POST-MEETING FIELD TRIP (2)

EIGHTH INTERNATIONAL CONGRESS ON RUDISTS
CRETACEOUS RUDISTS AND CARBONATE PLATFORMS
June 23-25, 2008, İzmir-Turkey

IRC 8
EXCURSION GUIDE

Post-meeting Field Trip (2)
June 26-27, 2008

Rudist-bearing marbles of the metamorphic Menderes Massif and the Upper Cretaceous limestones of the Bey Dağları carbonate platform (western Turkey)

Sacit ÖZER* (excursion leader of the Menderes Massif),
Bilal SARI* (excursion leader of the Bey Dağları carbonate platform)

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Front cover photographs:
Panaromic view of the Upper Cretaceous rudist-bearing neritic limestones of the Bey Dağları carbonate platform at the peak of the Susuz Dağ, Western Taurides.

Back cover:
Field Trip route map

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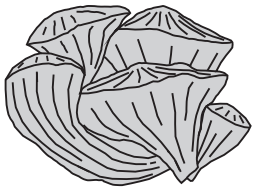
RUDIST-BEARING MARBLES OF THE METAMORPHIC MENDERES MASSIF AND THE UPPER CRETACEOUS LIMESTONES OF THE BEY DAĞLARI CARBONATE PLATFORM (WESTERN TURKEY)



Sacit ÖZER* (excursion leader of the Menderes Massif),
Bilal SARI* (excursion leader of the Bey Dağları Carbonate Platform)

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INTRODUCTION

In this field-trip, the rudist-bearing sequences of the metamorphic Menderes Massif and the Bey Dağları carbonate platform located in western Turkey will be visited (Fig. 1).

The geological setting and the description of the stops of these areas are as follow:

1. MENDERES MASSIF

Geological setting

The Menderes Massif is located in the western Turkey between the İzmir-Ankara Zone to the north and Lycian nappes to the South (Fig. 1A,B), and consists of, according to the long-established geological concepts (Schuiling, 1962; Brinkmann, 1967; Başarır, 1970; Boray et al.1973; Dürr, 1975; Çağlayan et al. 1980; Şengör et al. 1984; Konak et al. 1987; Okay, 1989; Dora et al. 1992; Candan et al. 2001; Özer et al. 2001; Güngör and Erdoğan, 2001; Bozkurt and Oberhansli, 2001; Erdoğan and Güngör, 2004), from bottom to top, core series (Late Proterozoic paragneiss-schist sequence intruded by Precambrian-Cambrian orthogneiss and metagabbros) and cover series (Paleozoic-Mesozoic-Lower Senozoic schists, platform-type marbles and blocky unit) (Fig. 1B). However, in contrary to the many previous studies mentioned above, the pile of nappe structure of the Menderes Massif (Dora et al. 1995; Ring et al. 1999; Gessner et al. 2001; Régnier et al. 2003) and also eastward lateral continuation of the Cycladic Masif to the whole or some parts of the cover rocks in the western Anatolia have been recently suggested (Candan et al., 1997; Oberhänsli et al. 2001; Ring et al. 1999, 2001, 2007; Okay, 2001; Rimmelé et al. 2003). According to the previous studies, the main Menderes metamorphism took place during the Late Eocene as a consequence of the southward transportation of the Lycian nappes and burial of the Menderes Massif beneath this nappe pile (Şengör et al. 1984; Konak et al. 1987; Okay, 1989; Dora et al. 1992; Oberhänsli et al. 2001; Ring et al. 1999; Rimmelé et al. 2003).

The uppermost part of the Mesozoic sequence of the Menderes Massif is dominated by platform-type carbonates and consists of, from bottom to top, emery-bearing marbles and rudist-bearing marbles (Milas Formation), reddish pelagic marbles (Kızılağaç Formation) and flysch-like rocks (Kazıklı Formation) (Fig. 2). This sequece was metamorphosed to greenschist/blueschist-facies conditions and contains a few datable fossils. Rudists of the Milas Formation form the main palaeontological database (Dürr, 1975; Özer, 1993, 1998); however the planktonic foraminifers are also found in the Kızılağaç and Kazıklı Formation by Özer (1998) and Özer et al. (2001).

The first announcement of the rudists was made by Dürr (1975) in the Akbük-Milas area (southwestern of Menderes Massif), and later around southeast of Milas by Çağlayan et al. (1980) and Konak et al. (1987). The detailed palaeontological studies of rudists were carried out by Özer (1993, 1998, 1999, 2002, 2006), Özer and Sözbilir (2003), Özer et al. (2001, 2007), Özer and Sarı (2008) and Garcia-Garmilla et al. (2004), which show that the rudists have a wide geographic distribution in the Menderes Masif (Fig. 1B). These studies allowed to recognition of three separate rudist associations of middle-late Cenomanian, late Turonian and Santonian-Campanian in age, which will be presented in the following stops:

