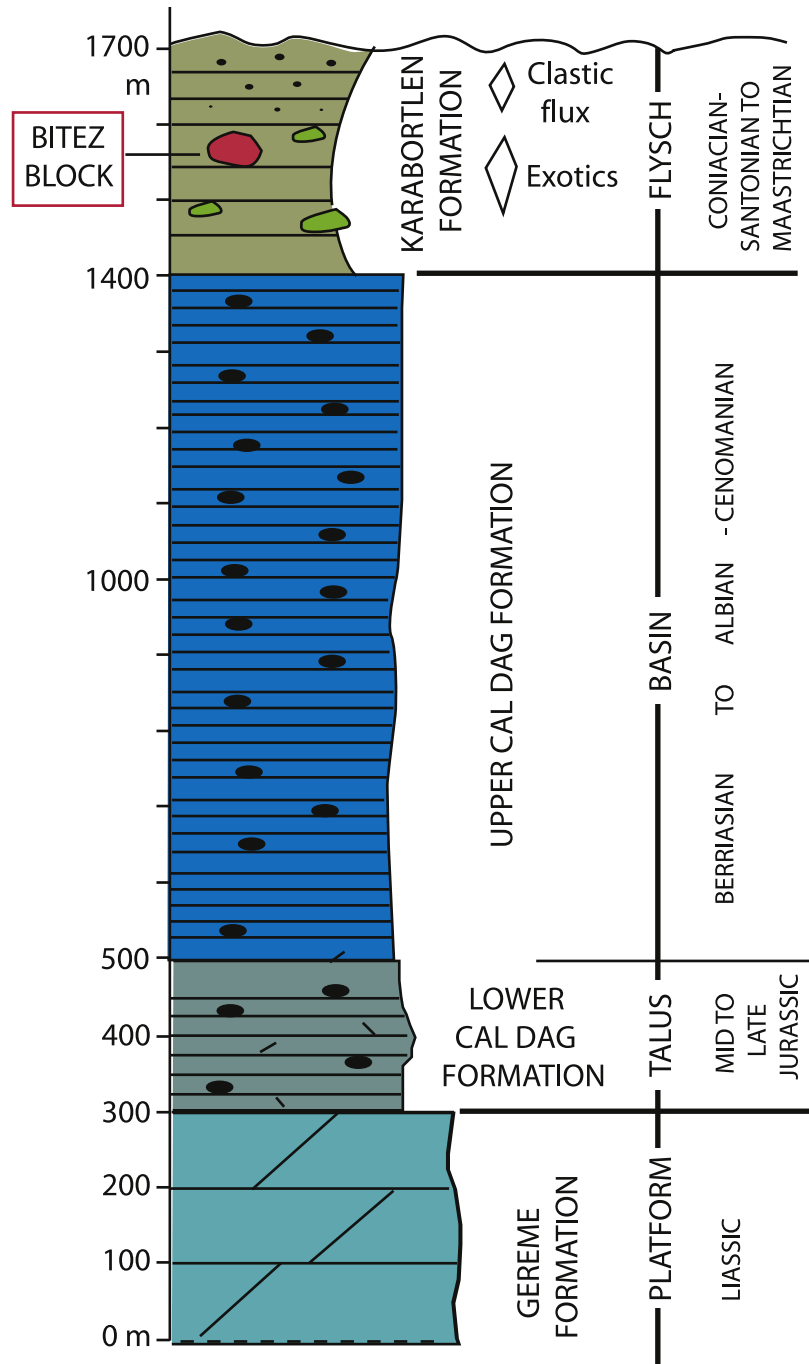
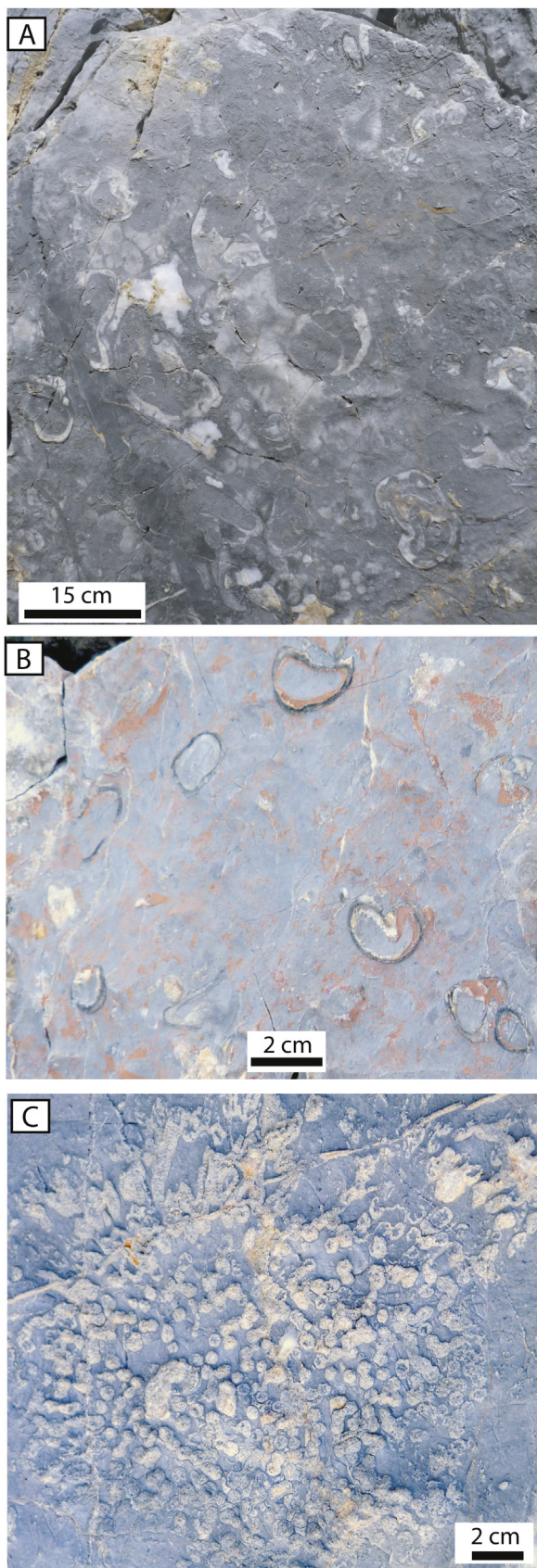


Fig. 4. Stratigraphic section of the Jurassic and Cretaceous succession of the Bodrum area, Lycian Nappes, and location of the Bitez block (modified after Bernoulli et al., 1974).

(Arnaud-Vanneau et al., 1988; Bucur et al., 1995; Bucur and Sasaran, 2005; Bucur et al., 2014a,b). *Neotrocholina molesta* (Gorbachik) (Fig. 6L) is one of the smallest representatives (diameter in the range of 0.5 mm) of the genus *Neotrocholina*. It was originally described from the Berriasian of Crimea (Gorbachik, 1959) and appears to be common in the Torinosu limestone of Japan, Tithonian-Berriasian in age, where it was figured as *Trocholina molesta* (Kobayashi and Vuks, 2006; Kobayashi and Wernli, 2014). The so-called "*Trocholina*" *molesta* of Arnaud-Vanneau et al. (1988) and Arnaud-Vanneau and Masse (1989), mentioned from the Barremian-Hauterivian, does not match the characters of the Gorbachik species. Consequently the Tithonian–Barremian range

reported by Krajewski and Olszewska (2007), and referring to the French authors, is too wide and the stratigraphic distribution of the species is essentially Tithonian–Berriasian (lower Valanginian?). *Protopenneroplis ultragranulata* (Gorbachik) (Fig. 6M, N) is a typical component of the Stramberk limestones (Sotak, 1987), its acme zone is the Berriasian (Bucur and Sasaran, 2005), whereas Heinz and Isenschmid (1988) have pointed out its FO in the mid-Tithonian. Its range is late Tithonian to Valanginian (Altner, 1991; Krajewski and Olszewska, 2007) and may extend to the Barremian (Bucur et al., 1995). *Mohlerina basiliensis* (Mohler) (Fig. 6O) formerly assigned to *Conicospirillina*, and presently attributed to *Mohlerina* (Bucur et al., 1996), is typified by its trochospiral mode of





**Fig. 5.** Field views illustrating the lithology and biota of the Bitez block. (A) diceratid rudists and corals; (B) requeniid rudists; (C) branching coral colony.

coiling and a brown, perforated, calcitic wall. Its stratigraphic range is wide: Oxfordian to Valanginian (Bucur et al., 1996, 2005; Krajewski and Olszewska, 2007). It has been recorded by Altner (1991) from the western Pontides.

The foregoing inventory includes relatively long range species, that is spanning the Kimmeridgian–Valanginian, but most of them are Tithonian–Berriasian or Berriasian–Valanginian. The absence of typical Valanginian species, such as *Montsalevia salevensis* (Charollais et al.) a marker of the lower Valanginian (Salvini-Bonnard et al., 1984; Altner, 1991) is highly significant. This suggests that the assemblage of species identified in the Bitez limestone actually marks the Berriasian, and matches the foraminiferal biozone III proposed by Altner (1991) and Rojay and Altner (1998) for the Pontides. The taxonomic composition is Mediterranean s.l. and cannot be used to distinguish Northern and Southern Tethys biotas.

### 3.1.3. Problematica

*Thaumatoporella parvovesiculifera* Raineri is represented by monostromatic elements (Fig. 6P) either as bioclastic fragments or *in situ* crusts, as so it belongs to the microencruster group associated with the *Bacinella*–*Lithocodium* consortium. This mode of occurrence has been frequently reported in Stramberk type limestones (e.g. Bucur et al., 2005).

*Crescentiella morronensis* (Crescenti) (Fig. 6Q), formerly assigned to *Tubiphytes*, has its FO in the Kimmeridgian (Altner, 1991), its LO is usually coeval with that of *Clypeina sulcata*, that is close to the lower/upper Berriasian boundary (Altner, 1991; Masse et al., 1999, 2009), even if a closely related form has been mentioned up to the Barremian (Bucur and Pomarjanschi, 1987). Usually free, this form may be sometimes attached to a skeletal support (e.g. coral fragments) and so, pertains to the group of microencrusters (Uta and Bucur, 2003).