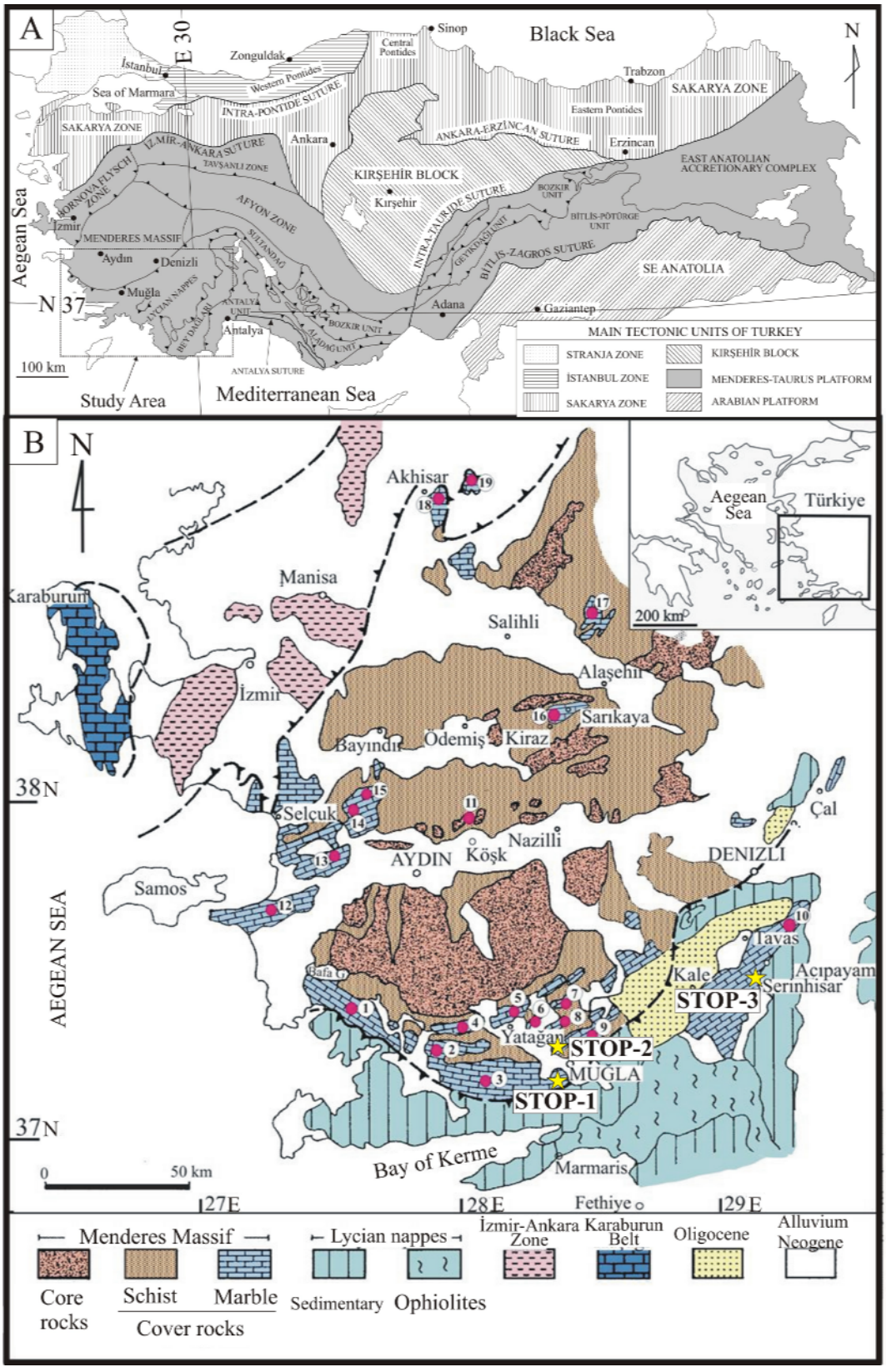


Fig.1. A) Structural map of Turkey showing the study area (after Görür and Tüysüz, 2001). B) Simplified geological map of the western Turkey showing the location of the Menderes Massif between the tectonic belts of the İzmir-Ankara zone to the north and Lycian thrust sheets to the south (after Brinkmann, 1967; Dürr, 1975; Çağlayan et al., 1980; Konak et al., 1987) and also the distributions of the rudist localities (red dots) (after Özer, 1993, 1998, 1999; Özer et al., 2001 and 2007; Özer and Sözbilir, 2003) and field trip stops (yellow stars).

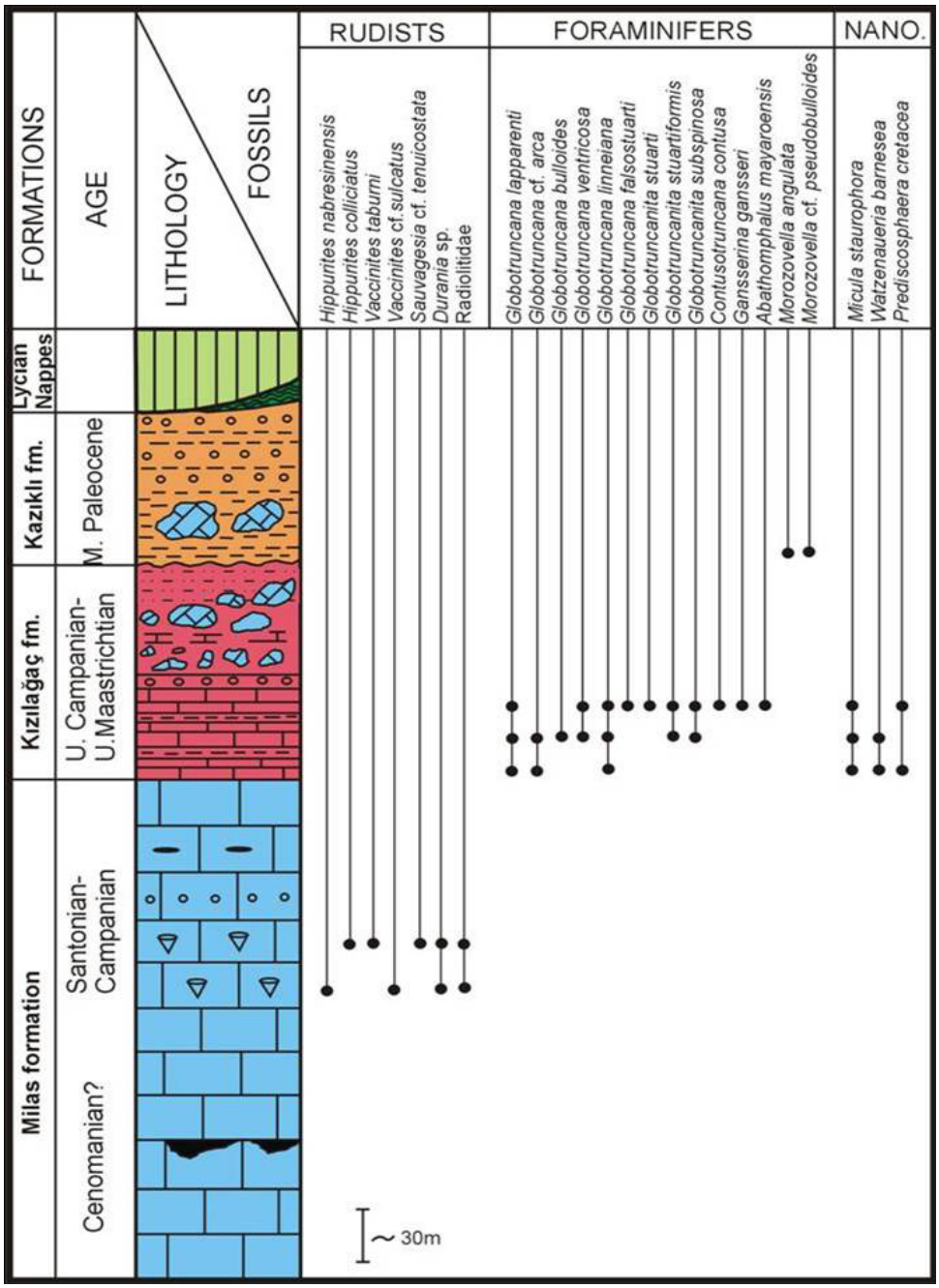


Fig. 2. Generalized stratigraphic section of the Upper Cretaceous-Paleocene sequence of the Menderes Massif aroun Milas area, showing the distribution of the rudists, planktic foraminifers and nanoplanktons (after Özer, 1998; Özer et al., 2001 and 2007).

FIELD TRIP ITINERARY

DAY-1: June 26th, 2008

Stop-1: Çiftlikköy-Muğla

The Milas Formation widely crops out in the Muğla area and is represented mainly by massive, gray, dark-gray, very thick (more than 600 m) marbles without fossils. Around Çiftlikköy, Yeniköy villages and northern of Meke village (Fig.1B), these marbles pass upward to the grayish-gray marbles with rudists. The stratigraphic section from these rudist-bearing marble succession (Fig. 3) allows us to distinguish seven levels of which detailed lithological and facies characteristics and fossil contents are described below:

***-intraformational carbonate breccias (level A)*:** the 20-m-thick, massive, bituminous and dark gray intraformational carbonate breccias constitue the lowermost part of the section. The components of the breccias are complately pebble-size carbonate clasts having angular shape.

***-lower rudist-bearing marbles (level B)*:** approximately 40-m-thick, massive, bituminous and grayish-gray marbles are characterized by the presence of the rudist sections. The rudist are very rare in the 15-m-thick lower part of the level, only some *Distefanella* and probabaly hippuritid and radiolitid sections are observed. These pass upward to massive, 7-m-thick, dolomitic and bituminous, gray rudist-bearing marbles interbedded with intraformational breccias. Towards the upper part of the level, 10-m-thick marbles contain very abundant rudists, which are dominated by *Distefanella bassanii* Parona (Fig. 3). Besides, biostratigraphically important species such as *Vaccinites inferus* (Douvillé), *Vaccinites* sp. (aff. *praegiganteus*), *Hippurites socialis* Douvillé and *Radiolites* sp. are determined (Fig. 3). Many small hippuritid and radiolitid sections, which can not be recognized are also observed. The 8-m-thick intraformational breccias of the uppermost part of the level contains rare rudist sections (*Distefanella* sp.).

***-massive marbles (level C)*:** the 20-m-thick, massive, gray marbles overlie the previous level and separates the level B from the level D. This level is barren of rudists and other fossils.