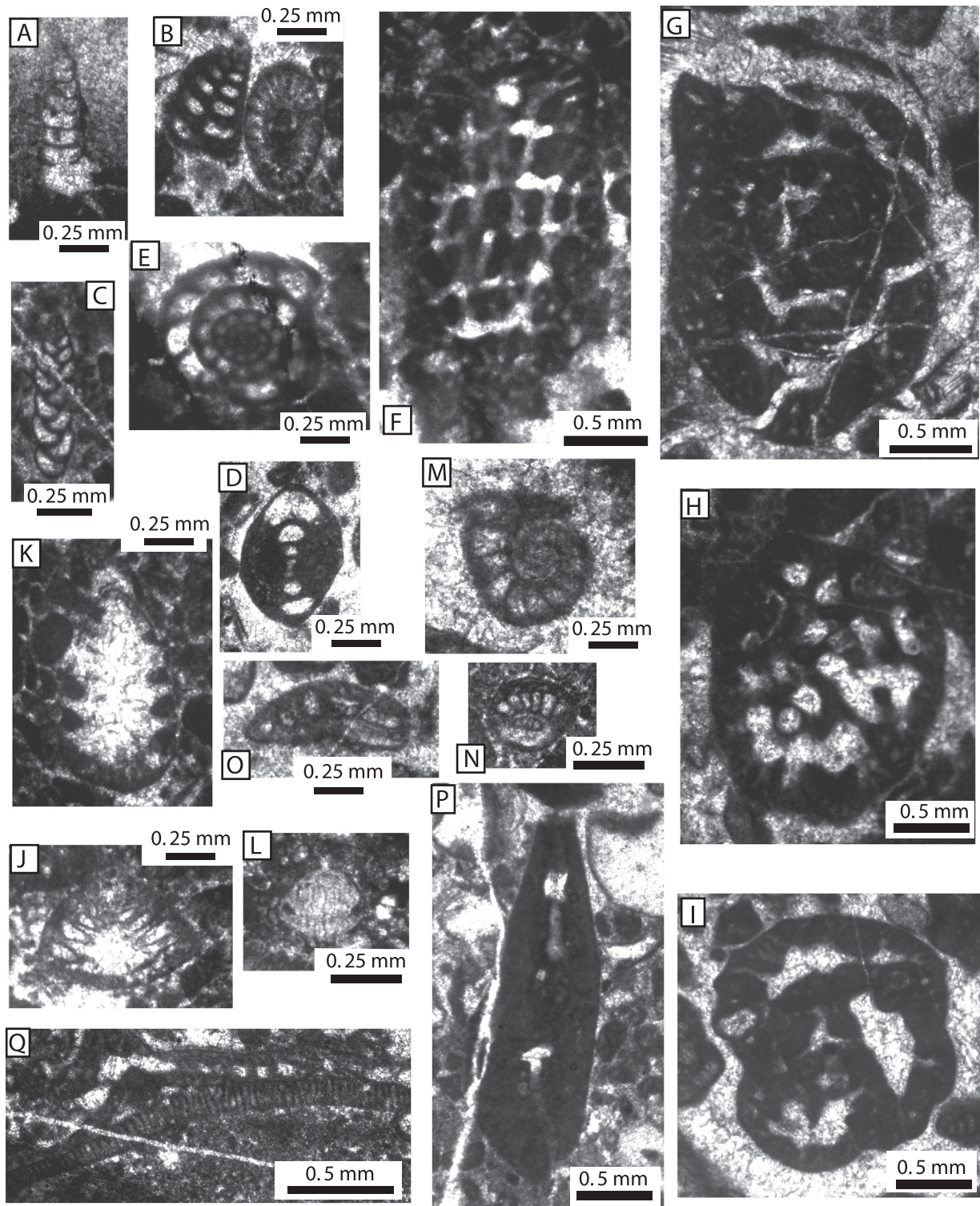
*Lithocodium aggregatum* Elliott and *Bacinella irregularis* Radoicic form a consortium which has been variously interpreted either as: a green algae (“Codiacea” or Heterotrichale), a sponge, a microbial structure or a foraminifera (see discussion in Schlagintweit, 2010). We favour a calcified microbial origin frequently bored by “*Entobia*” (boring sponge) excavations (Schlagintweit, 2010). The *Bacinella*–*Lithocodium* consortium is one of the major contributors to the microencrusting community found in Stramberk type limestones (Leinfelder et al., 1993; Uta and Bucur, 2003).

### 3.1.4. Calcareous algae

Dasycladaleans are relatively diversified and include several distinctive genera and species.

*Salpingoporella pygmaea* (Guembel) may possibly include several species, as proposed by Bernier (1984), the clear-cut delimitation of which has been critically addressed by Senowbari-Daryan et al. (1994), Carras et al. (2006), Bucur et al. (2005), and Bucur and Sasaran (2005), who retained a single specific entity i.e. *Salpingoporella pygmaea*. This species is commonly reported from the Tithonian–Berriasian but may extend to the Barremian (Carras et al., 2006). Our material includes both small forms, i.e. *Salpingoporella pygmaea* (Fig. 7A), and large forms tentatively ascribed to *Salpingoporella enayi* Bernier (Fig. 7B), a species which has been recognized in the Pontides (Farinacci and Radoicic, 1991). *Salpingoporella steinhauseri* Conrad et al. (1973) is a small species typified by regularly spaced whorls, laterals tend to be somewhat aligned vertically in adjacent consecutive whorls (Conrad et al., 1973), this organisation acknowledges the symmetry of laterals observed in longitudinal sections (Fig. 7C). The type level of *Salpingoporella steinhauseri* is the Berriasian of the Swiss Jura, and has been reported from this stratigraphic interval in many localities (Granier et al., 2014). *Clypeina* aff. *sulcata* (Alth) is represented by



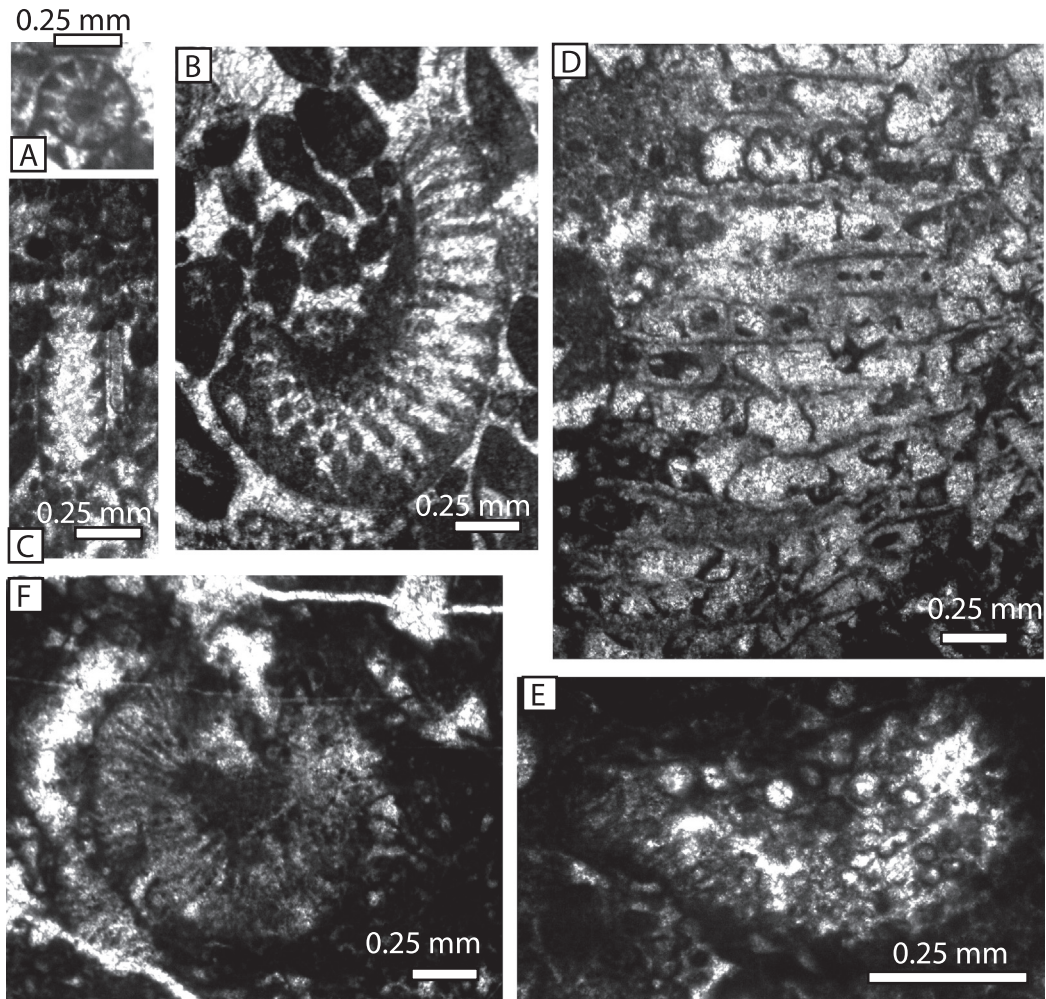


**Fig. 6.** Benthic foraminifera. (A) *Troglotella incrustans* (1441); (B) *Verneuilinoides polonicus* (associated with *Salpingoporella pygmaea*) (1442); (C) *Belussiella taurica* (1457); (D, E) *Charentia* cf. *evoluta* (1410); (F) *Brankampella arabica* (1409); (G) *Pseudocyclammina lituus* (1451); (H) *Coscinochama cribrosum* (1408); (I) *Buccicrenata* aff. *primitiva* (1453); (J) *Coscinoconus alpinus* (1407); (K) *Coscinoconus cherchiai* (1445); (L) *Neotrocholina* cf. *molesta* (1401); (M, N) *Protopenneroplis ultragranulata* (1440); (O) *Mohlerina basiliensis* (1442). Problematica. (P) *Thaumatoporella parvovesiculifera* (1409); (Q) *Crescentiella morronensis* (1405).

longitudinal sections showing the vertical alternation of fertile and sterile laterals, with a fibrous, yellowish calcareous thallus, which looks alike *Clypeina sulcata* or *Clypeina jurassica* Favre. The sterile whorls show a single row of laterals (Fig. 7D) instead of the multiple irregular pattern, i.e. “calyx”, observed in *Clypeina sulcata*, e.g.

figures given by Radoicic (1969), and comments in Bassoullet et al. (1978). The taxonomic significance of this pattern needs further investigations. In addition we notice the irregular organisation of some fertile laterals, which may suggest some teratologic growth pattern, a possible reaction to the microbial context. Widely

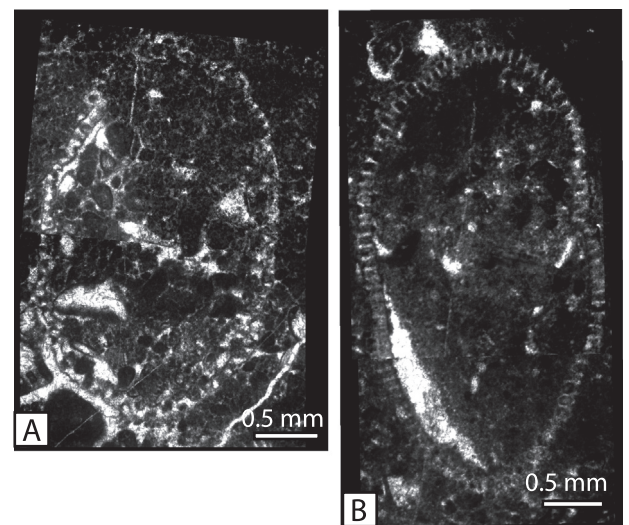




**Fig. 7.** Calcareous algae. Dasycladaleans. (A) *Salpingoporella pygmaea*, transverse section (1410); (B) *Salpingoporella* cf. *enayi*, longitudinal oblique section (1453); (C) *Salpingoporella steinhauseri*, longitudinal oblique section (1440); (D) *Clypeina* aff. *sulcata*, longitudinal, tangential section (1410); (E) *Steinmanniporella svilajensis*, longitudinal oblique section (1408). Caulerpales. (F) *Nipponophycus ramosus*, transverse section (1406).

distributed in the Mediterranean region, including Turkey (Rojay and Altner, 1998; Yilmaz, 1999), this species is documented from the Kimmeridgian–Berriasian interval (Bassoullet et al., 1978; Rasser and Fenninger, 2002). Its LO is close to the lower/upper Berriasian boundary (Masse et al., 1999, 2009; Granier et al., 2014). *Steinmanniporella svilajensis* (Sokac and Velic) formerly placed in the genus *Linoporella* by its authors, is presently ascribed to the genus *Steinmanniporella* (Bucur et al., 2010). The species, first described from Croatia by Sokac and Velic (1976), is synonym of *Montenegrella florifera* Bernier (Bernier, 1978) and possibly, according to Farinacci and Radoicic (1991), to “*Dissocladella intercedens*” Bakalova figured from Capri (Barattolo and Pugliese, 1987) (see discussion in Bucur et al., 2005). In the Bitez limestone *Steinmanniporella svilajensis* is represented by small fragments (Fig. 7E), showing two orders of laterals. It has been recognized in the Outer Carpathians (Bucur et al., 2005) and the Northern Calcareous Alps, as “*Montenegrella florifera*” (Schlagintweit, 2005). In Turkey it has been recorded in the Pontides, from the Aktaş formation, assumed to be of Berriasian age (Farinacci and Radoicic, 1991, and Masse, unpublished data). The age of *Steinmanniporella svilajensis* is Tithonian–Berriasian.

Bulbous caps with laterals (Fig. 8A, B), are reminiscent of the genus *Petrascula*, but the absence of stems with the typical “*Montenegrella*” mode of organisation illustrated by Bernier (1979) for



**Fig. 8.** Calcareous algae. Dasycladaleans. *Griphoporella* species, longitudinal sections of bulbous caps with laterals, tentatively ascribed to *Griphoporella cekici* (A-1451, B-1455).