***-upper rudist-bearing marbles (level D)*:** the 80-m-thick, locally bituminous, gray, dark gray marble succesion is characterized by existence of the rudist and also some coral sections. The rudists are observed as three separate horizons in the succession, which are indicated in figure 3. The 12-m-thick lowermost part of the level contains rare rudist sections (Fig. 3D1) and passes upward the 38-40-m-thick rich rudist-bearing first horizon (Fig. 3D2), which is dominated by *Distefanella bassanii* Parona, *Distefanella raricostata* Sliskovic and some hippuritids such as *Hippurites socialis* Douvillé, *Hippurites resecta* (Defrance), *Vaccinites* aff. *praegiganteus* (Toucas) (Fig. 3). The many unidenfiable radiolitid sections are also present. The streched rudist sections can easily be observed. Especially the thick-walled radiolitid and hippuritid sections nicely show the metamorphism effects (Fig. 3).

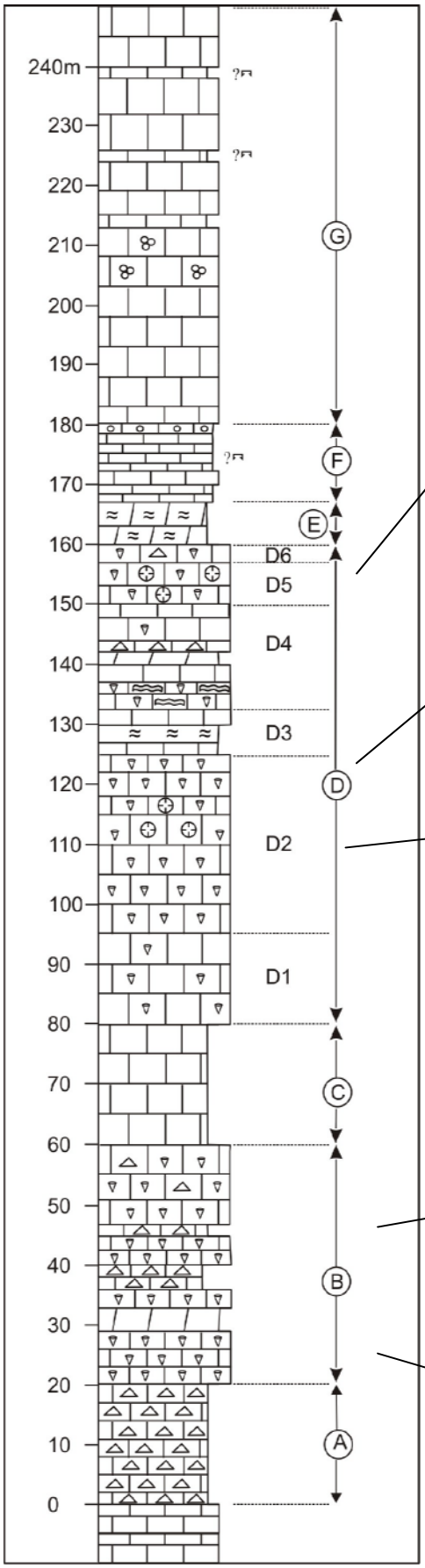
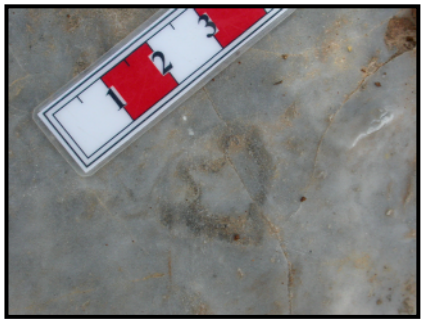
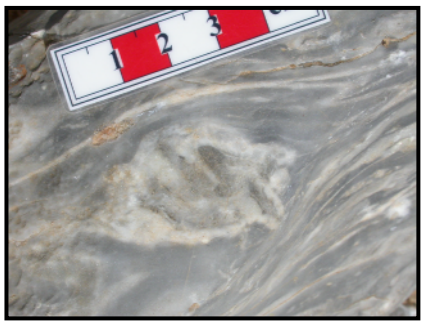


Fig. 3. Çiftlikköy measured-stratigraphic section and rudist photographs (Stop-1).

Hippurites resecta **(level-D)**



Hippurites socialis **(level-D)**



The streched rudist sections (probably hippuritid) **(level-D)**

Vaccinites inferus **(level-B)**

Distefanella bassanii **(level-B)**

Despite the metamorphism small hippuritid and radiolitid accumulations (build-ups) are observed. These beds are also contain hermatypic coral sections. These rudist-rich marbles pass upward to the 10-12-m-thick gray, fine crystalized marbles and dolomitic marbles without fossils (Fig. 3,D3) and to the 3-5-m-thick second horizon, which contains abundant *Distefanella* and some small hippuritid and radiolitid sections. The section continues upward to the 12-m-thick, rare rudist-bearing marbles and dolomitic marbles with local cryptalgal lamination and intraformational breccia (Fig. 3,D4). The succession ends with the 3-4-m-thick third rudist- and coral-bearing marble horizon (Fig. 3,D5) and the overlying 6-7-m-thick intraformational breccias with rare rudist sections (radiolitids and small hippuritids) (Fig. 3,D6).

***-dolomitic marbles (level E)*:** the 5-m-thick gray dolomitic marbles are observed over the level D. The marbles of this level contain cryptalgal lamination and separate the level F from the level D.

- pinkish-grayish laminated marbles (level F): the 18-20-m-thick, generally thin-bedded, pinkish-grayish marbles are observed over the dolomitic marbles. This level starts with pinkish-grayish marbles and continues upward with gray, fine crystalized marbles, gray marbles and pinkish-reddish marbles, which includes gray marble pebbles and laminated beds. In the gray marbles, some recristallized eye-shaped parts are observed in thin sections, which could be 'ghosts' of planktonic foraminifera sections.

***-massive marbles interbedded with pinkish-reddish marbles (level G)*:** the 60-70-m-thick, grayish-white, sometimes bituminous, fine crystallized marbles interbedded with pinkish marbles are observed at the uppermost part of the succession. In the middle part of the level, grayish bituminous marbles contain preserved determinable miliolid sections. At the uppermost part of the level, the interlayers of pinkish marbles yield the planktonic foraminifera 'ghosts' observed in the underlying level.

The rudist fauna observed in the marbles indicate a late Turonian age. The rudist association of this locality is resembles the assemblages determined recently from the upper Turonian of the Bey Dağları carbonate platform, western Taurides, Turkey by Sarı et al., (2004), Sarı (2006), Özer (2006), Sarı and Özer (2008). The rudist associaton of this area is also consistent with the biostratigraphic data presented by Sánchez (1981) and Steuber (2002), which also reported similar associations from the western and central Mediterranean regions.

The succesion can be separeted in two parts (Fig. 3), from bottom to top, the neritic (first five levels, A-E) and pelagic (levels F-G) parts indicating the change of the late Turonian dominant shallow marine conditions (peritidal) to the subsequent pelagic conditions because of the slight drowning of the platform.

Stop-2: Bozarmut village-Yatağan

(This stop will be visited if enough time is available)

The marbles of the Milas Formation are well observed in the Yatağan area. At this locality, the formation consists of, from bottom to top (Fig. 4) mica schists, emery-bearing marbles, dolomitic marbles and rudist-bearing marbles with nearly vertical dipping (Özer, 1998; Özer et al., 2001, 2007).