*Petrascula* species suggests that the bulbous caps and associated fragments with a somewhat vesicular structure hardly correspond to *Petrascula*. The revision by Bucur and Schlagintweit (2009), of the Jurassic–Lower Cretaceous representatives of the *Anisoporella*–*Pseudopimastopora*–*Gyroporella* group, with vesicular laterals and bulbous cap, shows that the different species described so far in the literature and assigned to the above genera may belong to a single genus: *Griphoporella* Pia emended by Barattolo et al. (1993). This group of forms includes: *Griphoporella jurassica* (Endo), *Griphoporella cretacea* (Dragastan), *Griphoporella cekici* (Radoicic), and possibly *Griphoporella lukicae* (Sokac and Velic); all closely related, and with a significant record in the Tithonian–Berriasian of the Mediterranean region. The sections of Fig. 8 illustrate this group of species and are tentatively ascribed to *Griphoporella cekici*. Similar forms are present in the western Pontides (Farinacci and Radoicic, 1991), and the western Taurides (Yilmaz, 1999).

Besides the dasyclads, Caulerpales are scarce and mainly represented by *Nipponophycus ramosus* Yabe and Toyama. For the systematic position and characters of this taxon we refer to the revision of Senowbari-Daryan et al. (1994). As for the Tithonian specimens from Sicily studied by the latter authors, the calcified thallus is usually more or less recrystallized, the cortical filaments obliquely divergent from the stem axis are seldom preserved and the preservation of the medullar filaments very rare (Fig. 7F). *Nipponophycus ramosus* has been asked to be a “reef building” organism associated with corals and microencrusters (e.g. Endo, 1961; Senowbari-Daryan et al., 1994). In the Bitez limestones it is found as loose elements and is not involved in bioconstructional phenomena. It is a typical component of the Torinosu limestone of Japan (Endo, 1961), an *alter ego* of the European Stramberk facies.

### 3.1.5. Calpionellids

*Calpionella alpina* (Lorenz) was found in the lower part of the section. Its stratigraphic distribution is late Tithonian–Berriasian, the acme zone being the early Berriasian (Andreini et al., 2007).

Most of the encountered calcareous algae and problematica are found in both the Tithonian and the Berriasian. We notice the absence of Tithonian markers or forms having their LO in the Tithonian, such as: *Campbelliella striata* (Carozzi), *Neoteutloporella socialis* (Praturlon), *Petrascula bursiformis* (Etallon), *Linoporella kapelensis* Sokac and Nikler (Bucur and Sasaran, 2005). Of interest is the presence of both *Crescentiella morronensis* and *Clypeina* aff. *sulcata*, restricted to the lower part of the succession, which may indicate the lower Berriasian. The above taxonomic composition is Mediterranean s.l. and cannot be used to distinguish Northern Tethys and Southern Tethys assemblages.

To conclude, the overall micropaleontological assemblage, including calpionellids, calcareous green algae, benthic foraminifera and some problematica, is consistent with a Berriasian age.

## 4. Systematic palaeontology of rudist bivalves

This section focuses on rudist bivalves but we also briefly mention some associated bivalves. The classification refers to Carter et al. (2011).

The classification used herein for this group refers to Skelton (2013).

Abbreviations used for the taxonomic description. LV- left valve, RV- right valve, ant- anterior, post- posterior, D- dorsal, V- ventral, Dap- antero-posterior diameter, Ddv- dorso-ventral diameter, bc- body cavity, am- anterior myophore, as- anterior socket, ps- posterior socket, pm- posterior myophore, ct- central tooth, L- ligament, ol- outer shell layer, il- inner shell layer, com- commissure.

### 4.1. Order Hippuritida

Suborder Requiieniina Skelton, 2013.

Superfamily Requienioidea Kutassy, 1934.

Family Epidiceratidae Renngarten, 1950.

Genus *Heterodicerus* Munier-Chalmas in Hebert 1869.

Type species *Dicerus luci* Defrance.

*Heterodicerus luci* (Defrance)

Fig. 9

1819- *Dicerus luci*, Defrance, p. 177.

1843- *Dicerus luci*, A. Favre, pl. 2, fig. 4; pl.3, figs 1–3; pl.4, figs 1–4; pl. 5, fig. 1.

1868- *Dicerus luci*, Pictet, pl. 12, fig. 2.

1873- *Dicerus luci*, Bayle, pl. 19, fig. 6.

1897- *Heterodicerus luci*, Paquier, pl. XXIII, fig. 7.

1913- *Heterodicerus luci*, E. Favre, in Joukowsky and Favre, pl. 34, figs 5–6.

The taxonomic history of this form goes back to the XVIII th century (personal communication from P.A. Proz, 2014 to whom we are indebted for the following). It was originally collected in 1771 in the Monnetier quarries (Mont Salève, near Geneva) by G.A. Deluc, and figured by De Saussure in 1779; but was named by Defrance (1819); it was then figured and reappraised by Favre (1843), and Joukowsky and Favre (1913).

*Heterodicerus luci* is characterized by an elongated twisted conical LV and a capuloid, twisted RV with a salient posterior side and a gently inclined anterior side (Fig. 9A). The posterior myophores on both valves are connected with the hinge plate and correspond with a transverse shell thickening, by contrast the anterior myophores are on the inner shell wall (Joukowsky and Favre, 1913; Skelton, 1978) (Fig. 9B, C). *Heterodicerus luci* is the only Tithonian–Berriasian diceratid known hitherto to possess longitudinal ribs (Pictet, 1868; Joukowsky and Favre, 1913; Schneider et al., 2013) (Fig. 9A). The type level of Mont-Salève was classically and still is regarded as Berriasian (*pro* “infra-Valanginian”).

We assign to *Heterodicerus luci* longitudinal, ventral, sections of bivalve specimens showing a triangular shell outline of the LV with a posterior side much thicker than the anterior, a low capuloid RV showing a salient posterior side with a transverse inner shell thickening (Fig. 9E). Some elongated longitudinal–oblique sections with a well preserved outer shell layer bear fine acute ribs on the LV (Fig. 9D, F).

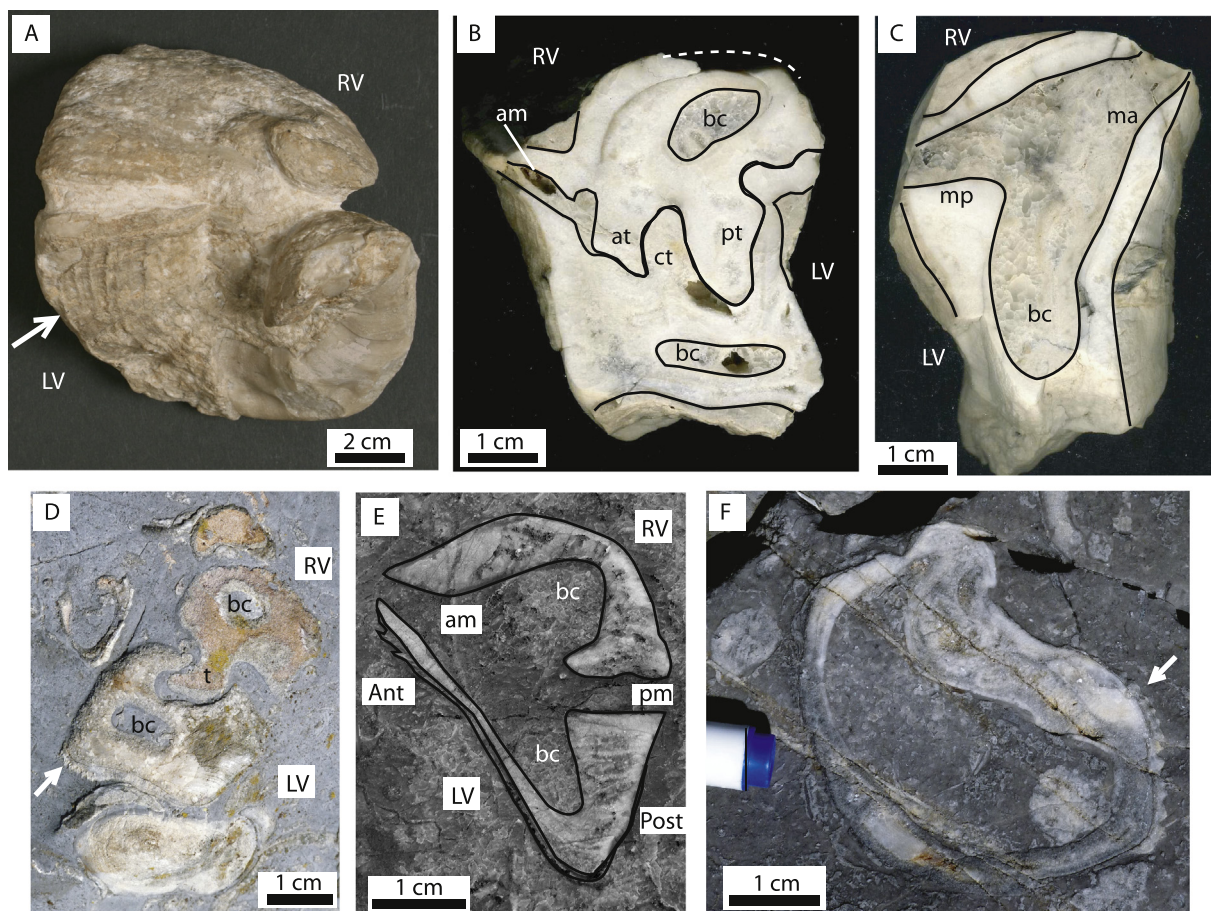
*Heterodicerus* sp.1.

Fig. 10

We ascribe to *Heterodicerus* sp.1 two sections of bivalve specimens (JPMA 17643,17644), and a LV (JPMA17649) having:

- asymmetrical LV with pm larger than am,
- a low (height/commissural diameter about 0.5), weakly spirogyrate LV with a thin calcitic and smooth outer shell layer, (Fig. 10A, B) the dimensions of the LV are relatively large (Dap = 6.0 cm, Ddv = 8.5 cm) with a wide, arcuate commarginal posterior tooth socket (Fig. 10 A);
- a rounded, low (height/diameter is 0.5), weakly spirogyrate RV, the posterior side is raised above the commissure.

This form differs from *Heterodicerus luci* by the shape of the LV, somewhat requieniform, the absence of ribs and the weakly developed beak; the RV is more rounded, lacks the steep elevated posterior margin and associated carina, and its beak is also more limited.



**Fig. 9.** *Heterodicerus luci*. (A) bivalve specimen from the type locality of Mont Salève (Berriasian, Geneva region) showing the overall morphology and the ribs of the anterior side (arrow) of the LV (by courtesy of the Museum d'Histoire Naturelle de Genève); (B) longitudinal, dorsal section of a bivalve specimen showing the myocardial organisation (Tithonian, Bois de Monnier, SE France, J-P Masse collection); (C) longitudinal ventral section of the same specimen showing the contrasting organisation of the anterior and posterior myophores; (D) longitudinal dorso-ventral section of a bivalve specimen; LV attached to a neighbouring shell (field view, Bitez); (E) longitudinal, ventral section of a bivalve specimen showing the contrasting organisation of the anterior and posterior myophores (field-view, Bitez); (F) transverse oblique section of a LV showing the anterior ribs (arrow) (field-view, Bitez).