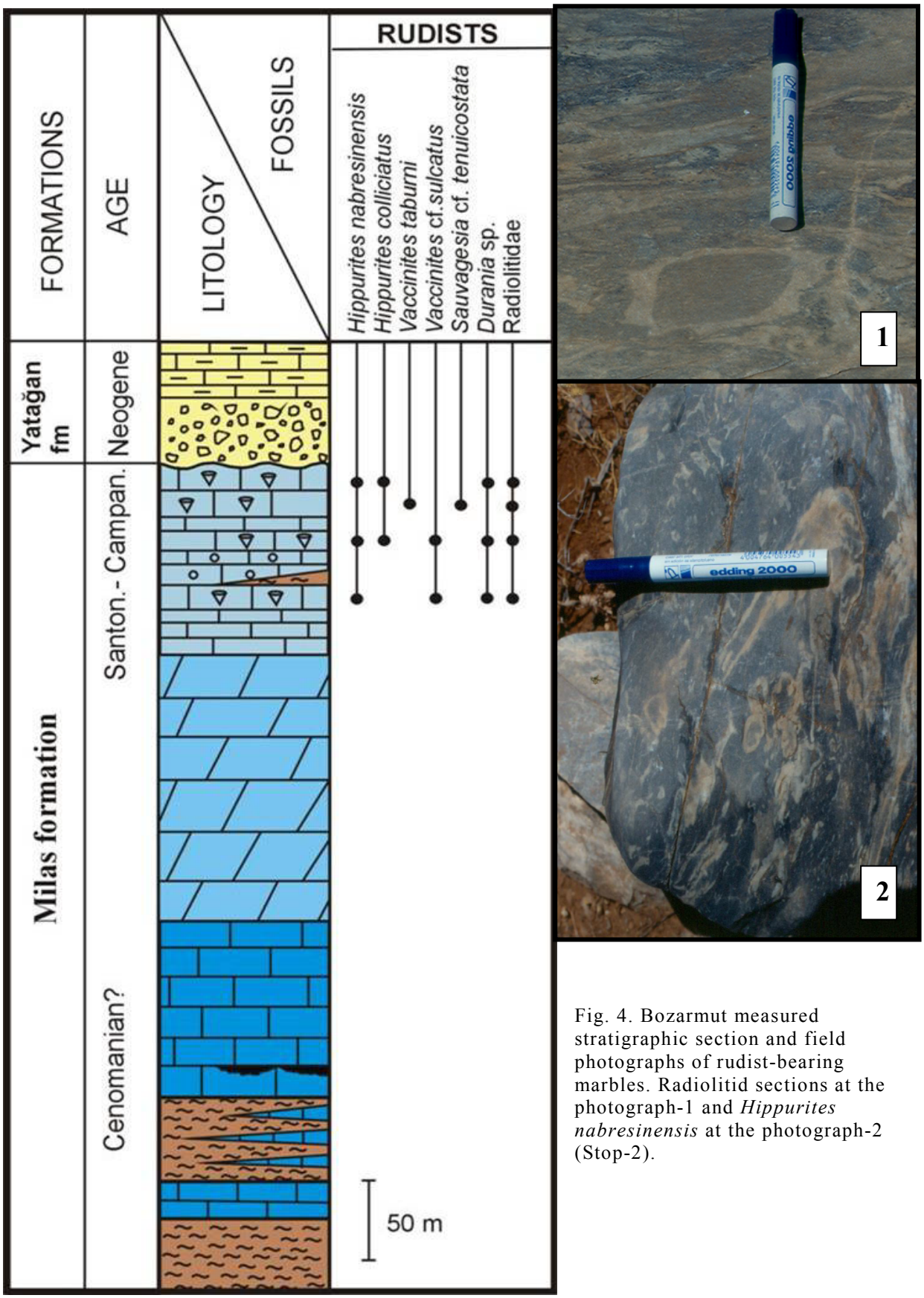


Fig. 4. Bozarmut measured stratigraphic section and field photographs of rudist-bearing marbles. Radiolitid sections at the photograph-1 and *Hippurites nabresinensis* at the photograph-2 (Stop-2).

The mica schists contain 1-3-m-thick and 5-100-m-long marble lenses. A gradiotional transition between the mica schists and emery-bearing marbles is observed. The emery-bearing marbles grade upwards into massive dolomitic marbles and rudist-bearing marbles. This marble succession contains mica-schist lenses and intraformational metaconglomerates. The rudist sections are generally elongated and deformed due to metamorphizm, however some hippuritids such as *Hippurites nabresinensis* Futterer, *Hippurites* aff. *colliciatus* Woodward, *Vaccinites* sp. (probabaly *sulcatus*) and radiolitids (probably *Sauvagesia* sp. and *Durania* sp.) can be determined (Fig. 4). The rudist-bearing marbles also contain rare coral sections. The rudist fauna suggests a Santonian-Campanian age for the Milas Formation.

Although, the Milas Formation is unconformably overlain by the Neogen Yatağan Formation at this locality, the rudist-bearing marbles grade upwards into thick, grey marbles and then pass into reddish pelagic marbles of the Kızılağaç Formation around Yatağan and Milas. The planktonic foraminifers and nanoplanktons indicating a late Campanian-late Maastrichtian age are found from the reddish marbles of the Kızılağaç Formation (Özer, 1998; Özer et al., 2001, 2007).

Stop-3: Serinhisar-Tavas

(in collaboration with Peter W. Skelton)

The cover rocks of the Menderes Massif crop out over a large area extending from south of Kale to Tavas and south-east of Denizli (Fig. 1B). Mesozoic monotonous platform-type neritic marbles are observed in a major NE-SW striking mountain chain extending south-east of Tavas to Denizli. According to the previous studies, the metamorphic rocks of the massif have an imbricate internal structure in this area (Poisson, 1977, 1985; Okay, 1989; Özkaya, 1990; Collins and Robertson, 1999).

Previous studies (Çağlayan et al., 1980; Okay, 1989; Özkaya, 1990) recognized that rudists formed the major component of the marbles at Serinhisar locality (formerly Kızılhisar). The rudists of this locality were first studied and two rudist associations suggesting middle-late Cenomanian and Santonian-Campanian age were determined by Özer (1998) and Özer et al. (2001). According to Okay (1989), the contact between the rudist-bearing marbles (Yılanlı Formation) and the overlying serpentinite breccias and red-pinkish metamudstones (Zeybekölentepe Formation) is conformable.

However, Özer et al. (2001) considered this contact to be an unconformity because of (1) there is no transition from the carbonate-dominated Yılanlı Formation to the overlying coarse detritic deposits of the Zeybekölentepe Formation and (2) the Zeybekölentepe Formation rests on the different levels of the Yılanlı Formation.

Our recent observations (Özer et al., 2007; personal communication with Peter W. Skelton in the field study, 2007) clarify the contact problem and show that the rudist-bearing marbles are in block position within an olistostromal megabreccia unit at this locality (Fig. 5). The matrix of the unit consists of generally reddish metaclastics. The components of the megabreccias are mainly serpentinite and marble clasts (Figs. 6 and 7). Some clasts have diameter about 100-150-cm.