### *Heterodicerus* ? sp.

#### Fig. 11

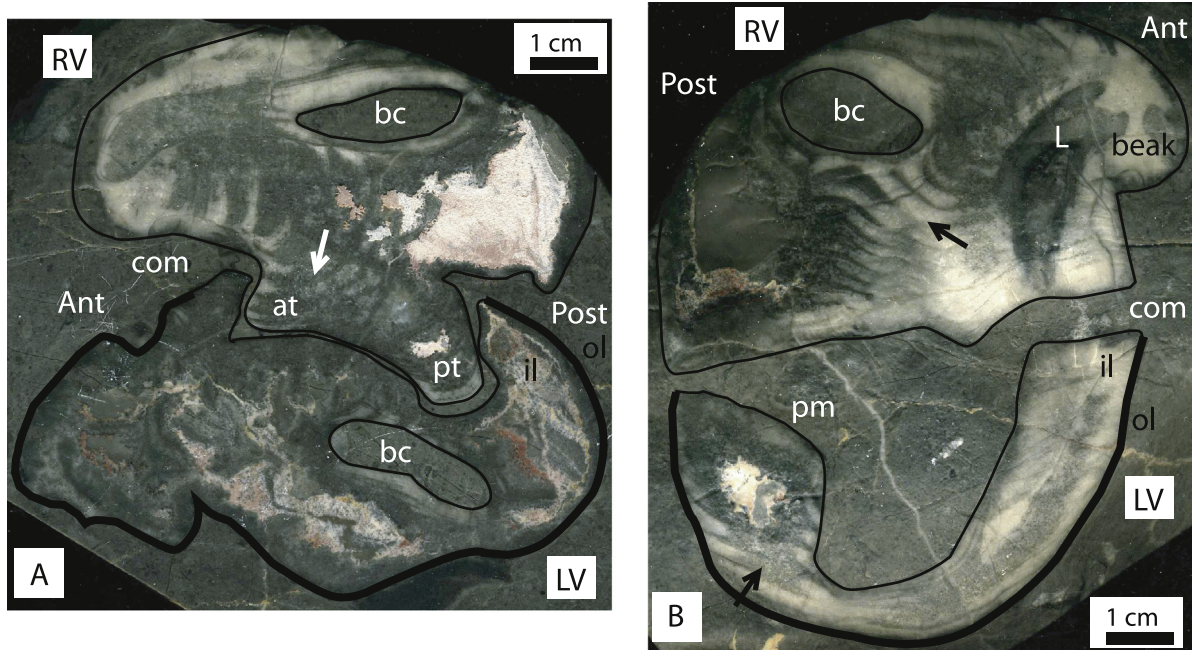
This form is represented by a bivalve specimen cut longitudinally (JPMA 17654). The section shows (Fig. 11A, B) a conical elongated LV (length 5 cm) with a posterior side thicker than the anterior, and a rounded (dorsal side) then low domal (ventral side) RV. The posterior tooth is robust and its corresponding socket (LV) wide. It may belong to *Heterodicerus* or, as suggested by Sano (personal communication), to a problematic group of forms, presently under study, including “*Valletia*” *auris* Favre from the French Jura, *Monopleura*? *taurica* Pchelintsev, *Monopleura*? *crimica* Yanin, both from Crimea, and *Valletia*? sp., from the Bau limestone (Malaysia) (Sano and Skelton, 2011).

Lycian diceratids usually possess a thick, white inner shell layer, and a black, very thin (<2 mm) calcitic outer shell layer on the lower valve, lacking on the upper valve. The inner shell layer displays, on both valves, banded structures which represent growth patterns, especially well marked within the teeth and the myophores (Fig. 9D, Fig. 10A, B, Fig. 12A, B). The banded structures are not always compact and voids, filled with muddy sediments, interspersed within the growth lamellae are locally present (Fig. 12). We favour for these structures a primary rather than a secondary origin, i.e. derived from (early?) dissolution. Another possibility is that they may represent the track of dissolved organic

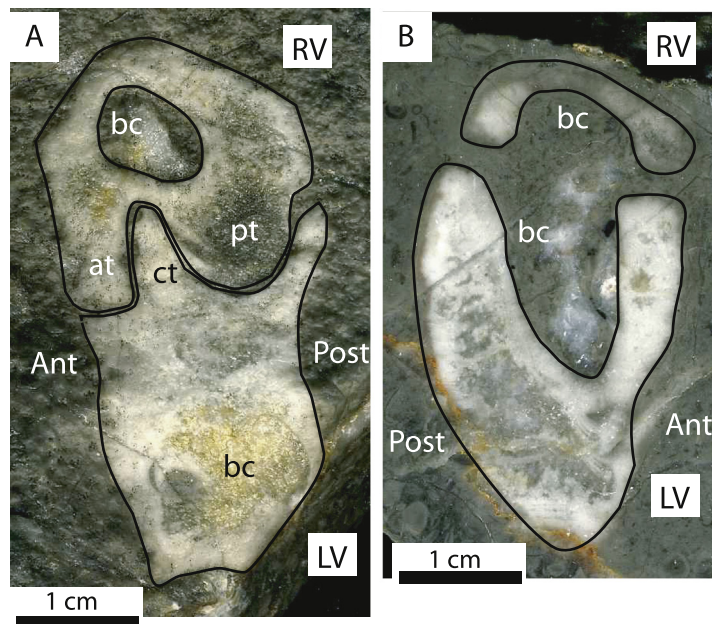
matter interbedded within the carbonate lamellae, similar to that of the inner (aragonitic) shell of modern oysters (Checa et al., 2007). We have observed similar structures in sections of some large diceratid rudists, e.g. *Heterodicerus* from Bois de Monnier in SE France. These observations call attention on the diagenetic context prone to insure or not the preservation of such shell structures, and questions their taxonomic value.

Aside *Heterodicerus luci*, the type species of *Heterodicerus*, several different nominal species of *Heterodicerus* have been described from the literature. Among them two were originally regarded by Boehm (1883) as varieties of the former species and were subsequently erected as distinctive species by Yin (1931): i.e. *H. communis* (Boehm) and *H. ovalis* (Boehm), also recognized as a true species by Pchelintsev (1959). These species were defined after few specimens and small internal differences which cannot be sustained, and we accordingly place them in synonymy with *H. luci*. The eleven Tithonian–Berriasian Crimean species proposed by Pchelintsev (1959) are essentially represented by closely similar isolated RV, some of them with poorly defined internal characters, and therefore their specific autonomy is doubtful. Among them, only four species: *Heterodicerus bajssuense*, *Heterodicerus subovale*, *Heterodicerus angustum*, and *Heterodicerus bajdarensis* were then recognized as valid by Yanin (1989), but the LV is not known, and they are much alike *Heterodicerus luci*. By contrast due to its strong spirograte coiling, non carinated and smooth RV *Heterodicerus*





**Fig. 10.** *Heterodicerus* sp.1 (Bitez block). Longitudinal sections of a bivalve specimen (slab, JPMA17644). (A) dorsal side showing the cardinal organisation; (B) idem, ventral section showing the asymmetry between the anterior and posterior side (thickened posterior myophore). Notice the well defined outer shell layer on the LV and the lamellar growth banding within the inner shell layer (arrows).

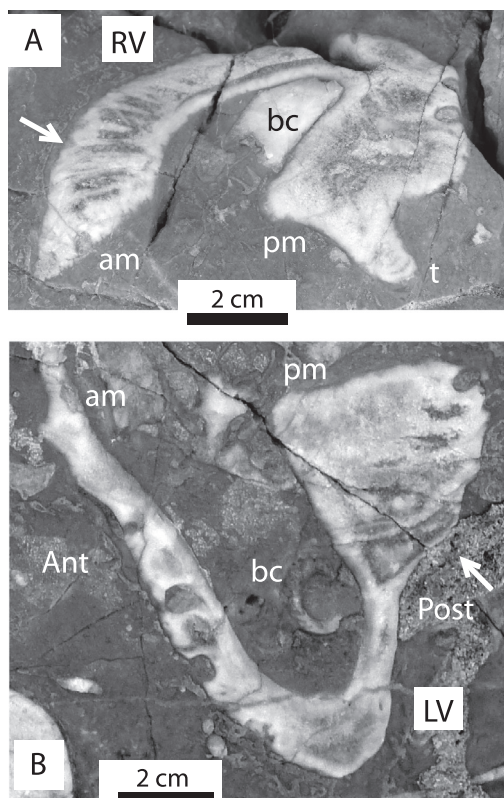


**Fig. 11.** *Heterodicerus?* sp. (Bitez block). Longitudinal sections (slabs) of a bivalve specimen (JPMA17654). (A) dorsal side showing the cardinal region; (B) ventral section showing the thickened posterior side and domal RV.

*crimicus* described by Yanin (1989) from the Berriasian (formerly Valanginian in Yanin, 1989, see comments below) of Crimea, might be a valid species.

*Heterodicerus* has a significant record in the upper Tithonian–Berriasian of SE France (Faure–Marguerit, 1920; Yin, 1931), Switzerland (Pictet, 1868; Joukowsky and Favre, 1913; Collet and Parèjas, 1929), Czech republic, Austria (Boehm, 1883; Sanders et al., 2007; Schneider et al., 2013), the Venetian Alps, possibly the Euboea Island (Greece), Caucasus (Haug, 1907) and Crimea

(Pchelintsev, 1959; Yanin, 1989). The revision of the so-called “*Valletia*” from Kefali (Parnassus zone from Greece), mentioned by Combes et al. (1981), shows that this form actually belongs to *Heterodicerus luci* (observations from JPM). The type level of *Heterodicerus luci* in the Mont Salève, near Geneva, is a 20 m thick stratigraphic unit (“*assise à Heterodicerus luci*” sensu Joukowsky and Favre, 1913) which corresponds with the lower part of the Pierre Chatel Formation (Clavel et al., 1986). In the lower part of this formation the presence of the ammonite *Subalpinites* marks the lower



**Fig. 12.** Banded, growth structures in the inner shell layer of Lycian diceratids (field views). (A) RV of *Heterodicerus* sp.; (B) LV of *Heterodicerus* sp., possibly *H. luci*.

Berriasian (Clavel et al., 1986). The Lycian specimens of *Heterodicerus* represent the first record of this genus in Turkey, and the first discovery of *H. luci* in this country.

Family Requieriidae Kutassy, 1934.

Genus *Hypelasma* Paquier, 1897.

Type species *Hypelasma colloti* Paquier, 1897.

*Hypelasma salevensis* (Joukowsky and Favre)

Fig. 13

1913- *Matheronia salevensis* Joukowsky and Favre, pl. 24, figs 1–14.

2003- *Hypelasma salevensis*, Gourrat et al., pl. 5, figs a–f.

The diagnostic characters of *Hypelasma* defined by Paquier (1897) have been discussed by Gourrat et al. (2003). The key feature is the presence of a posterior myophoral plate attached to the hinge plate of the RV and facing a crest on the opposite valve, the anterior myophore of the RV is a bulge. The RV is nearly uncoiled and raised above the commissural plan both dorsally and posteriorly. Radial bands are absent and a myophoral groove (which marks externally the presence of the posterior myophoral plate, e.g. in *Toucasia*) as well. *Hypelasma* has long been considered as a subgenus of *Matheronia* Munier-Chalmas (see discussion in Gourrat et al., 2003) but the morphology of the posterior myophores of the RV departs from that of *Matheronia*: in which pm is a plate and am is a bulge with a shallow central depression. This myophoral organisation has obviously some affinities with those of *Requienia* and *Toucasia*, nevertheless these two genera possess both a coiled RV and well-defined radial bands on the LV.

*Hypelasma* includes two species: *H. colloti* Paquier with a Tithonian age, and *H. salevensis* (Joukowsky and Favre) originally

described from the Tithonian-Berriasian (as “*Matheronia*” *salevensis*) (Joukowsky and Favre, 1913) and the Tithonian (Yin, 1931), whereas its FO is possibly in the Kimmeridgian (Skelton, 1999; Gourrat et al., 2003). The two species differ by the degree of antero-compression of the valve and the coiling habit of the LV, helicospiral in *H. colloti* and trochospiral in *H. salevensis*; in *H. colloti* the posterior part of the RV is more raised, with a well expressed carina, and the posterior myophoral ledge in the LV more expressed (Paquier, 1897; Gourrat et al., 2003). Based on specimens collected from the type locality at Bois de Monnier (southeast France), we have observed that the size of *Hypelasma colloti* is larger than that of *H. salevensis* and the thickness of the outer calcitic shell layer significantly smaller, whereas the inner shell layer, formerly aragonitic, is thicker, alike diceratids.

The Lycian material is represented by field photographs and 8 specimens cut into oriented slabs got from rock samples (JPMA 16646, 16647, 16651, 16655, 16656, 16657, 16659, 16660) housed at the Museum of Paleontology, Centre Saint-Charles, Aix-Marseille University (Collection J.-P. Masse).

Sections exhibit a typical spirogyrate (LV) requieniform habit (Fig. 13A, B, E, F). The posterior side is more convex than the anterior, almost flat or even slightly depressed (Fig. 13E, F); the dorsal side of the RV is raised (Fig. 13C, D), in correspondence with a small, dorsal, body cavity. There is a well defined fibrous outer shell layer on both valves, in the range of 1–2 mm thick, and even more on the anterior side of the LV, and somewhat lamellar (Fig. 13). A black colour characterises the outer shell layer which contrasts with the white colour of the inner shell layer, formerly aragonitic (Fig. 13A, C, E). This feature gives a clear-cut visual delimitation with the associated diceratids. Antero-posterior sections show the diagnostic myophoral characters of *Hypelasma*, i.e. a posterior myophoral plate attached to the hinge plate, a bulge on the anterior side of RV and a crest on LV corresponding with the posterior myophore (Fig. 13E, F). The posterior tooth of the RV is large and the corresponding socket of the opposite valve too (Fig. 13E, F). The overall morphological traits of the Lycian specimens conform to those of *H. salevensis* and their dimensions too, the commissural height of LV (2.5–3.3 cm) and total height (3.5–5.0 cm) fall in the range of the Salève type material studied by Gourrat et al. (2003).

*Hypelasma* was hitherto considered to be restricted to SE France, and possibly Azerbaïdjan (Yanin, 1989). A form closely resembling *Hypelasma salevensis*, and described as *Matheronia salevensis* has been figured by Pchelintsev (1959) from the Tithonian of Crimea. In addition one must be aware about the affinities in myophoral organisation and morphology of the RV (raised dorsal side) between *Hypelasma* and *Matheronia taurica* described from the “Valanginian” of Crimea by Yanin (1985) (presently regarded as Berriasian, as stated above), which might be a representative of *Hypelasma*. The Lycian specimens of *Hypelasma* represent the first record of *H. salevensis* on the southern Tethyan margin.

#### 4.2. Order Pectinida Gray, 1854

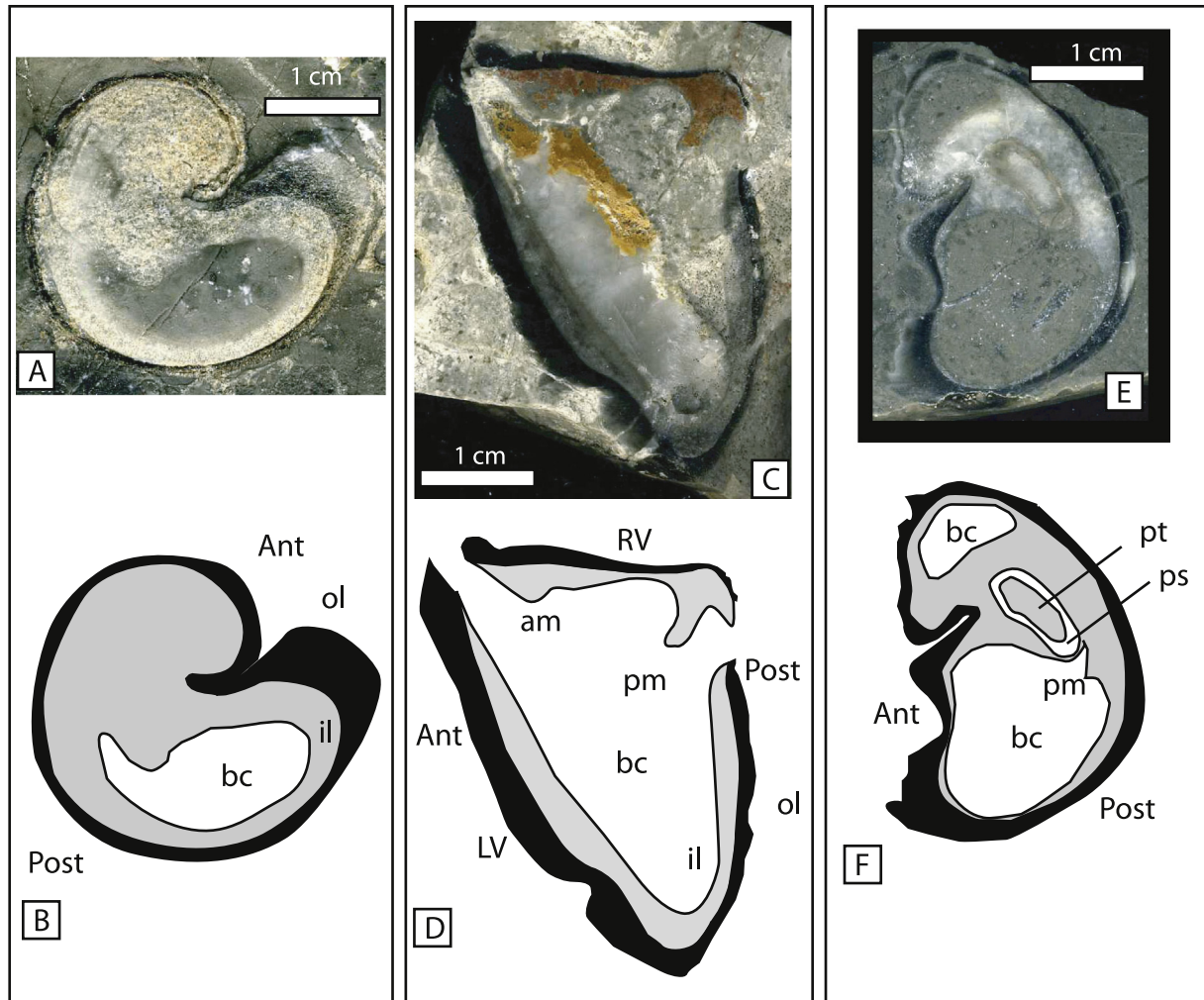
Super family Plicatuloidea Gray, 1854.

Family Chondrodontidae Freinex, 1960

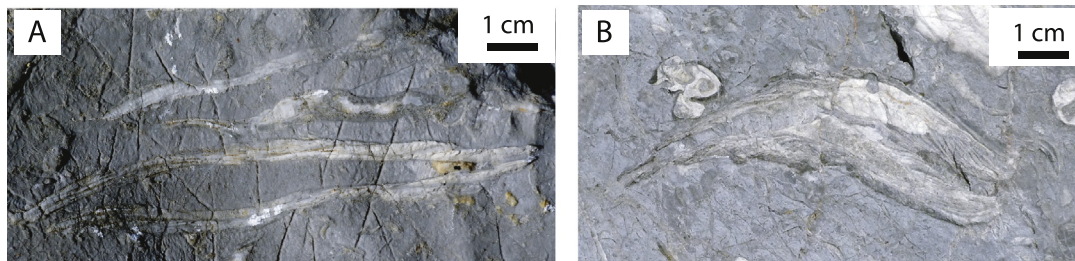
Genus *Chondrodonta* Stanton, 1947 (Fig. 14A, B)

Pre-Barremian representatives of chondrodontid bivalves are poorly documented. We tentatively ascribe to *Chondrodonta* Stanton (Stanton, 1947) sections of thick bivalve, flattened shells lacking ornamentation, especially the concentric commarginal plications near the umbo which characterize the genus *Turkmenia* Krimholz (Dhondt and Dieni, 1992). The outer shell (originally calcitic)





**Fig. 13.** *Hypelasma salevensis* (Bitez block). (A) section of an LV showing the requieniform habit (field view) and its interpretation in (B); (C) antero-posterior section showing the myocardial organisation, and its interpretation in (D) (slab, JPMA 17647); (E) transverse-oblique section of an LV showing the tooth/socket morphology and the myophore, and interpretation in (F) (slab, JPMA 17646).



**Fig. 14.** Non-rudist bivalves (Bitez block, field views). *Chondrodonta* sp., sections of bivalve specimens.

microstructure of the Bitez specimens conforms the lamellar mode which typifies *Chondrodonta*.

##### 5. Palaeoecological significance of the rudist assemblage

Diceratid bearing communities of Berriasian age, with *Heterodicerias* as a key taxon, studied in Southeast France (Fenerci-Masse, 2006), look alike those from Bitez. The Lycian assemblage is characterized by a low density, a significant shell aggregation and a modest coverage. Large size and thick shell are also key attributes of

the community. The presence of corals, small requieniids and chondrodontids is a trait common to the Lycian and French assemblages. The French diceratid community was interpreted as a distal one, i.e. of type 2, (of the palaeoenvironmental division of Fenerci-Masse, 2006), compared to type 1, more proximal and with smaller individuals and dominated by requieniids (Fenerci-Masse, 2006), such a palaeoecological interpretation matches the Lycian diceratid assemblage, and is supported by the frequent occurrence of corals. This environmental interpretation conforms the Stramberg model briefly exposed above. The Lycian diceratid assemblage

differs from the “diceratid shell beds” with *Heterodicerias*, described from the Northern calcareous Alps by Sanders et al. (2007), in which the shell beds consist of toppled disoriented individuals stripped of their calcitic outer shell layer, due to episodic high energy events originated in the vicinity of a low energy gravelly beach (Sanders et al., 2007). Notice that the beds in question were assigned to the Tithonian, owing to the presence of *Heterodicerias*, whereas micropaleontological components identified by Schlagintweit and Ebli (2000), more likely suggest an early Berriasian age.

## 6. Faunal comparisons with other regions

In the Western Pontides, diceratids and requieniids are present in the Günören Formation of the Bilecik group sensu Altner et al. (1991), formerly ascribed to the Valanginian. A revision of the Günören Formation in its type region of Bursa-Bilecik (Masse and Özer, unpublished observations) shows that the rudist-bearing beds are actually Berriasian and overlie Tithonian coral-dominated limestones (with sparse diceratids) of Stramberk type, actively carved for ornamental purpose. The rudist material observed in the Günören limestones is poorly preserved, its identification at generic level highly problematic, and it still needs additional investigations.

The rich and diversified diceratid fauna from Crimea formerly assigned to the Tithonian–Valanginian (Pchelintsev, 1959; Yanin, 1989) is presently considered Tithonian–Berriasian (Arkadiev and Bugrova, 1999; Baraboshkin, 2003; Krajewski and Olszewska, 2007). The Tithonian fauna compiled by Yanin (1989) consists of only four heterodiceratids (among the 12 reported by Pchelintsev 1959, see discussion above): *Heterodicerias bajdarensis* Pchelintsev, *H. bajssuense* Pchelintsev, *H. subovale* Pchelintsev; they are associated with *Valletia antiqua* Favre, “*Valletia auris* Favre, *Valletia urkustense* Pchelintsev and *Monopleura? crimica* Yanin; *Hypelasma cf. salevensis* must be also added to this list (see above). After Yanin (1989) the Berriasian fauna consists of: *Megadicerias koinautense* Pchelintsev, *Heterodicerias angustum* Pchelintsev, *H. crimicus* Yanin, associated with two Requieniidae: *Matheronia baksanensis* Yanin and *Matheronia taurica* Yanin, and a Monopleuridae, *Monopleura? taurica* Pchelintsev. As indicated above one must be aware that the foregoing inventory includes several diceratids with a poor or erroneous taxonomic assignment. Tithonian forms from SE France and Switzerland reported by Paquier (1897), Joukowsky and Favre (1913), Faure-Marguerit (1920), and Yin (1931) include: *Epidicerias beyrichi* (Boehm), *Epidicerias speciosum* (Munster), *Hypelasma colleti* Paquier and *Matheronia romani* Paquier. *Heterodicerias luci* (Defrance), *Valletia antiqua* Favre, and *Hypelasma salevensis* (Joukowsky and Favre) were found from both the Tithonian and the Berriasian. The foregoing data may suggest that the assemblage of *Epidicerias guirandi* (de Loriol) and *E. speciosum* reported by Sano and Skelton (2010) from Torinosu type limestones of southwest Japan and assigned to the Tithonian–Berriasian might be restricted to the Tithonian. This assemblage is quite similar to that of the Bau limestone from Sarawak (Kimmeridgian to Valanginian?, after Banda, 1995) in which *Heterodicerias* aff. *luci* first described by Lau (1973), has been revised by Skelton who assigned the form in question to *Epidicerias speciosum* (Skelton, 1985).