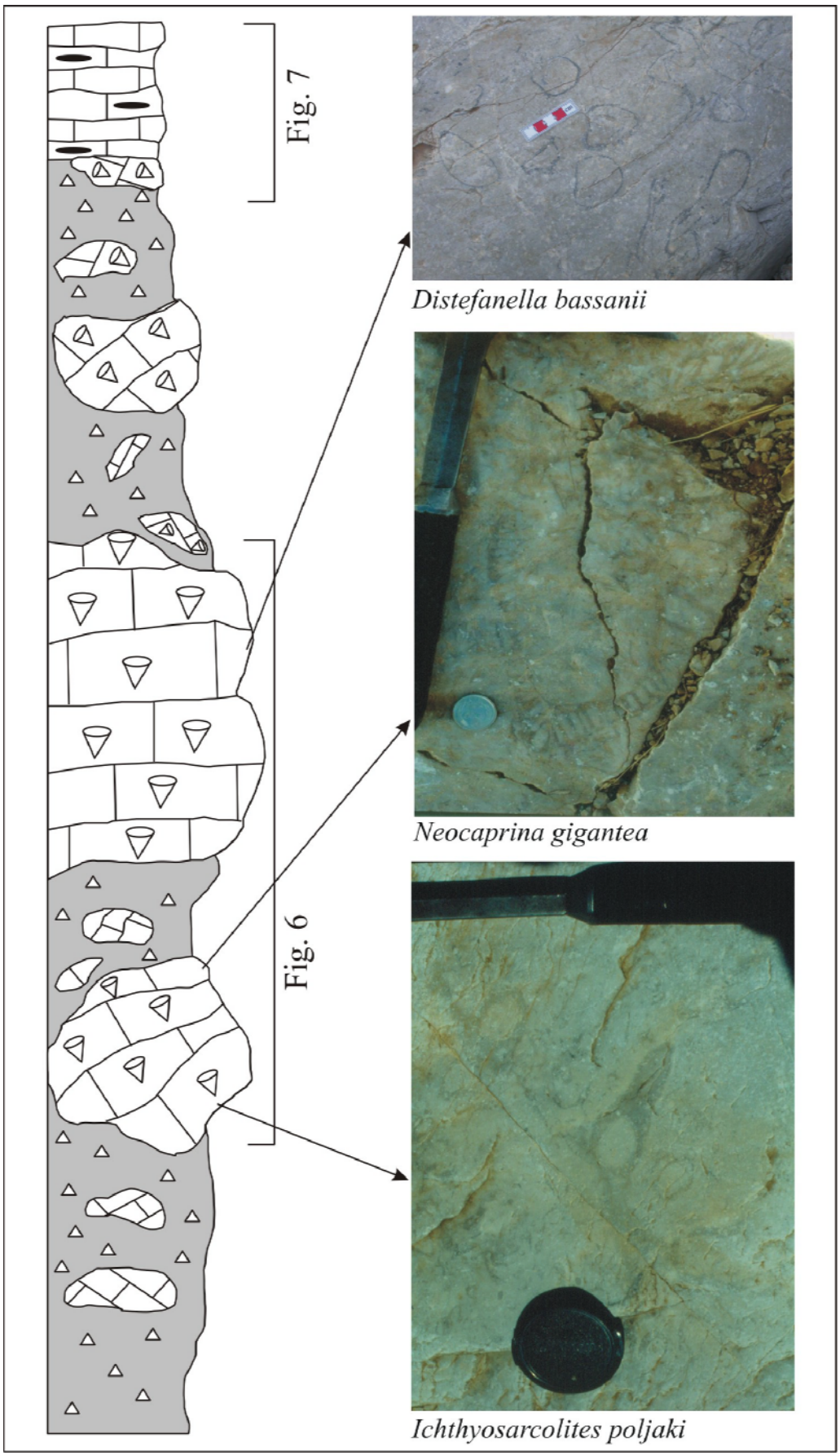


Fig. 5. Schematic columnar section of the Serinhisar locality (Stop-3) showing position of the rudist-bearing limestone blocks within the megabreccia unit.

Fig. 6. Rudist-bearing marble blocks within an olistostromal megabreccia unit, Serinhisar locality (Stop-3).

Fig. 7. Reddish metaclastic matrix of the megabreccia unit containing serpentinite and marble clasts and blocks, Serinhisar locality (Stop-3).

However, the rudist-bearing marbles are large-size block (approximately 100 m in diameter) in the olistostromal matrix.

Some marble blocks contain typical middle-late Cenomanian rudist association (Özer, 1998; Özer et al.,2001): *Ichthyosarcolites tricarinatus* Parona, *I. bicarinatus* (Gemmellaro), *I. poljaki* Polsak, *Sphaerucaprina* cf. *forojuliensis* Boehm, *Neocaprina gigantea* Plenicar, *Schisois* cf. *schiosensis* Boehm and *Caprina schiosensis* Boehm (Fig. 5). *Eoradiolites* sp., *Apricardia* sp. and *Chondrodonta* sp. are also associated with this fauna. This association is well known from the Cenomanian (middle-upper) beds of the Apulian platform (Sánchez, 1981; Steuber, 2002) and also in the Bey Dağları carbonate platform (Özer, 1988; Sarı, 2006; Sarı & Özer, 2008).

Some marble blocks consists mainly of distefanellid sections. The sections of *Distefanella bassanii* Parona are abundant (Fig. 5). However, some sections belong probably to *D.* cf. *montagnei* Sliskovic and also a new species *D. tavassiana* Özer (Özer, 1999; Özer et al., 2001). Besides some hippuritid sections are also found in the marble blocks.

Conclusions

Biostratigraphic data obtained from rudists of the metamorhic Menders Masif, reveal the presence of three different associations, which are as follows (Table-1):

1) 'caprinid association' is observed in a sliver of the Massif around Serinhisar (Kızılhisar) area (SE of Tavas) and comprises *Neocaprina gigantea* Plenicar, *Caprina schiosensis* Boehm, *Schiosia* cf. *schiosensis* Boehm, *Sphaerucaprina* cf. *forujuliensis* Boehm, *Ichthyosarcolites bicarinatus* (Gemmellaro), *Ichthyosarcolites triangularis* Desmarest, *Ichthyosarcolites poljaki* Polsak, *Distefanella tavasiana* Özer, *Eoradiolites* cf. *liratus* Conrad, *Durania* sp., *Chondrondonta* sp., which suggest a middle-late Cenomanian age.