The foregoing review shows the absence in the Tithonian–Berriasian of *Dicerias* and *Plesiodicerias*, and the apparent rarity of *Epidicerias* in the Berriasian. However if we follow the suggestion of Skelton (1999, 2013) to consider *Megadicerias* Pchelintsev and *Epidicerias* Dechaseaux (ex. Douvillé) as synonyms, *Epidicerias* may be actually present in the Berriasian and represented by *Epidicerias koinautense* (Pchelintsev) and possibly, owing to the Berriasian age

of a part of the Torinosu limestone of Japan (Kobayashi and Wernli, 2014), *E. guirandi* and *E. speciosum*. Lycian rudists suggest that the age of the assemblage dominated by *Heterodicerias* and *Hypelasma* is consistent with the Berriasian. This does not exclude the possibility, in forthcoming investigations on the Lycian faunas, to find out and/or reappraise as *Epidicerias*, some poorly explicit or poorly understood rudist sections observed in the field, and including the “*Valletia auris* group.

## 7. Conclusions

Rudist bivalves play a significant role in the Bitez block: a megablock of coral-rudist bearing platform limestone, of Stramberk type, reworked in upper Santonian–Campanian (possibly Maastriechian) flysch-like deposits of the Karabortlen Formation, near Bodrum. These beds belong to the Lycian nappes and the palaeogeographic origin of the megablock is unclear. The micropaleontological content of benthic foraminifera, calcareous green algae and problematica (*Crescentiella morronensis*–*Protopenneroplis ultragranulata*–*Troglotella incrustans*–*Clypeina sulcata* assemblage) of the Bitez block indicates a Berriasian age. Rudists are represented by *Heterodicerias luci* (Epidiceratidae) and *Hypelasma salevensis* (Requieniidae), and poorly defined other representatives of *Heterodicerias* or even of the “*Valletia auris* group. The two identified species are common in the upper Tithonian–Berriasian of the European margin of the Mediterranean Tethys. The associated non-rudist bivalves consist of *Chondrodonta* and possibly megalodontids. The Lycian specimens of *Hypelasma* represent the first record of this taxon on the southern Tethyan margin whereas *Heterodicerias* has been reported from the peri-Adriatic regions but is found for the first time in Turkey. The occurrence of the two taxa in Stramberk type limestones in Turkey extends their biogeographical distribution and tend to support their biostratigraphic significance.

## Acknowledgements

We thank P.A. Proz, collaborateur scientifique, Museum of Natural History of Geneva, for the communication of informations, figures and photographs of the type material of *Heterodicerias luci* from Mont-Salève. This study was financially supported by TÜBİTAK Project no. 113Y144 (Turkey). The pertinent comments provided by the two reviewers: I. I. Bucur (Cluj-Napoca University, Romania) and S. Sano (Fukui Prefectoral Dinosaur Museum, Japan) were appreciated and helped to improve the quality of a former version of the manuscript. We also thank the Editor for his valuable contribution.

## References

- Altner, D., 1991. Microfossil biostratigraphy (mainly foraminifers) of the Jurassic–Lower cretaceous carbonate successions in north-western Anatolia (Turkey). *Geologica Romana* 27, 167–213.
- Altner, D., Koçyigit, A., Farinacci, A., Nicosia, U., Conti, M.A., 1991. Jurassic–Lower Cretaceous stratigraphy and paleogeographic evolution of the southern part of North-western Anatolia (Turkey). *Geologica Romana* 27, 13–80.
- Andreini, G., Caracul, J.E., Parisi, G., 2007. Calpionellid biostratigraphy of the Upper Tithonian–Valanginian interval in Western Sicily (Italy). *Swiss Journal of Geosciences* 100, 179–198.
- Arkadiev, V.V., Bugrova, I.Y., 1999. Facies of the Cretaceous (Berriasian) deposits from the river Belbek area (Southwestern Crimea). *Facies* 40, 71–80.
- Arnaud-Vanneau, A., 1980. Micropaléontologie, paléocéologie et sédimentologie d'une plate-forme carbonatée de la marge passive de la Téthys: l'Urgonien du Vercors septentrional et de la Chartreuse (Alpes occidentales). *Géologie Alpine, Mémoire* 11, 874.
- Arnaud-Vanneau, A., Masse, J.-P., 1989. Les foraminifères benthiques des formations carbonatées de l'Hauteriviens–Barrémien *pro parte* du Jura vaudois et neuchâtelois (Suisse). *Mémoire de la société neuchâteloise de sciences naturelles* 11, 257–276.



- Arnaud-Vanneau, A., Boisseau, T., Darsac, C., 1988. Le genre *Trocholina* Paalzov 1922 et ses principales espèces au Crétacé. *Revue de Paléobiologie* 353–377 volume special 2 (benthos 86).
- Arsilan, A., Güngör, T., Erdoğan, B., Passchier, C.W., 2013. Tectonic transport directions of the Lycian nappes in southwest Turkey constrained by kinematic indicators. *Journal of Asian Earth Sciences* 64, 198–209.
- Banda, R.M., 1995. The Cretaceous of Sarawak, Malaysia. In: *The Cretaceous system in East and South Asia*, Newsletter special Issue 2, IGCP 350. Kyushu University, Japan, pp. 35–42.
- Baraboshkin, E.Y., 2003. Early Cretaceous development of the Mountain Crimea. Annual University of Mining and Geology “St. Ivan Rilski”, part 1. *Geology and Geophysics* 46, 25–30.
- Barattolo, F., Pugliese, A., 1987. Il Mesozoico dell’Isola di Capri. *Quaderni dell’Accademia Pontaniana* 8, 172.
- Barattolo, F., De Castro, P., Parente, M., 1993. Some remarks on *Griphoporella curvata* (Gümbel, 1872) Pia 1915, dasycladalean green alga from the Upper Triassic. In: Barattolo, F., De Castro, P., Parente, M. (Eds.), *Studies on fossil benthic algae*. *Bollettino della Società Paleontologica Italiana*, Special volume 1, pp. 23–45.
- Bassoullet, J.-P., Bernier, P., Conrad, M.A., Deloffre, R., Jaffrezo, M., 1978. Les algues dasycladales du Jurassique et du Crétacé. *Géobios, Mémoire special* 2, 1–330.
- Bayle, E., 1873. Observations sur quelques espèces du genre *Diceras*. In: Bayan, J.F.F. (Ed.), *partie 2: Etudes faites dans la collection de l’Ecole des Mines sur les fossiles nouveaux ou mal connus*. Unpublished report of the Ecole des Mines, Paris.
- Bernier, P., 1978. Une nouvelle dasycladacée du Portlandien du Jura méridional français: *Montenegrella florifera* nov. sp. *Géobios* 11 (1), 141–147.
- Bernier, P., 1979. Le genre *Petrascula* Gümbel 1873, algue dasycladacée: émendation, révision des espèces du genre, création de nouvelles espèces. *Géobios* 12 (6), 839–861.
- Bernier, P., 1984. Les formations carbonatées du Kimmérien et du Portlandien dans le Jura méridional. *Stratigraphie, micropaléontologie, sédimentologie*. Documents laboratoire de Géologie de Lyon 92 (1–2), 1–108.
- Bernoulli, D., Graciansky, P., de Monod, O., 1974. The extension of the Lycian Nappes (SW Turkey) into the southeastern Aegean Islands. *Eclogae Geologiae Helveticae* 67/1, 39–90.
- Boehm, G., 1883. Die Bivalven der Stramberger-Schichten. *Verte Abteilung, Palaeontographica*, supplement 2, pp. 493–680.
- Boudagher-Fadel, M., 2001. The taxonomy and evolution of the foraminifer genus *Buccicrenata* Loeblich and Tappan. *Micropaleontology* 47 (2), 168–172.
- Brunn, J.H., Dumont, J.F., de Graciansky, Ch. P., Gutnic, M., Juteau, T., Marcoux, J., Monod, O., Poisson, A., 1971. Outline of the Geology of the western Taurids. A.S. Campbell edit. In: *Geology and History of Turkey*. Petroleum Exploration Society of Lybia, Tripoli, pp. 225–255.
- Bucur, I.I., Pomarjanschi, D., 1987. Microfacies, diagenesis and geochemistry of carbonate rocks in the surroundings of Resita. In: *Dari de seama ale sedintelor*. Institutul de Geologie si Geofizica, 70–71/4, 63–77.
- Bucur, I.I., Sasaran, E., 2005. Micropaleontological assemblages from the Upper Jurassic-Lower cretaceous deposits of Trascau mountains and their biostratigraphic significance. *Acta paleontologica Romaniae* 5, 27–38.
- Bucur, I.I., Schlagintweit, F., 2009. Taxonomic revision of *Epimastopora* Endo 1960 and its Upper Jurassic to Lower Cretaceous representatives. In: *IFAA, 6th Regional Symposium, Milan, Italy*. Abstract Book, 20.
- Bucur, I.I., Conrad, M.A., Radoicic, R., 1995. Foraminifers and calcareous algae from Valanginian limestones in the Jerma river canyon, Eastern Serbia. *Revue de Paléobiologie* 14 (2), 349–377.
- Bucur, I.I., Senowbari-Daryan, B., Abate, B., 1996. Remarks on some foraminifera from the Upper Jurassic (Tithonian) reef limestone of Madonie Mountains (Sicily). *Bollettino della società Paleontologica Italiana* 35, 65–80.
- Bucur, I.I., Hoffmann, M., Kolodziej, B., 2005. Upper Jurassic-lowermost Cretaceous benthic algae from Tethys and the European platform: a case study from Poland. *Revista Espanola de Micropaleontologia* 31 (7), 105–129.
- Bucur, I.I., Granier, B., Schlagintweit, F., 2010. *Steinmanniporella*, a new dasycladale genus name for “*Linoporella*” with two orders of laterals. *Facies* 56, 317–321.
- Bucur, I.I., Gradinaru, E., Lazar, I., Gradinaru, M., 2014a. Early Cretaceous micropaleontological assemblages from a condensed section of the Codlea area (Southern Carpathians, Romania). *Acta Paleontologica Romaniae* 9 (2), 67–84.
- Bucur, I.I., Pacurariu, A., Sasaran, E., Filipescu, S., Filipescu, R., 2014b. First record of lowermost Cretaceous shallow water limestones in the Bazegane of the Transylvanian depression (Romania). *Carnets de Géologie, Brest* 14 (11), 199–210.
- Canavari, M., 1893. Idrozoi titoniani della regione mediterranea appartenenti alla famiglia delle Ellipsactinidi. *Memorie del regio Comitato geologica d’Italia* 4 (2), 155–209.
- Carras, N., 1989. La posizione stratigrafica dei calcari ad Ellipsactinie nella zona del Parnasso. *Annales géologiques des Pays Helleniques* 34 (1), 65–76.
- Carras, N., Conrad, M.A., Radoicic, R., 2006. *Salpingoporella*, a common genus of Mesozoic dasycladales (calcareous green algae). *Revue de Paléobiologie, Genève* 25 (2), 457–517.
- Carter, J.G., fifty others, 2011. A synoptical classification of the Bivalvia (Mollusca). *Paleontological contributions*, 4. The University of Kansas, Paleontological Institute, p. 47.
- Checa, A.G., Jimenez-Lopez, C., Rodriguez-Navarro, A., Machado, J.P., 2007. Precipitation of aragonite by calcitic bivalves in Mg-enriched marine waters. *Marine Biology* 150, 819–827.
- Clavel, B., Charollais, J., Busnardo, R., Le Hegarat, G., 1986. Précisions stratigraphiques sur le Crétacé inférieur basal du Jura méridional. *Eclogae Geologiae Helveticae* 79 (2), 319–341.
- Collet, L.W., Paréjas, E., 1929. La géologie du Hockenhorn. *Eclogae Geologiae Helveticae* 22, 61–62.
- Collins, A.S., Robertson, A.H.F., 1998. Processes of Late Cretaceous to Late Miocene episodic thrust-sheet translation in the Lycian Taurides, SW Turkey. *Journal of the Geological Society, London* 155, 759–772.
- Combes, P.-J., Fourcade, E., Masse, J.-P., Philip, J., 1981. Observations stratigraphiques et paléontologiques sur le Crétacé de la zone du Parnasse (Grèce). *Travaux du comité international pour l’étude des bauxites, de l’alumine et de l’aluminium*. Académie Yougoslave des Sciences et des Arts, Zagreb 11 (16), 347–365.
- Conrad, M., Pratulon, A., Radoicic, R., 1973. Reinstatement of the genus *Salpingoporella* Pia (Dasycladaceae) followed by *S. steinhauseri*. *Comptes Rendus de la Société de Physique et Histoire Naturelle de Genève, N.S VII* (2–3), 103–111.
- Defrance, J.L.M., 1819. La dicerate de Deluc. *Dictionnaire des Sciences naturelles*, Paris 13, 177.
- Dhondt, A., Dieni, I., 1992. Non rudistid bivalves from Cretaceous rudist formations. *Geologica Romana* 28, 211–218.
- Dora, O.O., Candan, O., Kaya, O., Koray, E., Dürr, S., 2001. Revision of “Leptigneisses” in the Menderes Massif: a supracrustal metasedimentary origin. *International Journal of Earth Sciences* 89 (4), 836–851.
- Douvillé, H., 1896. Sur la constitution géologique des environs d’Héraclée (Asie Mineure). *Comptes rendus de l’Académie des sciences, Paris* 122, 678–680.
- Dürr, S., 1975. Über Alter und geotektonische Stellung des Menderes Kristallins SW-Anatolien, und seine aquivalente in der mittlere Aegaeis. *Habilitation Thesis*. Marburg University, p. 106.
- Elamri, Z., Zaghbib-Turki, D., 2014. Santonian-Campanian biostratigraphy of the Kalaat Senan area (West-Central Tunisia). *Turkish Journal of Earth Sciences* 23, 184–203.
- Eliasova, H., 2008. Corals from the Stramberk limestone (Silesian unit, outer western Carpathians, Czech Republic). *Geologia* 34 (3/1), 151–160.
- Endo, R., 1961. Calcareous algae from the Jurassic Torinosu limestones of Japan. *The Science Reports Saitama University, B, Biology and earth Sciences*, Commemorative volume dedicated to professor Riujii Endo, pp. 53–75.
- Farinacci, A., Radoicic, R., 1991. Late Jurassic-Early Cretaceous dasycladales (Green algae) from the western Pontides, Turkey. *Geologica Romana* 27, 135–165.
- Favre-Marguerit, G., 1920. *Monographie paléontologique des assises coralligènes du promontoire de l’Echaillon (Isère)*. *Travaux du Laboratoire de géologie, Grenoble*, pp. 9–108. XII, fasc. 2.
- Favre, A., 1843. Considérations géologiques sur le Mont-Salève et sur les terrains des environs de Genève. *Mémoire de la Société de Physique et d’Histoire naturelle de Genève* 10, 49–162.
- Fenerci, M., 1999. Cretaceous rudist fauna of Kocaeli Peninsula and western Pontides. PhD thesis. University of Dokuz Eylül, İzmir, Turkey, p. 232.
- Fenerci-Masse, M., 2006. Les communautés à rudistes du Crétacé inférieur de la marge européenne de la Téthys. *Thèse université d’Aix-Marseille I*, p. 436.
- Freneix, S., 1960. *Étude complémentaire des Lamellibranches du Crétacé de Nouvelle-Calédonie*. *Sciences de la Terre* 6, 5–56.
- Gourrat, C., Masse, J.-P., Skelton, P.W., 2003. *Hypelasma salevensis* (Favre, 1913) from the Upper Kimmeridgian of the French Jura, and the origin of the rudist family Requeniidae. *Geologia Croatica* 56 (2), 139–148.
- Gorbatchik, T.N., 1959. *Novye vidy foraminifer iz nizhnemelovykh otlozheniy Kryma i severo-zapadnogo Kavkaza* (In Russian). *Paleontologicheskii Zhurnal* 1, 78–83.
- Gorbatchik, T.N., 1971. On early Cretaceous foraminifera of the Crimea. *Voprosy Mikropaleontologii, Moscow* 14, 130.
- Gorbatchik, T.N., Mohamad, G.K., 1997. New species of Lituolida (Foraminifera) from the Tithonian and Berriasian of the Crimea. *Paleontological journal* 4, 3–9.
- Graciansky, P., de Lemoine, M., Lys, M., Sigal, J., 1967. *Güney Anadolu silsilesinin (Fethiye kuzeyi) bati ucundaki ust Paleozoic ve Mesozoikite stratigrafik bir kesit*. *Maden Tetkik Arama Dergisi* 69, 11–32.
- Granier, B., Clavel, B., Charollais, J., Weidmann, M., 2014. Latest Jurassic-early Cretaceous dasycladalean algae (Chlorophyta) from the Morand drilling at Montricher (canton of Vaud, Switzerland). *Acta Paleontologica Romaniae* 10 (1–2), 25–38.
- Gray, J.E., 1854. A revision of the arrangement of the families of bivalve shells (Conchifera). *The Annals and Magazine of Natural History* 13 (77), 408–418, 2.
- Güngör, T., Erdoğan, B., 2001. Emplacement age and direction of the Lycian nappes in the Söke-Selçuk region, western Turkey. *International Journal of earth Sciences* 89, 874–882.
- Gutnic, M., Monod, O., Poisson, A., Dumont, J.-F., 1979. *Géologie des Taurides occidentales (Turquie)*. *Mémoires de la Société géologique de France*, LVIII, *Mémoire*, 37, pp. 1–112.
- Haug, E., 1907. *Traité de géologie. II- Les périodes géologiques. Le Jurassique*. Masson, Paris, pp. 929–1152.
- Heinz, R.A., Isenschmid, C., 1988. Mikrofazielle und stratigraphische Untersuchungen in Massivkalk (Malm) der Préalpes médianes. *Eclogae Geologiae Helveticae* 81 (1), 1–62.
- Housa, V., 1975. *Geology and palaeontology of the Stramberk Limestone (Upper Tithonian) and associated Lower Cretaceous beds*. *Colloque sur la limite Jurassique-Crétacé, Mémoire*, 86. Bureau des Recherches Géologiques et Minières, Paris, pp. 342–349.

- Huber, B.T., Leckie, R.M., Norris, R.D., Bralower, T.J., Cobabe, E., 1999. Foraminiferal assemblage and stable isotopic change across the Cenomanian–Turonian boundary in the subtropical North-Atlantic. *Journal of Foraminiferal Research* 29 (4), 392–417.
- Ivanova, D., Kolodziej, B., 2010. Late Jurassic–Early Cretaceous foraminifera from Stramberk-type limestones, Polish outer Carpathians. *Studia Universitatis Babeş-Bolyai, Geologia* 55 (2), 3–31.
- Joukowsky, E., Favre, J., 1913. Monographie géologique et paléontologique du Salève (Haute-Savoie, France). *Mémoire de la Société Physique et Histoire naturelle de Genève* 37 (4), 295–523.
- Karacabey, N., 1970. Quelques espèces de *Vaccinites* et de *Pironaeva* de l'Anatolie orientale. *Bulletin of the Mineral Research and Exploration* 74, 84–90.
- Karacabey-Öztemür, N., 1980. Two new genera of Radiolitiidae (*Balabania* n. gen., *Kurtinia* n. gen.) from Turkey. *Bulletin of the Geological Society of Turkey* 23, 79–86.
- Kobayashi, F., Vuks, V.J., 2006. Tithonian–Berriasian foraminiferal faunas from the Torinosu-type calcareous blocks of the southern Kanto Mountains, Japan: their implications for post-accretionary tectonics of Jurassic and Cretaceous terranes. *Geobios* 39, 833–843.
- Kobayashi, F., Wernli, R., 2014. Early Cretaceous (Berriasian to Valanginian) foraminifera from the Torinosu limestone at the locality of Sakawa, Shikoku, Japan. *Revue de Paléobiologie, Genève* 33 (1), 67–78.
- Kolodziej, B., 1997. Boring foraminifera from exotics of Stramberk-type limestones (Tithonian–Lower Berriasian, Polish Carpathians). *Annales Societatis Geologorum Poloniae* 67, 249–256.
- Konak, N., Akdeniz, N., Öztürk, E.M., 1987. Geology of the South of Menderes Massif, ICGP Project 5: Guide Book field excursion western Anatolia, Turkey. *Mineral Research and Exploration Institute of Turkey Publication*, pp. 42–53.
- Krajewski, M., Olszewska, B., 2007. Foraminifera from the late Jurassic and early Cretaceous carbonate platforms facies of the southern part of the Crimea Mountains; southern Ukraine. *Annales Societatis Geologorum Poloniae* 77, 291–311.
- Kutassy, A., 1934. *Pachydoma mesozoica* (Rudistis exclusis). *Fossilium Catalogus*, 1: Animalia, pars 68. Gustav Feller. Neubrandenburg, p. 202.
- Kutznetsova, K.I., Gorbachik, T.N., 1985. Upper Jurassic and Lower Cretaceous stratigraphy and foraminifera of the Crimea. *Nauka, Moscow*, p. 119 (in Russian).
- Lau, J.W.E., 1973. The rediscovery of rudist with its associated fauna in the Bau Limestone and its palaeobiogeographic significance in circumglobal correlation and plate tectonic studies. *Malaysia Geological Survey Annual Report for 1973*, pp. 188–197.
- Leinfelder, R.R., Nose, M., Schmidt, D.U., Werner, W., 1993. Microbial crusts of the Late Jurassic. Composition, palaeoecological significance and importance in reef construction. *Facies* 29, 195–230.
- Masse, J.-P., 1976. Les calcaires urgoniens de Provence (Valanginien–Aptien inférieur). Stratigraphie, paléontologie, les paléoenvironnements et leur évolution. Thèse Université Aix-Marseille II, p. 445.
- Masse, J.-P., Bucur, I.I., Virgone, A., Dalmasso, E., 1999. Nouvelles espèces de Dasycladales du Crétacé inférieur de Provence (SE France). *Revue de Micropaléontologie* 42 (3), 231–243.
- Masse, J.-P., Fenerci-Masse, M., Özer, S., 2002. Late Aptian rudist faunas from the Zonguldak region, Western Black Sea, Turkey (taxonomy, biostratigraphy, palaeoenvironment and palaeobiogeography). *Cretaceous Research* 23, 523–536.
- Masse, J.-P., Özer, S., Fenerci, M., 2004. Upper Barremian–Lower Aptian rudist faunas from the western Black sea region (Turkey). *Courier Forschungsinstitut Senckenberg* 247, 75–88.
- Masse, J.-P., Villeneuve, M., Leonforte, E., Nizou, J., 2009. Block tilting of the North Provence early Cretaceous carbonate margin: stratigraphic, sedimentologic and tectonic data. *Bulletin de la Société géologique de France* 180 (2), 105–115.
- Masse, J.-P., Fenerci-Masse, M., İşintek, I., Güngör, T., 2010. Albian rudist faunas from the Karaburun peninsula, Izmir region, Western Turkey. *Turkish Journal of Earth Sciences* 19 (6), 671–683.
- Morycowa, E., Moryc, W., 2011. Upper Jurassic–?Lower Cretaceous carbonate complex in Dabrowa Tarnowska–Szczucin area (Carpathian foreland). *Biuletyn Państwowego Instytutu Geologicznego* 447, 25–48.
- Munier-Chalmas, H., 1869. *Requienia* et *Heterodicerias*, 2, 27. In: Hébert, E. (Ed.), *Examen de quelques points de la géologie de la France méridionale*. *Bulletin de la Société géologique de France*, p. 116.
- Neagu, T., 1994. Early Cretaceous *Trocholina* group and some related genera from Romania. Part 1. *Revista Espanola de Micropaleontologia* 26 (3), 117–143.
- Okay, A.I., Tuysuz, O., 1999. Tethyan sutures of northern Turkey. In: Durand, B., Jolivet, L., Horvath, F., Seranne, M. (Eds.), *The Mediterranean Basins: Tertiary extension within the Alpine orogen*. Geological Society, Special Publication, 156, pp. 475–515.
- Özer, S., 1983. Université de Provence, Nouvelle série. Les formations à rudistes du Sénonien supérieur d'Anatolie Centrale (Turquie): Travaux Laboratoire de Stratigraphie et de Paléocologie, Volume 1, p. 32. Marseille-France.
- Özer, S., 1998. Rudist bearing Upper Cretaceous metamorphic sequences of the Menderes Massif (western Turkey). *Geobios, Mémoire* 22, 235–249.
- Özer, S., 2002. Distributions stratigraphiques et géographiques des rudistes du Crétacé supérieur en Turquie. In: *Proceedings First international Conference on rudists*. Beograd 1988 “Rudists”. Union of Geological Societies of Yugoslavia, Memorial Publication, Sladic-Trifunovic, M. Edit, pp. 173–185.
- Özer, S., 2010a. *Dictyoptychus* Douvillé: taxonomic revision. Phylogeny and biogeography. *Turkish Journal of Earth Sciences* 19 (5), 583–612.
- Özer, S., 2010b. Campanian–Maastrichtian *Pseudosabinia* from Turkey: description and taxonomic problems. *Turkish Journal of Earth Sciences* 19 (5), 643–669.
- Özer, S., Sözbilir, H., Özkaz, İ., Tokar, V., Sarı, B., 2001. Stratigraphy of Upper Cretaceous–Paleogene sequence in the southern and eastern Menderes Massif (western Turkey). *International Journal of Earth Sciences* 89, 852–866.
- Özer, S., Meriç, E., Görmüş, M., Kanbur, S., 2009. Biogeographic Distributions of the Rudists and Benthic Foraminifers: An Approach to Campanian–Maastrichtian Paleobiogeography of Turkey. *Geobios* 42, 623–638.
- Paquier, V., 1897. Sur quelques Diceratinés nouveaux du Tithonique. *Bulletin de la Société géologique de France* 3 (XXV), 843–851.
- Parona, C.F., 1905. Nuove osservazioni sulla fauna dei calcari con *Ellipsactinia* dell'isola di Capri. *Rendiconti della Real Accademia dei Lincei, Scienze fisiche, matematiche e naturali* XVI, 59–69.
- Pchelintsev, V.F., 1959. Rudisty Mezozoya gornogo Kryma. *Geologicheskii Musei A.P. Karpinski. Akademia Nauk, USSR*, p. 178.
- Pictet, F.J., 1868. Etude provisoire des fossiles de la Porte de France, d'Aizy et de Lemenc. *Mélanges paléontologiques*. *Bulletin de la Société géologique de France* 2 (XXVI), 588–604.
- Poisson, A., 1974. Présence de Jurassic et de Crétacé inférieur à faciès de type plate-forme dans l'autochtone lycien près d'Antalya (massif des Bey Daglari s.l., Turquie). *Comptes rendus de l'Académie des sciences, Paris* 278, 835–838.
- Poisson, A., 1985. The extension of the Ionian trough into southwest Turkey. In: Dixon, J.E., Robertson, A.H.F. (Eds.), *The geological evolution of the Eastern Mediterranean*. Special publication of the Geological Society, London, 17, pp. 241–249.
- Radoicic, R., 1969. A new Lower Cretaceous dasycladacea: *Clypeina pejovici*, and note on some *Clypeina*. *Geologica Romana* VIII, 71–84.
- Radoicic, R., 2005. New dasycladales and microbiota from the lowermost Valanginian of the Mirdita zone. *Annales géologiques de la péninsule Balkanique* 66, 27–53.
- Rasser, M.W., Fenninger, A., 2002. Jurassic/Cretaceous dasycladalean algal stratigraphy in the Northern Calcareous Alps: a critical review and a palaeobiogeographic approach using similarity indices. *Research Advances in calcareous algae and microbial carbonates*, Bucur, I.I. and Filipescu, S. Edits. Cluj University Press., pp. 167–190.
- Redmond, C.D., 1964. Lituolid foraminifera from the Jurassic and Cretaceous of Saudi Arabia. *Micropaleontology* 10 (4), 405–414.
- Renngarten, V.P., 1950. Rudistovye fauni melovich otlojenii Zakavkasja. *Trudy Institut Geologii Nauk* 180 (51), 1–92.
- Rigaud, S., Blau, J., Martini, R., Rettori, R., 2013. Taxonomy and phylogeny of the Trocholinitidae (Involutinina). *Journal of Foraminiferal Research* 43 (4), 317–339.
- Rojay, B., Altiner, D., 1998. Middle Jurassic–Lower Cretaceous biostratigraphy in the Central Pontides (Turkey): remarks on palaeogeography and tectonic evolution. *Rivista Italiana di Paleontologia e Stratigrafia* 104 (2), 167–180.
- Russo, A., Morsilli, M., 2007. New insight on architecture and microstructure of *Ellipsactinia* and *Sphaeractinia* (Demosponges) from the Gargano promontory (Southern Italy). *Geologica Romana* 40, 1–16.
- Salvini-Bonnard, G., Zaninetti, L., Charollais, J., 1984. Les foraminifères du Crétacé inférieur (Berriasien moyen–Valanginien inférieur) de la région de la Corrairie, Grand Salève (Haute-Savoie, France): inventaire préliminaire et remarques stratigraphiques. *Revue de Paléobiologie* 3 (2), 175–184.
- Sanders, D., Lukesch, M., Rasser, M., Skelton, P.W., 2007. Shell beds of dicertid rudists ahead a low-energy gravelly beach (Tithonian, Northern calcareous Alps, Austria). *Palaeoecology and taphonomy*. *Austrian Journal of Earth Sciences* 100, 186–199.
- Sano, S.I., Skelton, P.W., 2010. *Epidiceras* (Bivalvia, Hippuritoidea) from the Tithonian–Berriasian Torinosu-type limestones of the Sakawa area, southwest Japan. *Turkish Journal of Earth Sciences* 19 (6), 733–743.
- Sano, S., Skelton, P.W., 2011. A late Jurassic–earliest Cretaceous primitive uncoiled rudist from southwest Japan and its significance for the early evolutionary history of rudists. *Ninth International Congress on rudist Bivalves*, Kingston, Jamaica. Abstracts, pp. 8–9.
- Sarı, B., 2006. Upper Cretaceous planktonic foraminiferal biostratigraphy of the Bey Daglari autochthon in the Korkuteli area, Western Taurides, Turkey. *Journal of Foraminiferal Research* 36 (3), 241–261.
- Schlagintweit, F., 2005. *Neogyroporella? gawlicki* n. sp., a New Dasycladale from the Upper Jurassic–Lower Cretaceous “Lärchberg Formation” of the Northern Calcareous Alps, Austria. *Geologica Croatica* 58 (2), 103–117.
- Schlagintweit, F., 2010. Taxonomic revision of Late Jurassic “*Lithocodium aggregatum* Elliott” sensu Schmid and Leinfelder, 1996. *Jahrbuch der Geologischen Bundesanstalt* 393–406. Band 150, 3–4, 5.
- Schlagintweit, F., Eblil, O., 1999. New results on microfacies, biostratigraphy and sedimentology of late Jurassic–early Cretaceous platform carbonates of the Northern calcareous Alps. *Abhandlungen der Geologischen Bundesanstalt* 56, 379–418.
- Schlagintweit, F., Eblil, O., 2000. Short note on *Clypeina catinula* Carozzi, 1956 (dasycladale) from the late Jurassic–early Cretaceous of the northern calcareous Alps (Lofer member, Austria). *Revue de Paléobiologie, Genève* 19 (2), 465–473.
- Schneider, S., Harzhauser, M., Kroh, A., Lukeneder, A., Zuschin, A., 2013. Ernstbrunn limestone and Klentnice beds (Kimmeridgian–Berriasian, Waschberg–Zdanice unit, NE Austria and SE Czech republic): state of the art and bibliography. *Bulletin of Geosciences*, Prague 88 (1), 105–130.
- Senowbari-Daryan, B., Bucur, I.I., Abate, B., 1994. Upper Jurassic calcareous algae from the Madonie Mountains, Sicily. *Beitrag zur Paläontologie* 19, 227–259.



- Serban, D., Bucur, I.I., Sasaran, E., 2004. Micropaleontological assemblages and microfacies characteristics of the Upper Jurassic limestones from Caprioara-Pojoga (Mures Trough). *Acta Palaeontologica Romaniae* 4, 475–484.
- Skelton, P.W., 1978. The evolution of functional design in rudists (Hippuritacea) and its taxonomic implications. *Philosophical Transactions of the Royal Society of London, B* 284, 305–318.
- Skelton, P.W., 1985. Preadaptation and evolutionary innovation in rudist bivalves. *Special papers in Palaeontology* 33, 159–173.
- Skelton, P.W., 1999. Synoptic guide to Kimmeridgian rudists for the Kelheim field visit. *Erlangen geologische Abhandlungen, sonderband* 3, 83–88.
- Skelton, P.W., 2013. Rudist classification for the revised *Bivalvia* volumes of the “Treatise on Invertebrate Palaeontology”. *Caribbean Journal of Earth Sciences* 45, 9–33.
- Sokac, B., Velic, I., 1976. *Linoporella svilajensis* n. sp. (calcareous algae, dasycladaceae) from the Upper Jurassic?-Lower Cretaceous? Limestone of Mt Svilaja, southern Croatia (Dalmatia). *Geoloski vjesnik* 29, 173–179.
- Sotak, J., 1987. Protopenneroplide foraminifers from lowermost Cretaceous of the Stramberk carbonate platform (outer western Carpathians). *Geologica Carpathica* 38 (6), 651–667.
- Stanton, T.W., 1947. Studies of some Comanche pelecypods and gastropods. *Geological Survey, Professional papers*. 211, p. 253.
- Şenel, M., 1997. 1:000 000 ölçekli Türkiye Jeoloji haritaları, No:1, Fethiye-L 7 paftası. Maden Tetkik ve Arama Genel Müdürlüğü, Ankara, p. 17.
- Şengör, A.M.C., Yılmaz, Y., 1981. Tethyan evolution of Turkey: a plate tectonic approach. *Tectonophysics* 75, 181–241.
- Uta, A., Bucur, I.I., 2003. Microbial structures and microencrusts in the Upper Jurassic-Lower Cretaceous deposits from Buila-Vanturarita massif (South Carpathians). *Studia Universitatis Babeş-Bolyai. Geologia XLVIII* (2), 3–14.
- Vasicek, Z., Skupien, P., 2013. Early Berriasian ammonites from the Stramberk limestone in the Kotouc quarry (Outer Western Carpathians, Czech republic). *Annales Societatis Geologorum Poloniae* 83 (4), 329–342.
- Yanin, B.T., 1985. Rudistae *Matheronia* from Lower Valanginian of the Crimea. *Paleontologia Zborny (Lvov)* 22, 25–30 (in Russian).
- Yanin, B.T., 1989. The Jurassic and Cretaceous rudists: stratigraphical and geographical distribution. *Academy Nauk USSR, Moscow*, p. 214 (in Russian).
- Yılmaz, İ.Ö., 1999. Taxonomic and palaeogeographic approaches to the dasyclad algae in the Upper Jurassic (Kimmeridgian)- Upper Cretaceous (Cenomanian) peritidal carbonates of the Fele (Yassibel) area (Western Taurides, Turkey). *Turkish Journal of Earth Sciences* 8, 81–101.
- Yin, T., 1931. Etude de la faune du Tithonique coralligène du Gard et de l'Hérault. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de Lyon XVII*, 200. Mémoire 14.