2) 'hippuritid association' is observed within the marbles of the Çiftlikköy-Yeniköy area (NW of Muğla). The rudist association comprising *Hippuritella resecta* (Defrance), *Hippurites socialis* Douvillé, *Vaccinites inferus* (Douvillé), *Vaccinites* cf. *praegiganteus* (Toucas), *Distefanella bassanii* Parona, *Distefanella raricostata* Sliskovic ve *Distefanella* cf. *heraki* Sliskovic suggests a late Turonian age. The association is accompanied by *Radiolites* sp., *Milovanovicia* sp., *Biradolites* sp., *Durania* sp., hermatipyc corals and gastropods.

3) 'hippuritid-radiolitid association' is widespread in the marbles of the Massif and observed in the southern part (Akbük, Asinyeniköy, Milas, Akdağ, Yatağan, Bozarmut and Eyli Tepe), central part (N of Köşk and around Eğrikavak village) and northern part of the Massif (aroud Kurşak, Tuzburgaz and Gülbahçe villages). The association made up of *Hippurites nabresinensis* Futterer, *Hippurites colliciatus* Woodward, *Vaccinites taburni* Guiscardi, *Vaccinites* cf. *sulcatus* Defrance, *Sauvagesia* cf. *tenuicostata* Polsak, *Durania* sp.and unidentifiable radiolitid sections, indicates Santonian-Campanian.

STAGE		RUDIST ASSOCIATIONS
UPPER CRETACEOUS	Maastrichtian	
	Campanian	HIPPURITID-RADIOLITID ASSOCIATION
	Santonian	
	Coniacian	
	Turonian	HIPPURITID ASSC.
	Cenomanian	CAPRINID ASSOCIATION

Table-1. Upper Cretaceous rudist associations of the metamorphic Menderes Massif (after Özer, 1993, 1998, 1999, 2006; Özer and Sözbilir, 2002; Özer et al., 2001, 2007).

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References

Başarır, E., 1970. Geology and petrography of the southern margin of the Menderes Massif to the east of Lake Bafa. Faculty of Science Publications, Ege University, İzmir, 102 p. (in English with Turkish abstract).

Boray, A., Akat, U., Akdeniz, N., Akçaören, Z., Çağlayan, A., Günay, E., Korkmazer, B., Öztürk, E.M., Sav, H., 1973. Menderes Masifinin güney kenarı boyunca bazı önemli sorunlar ve bunların muhtemel çözümleri. Cumhuriyetin 50. yılı Yerbilimleri Kongresi Kitapçığı, General Directorate of Mineral Research and Exploration Institute of Turkey Publications, 11-20.

Bozkurt, E., Oberhänsli, R., 2001. Menderes Massif (western Turkey): structural, metamorphicand magmatic evolution-a synthesis. International Journal of Earth Sciences, 89: 679-708.

Brinkmann, R., 1967. Die Südflanke des Menderes-Massivs bei Milas, Bodrum und Ören. Scientific Reportsof Faculty Science of Ege University, İzmir, no 43.

Candan, O., Dora, O.Ö., Oberhänsli, R., Oelsner, F., Dürr, S., 1997. Blueschist relics in the Mesozoic cover series of the Menderes Massif and correlations with Samos island, Cyclades. Schweiz. Mineral. Petrogr. Mitt., 77, 95-97.

Candan, O., Dora, O.Ö., Oberhänsli, R., Çetinkaplan, M., Partzsch, J.H., Warkus, F., Dürr, S., 2001. Pan-African high-pressure metamorphism in the Precambrian basement of the Menderes Massif, Western Anatolia, Turkey. International Journal of Earth Science (Geologische Rundschau), 89, 4,793-811.

Collins, A.S., Robertson, A.H.F., 1999. The Lycian Melange, South-west Turkey: an emplaced ccretionary complex. Geology, 25: 255-258.

Çağlayan, A.M., Öztürk, E.M., Öztürk, Z., Sav, H., Akat, U., 1980. Structural observations on the southern Menderes Massif. Jeoloji Mühendisleri Dergisi, 10: 9-18.

Dora, O.Ö., Kun, N., Candan, O., 1992. Metamorphic history and geotectonic evolution of the Menderes Massif. Savaşçın, M.Y.and Eronat, A.H. : (eds.), Proceedings of International Earth Sciences Congress on Aegean Regions 1990, Dokuz Eylül University Publications, 2: 107-115.

Dora, O.Ö., Candan, O., Dürr, S., Oberhänsli, R., 1995. New evidence on the geotectonic evolution of the Menderes Massif. Pişkin, Ö. Ergün, M. Savaşçın, M.Y. and Tarcan, G. (eds)., Proceedings of International Earth Sciences Congress on the Aegean Regions 1995, Dokuz Eylül University Publications, 53-72.

Dürr, S., 1975. Über Alter und geotektonische Stellung des Menderes-Kristallins/SW-Anatolien und seine Aequivalente in der mittleren Aegaeis. PhD Thesis, Univ. Marburg/Lahn, Germany, 106 p.

Erdoğan, B., Güngör, T., 2004. The problem of the Core-Cover boundary of the Menderes Massif and emplacement mechanism for regionally extensive gneissic granites, western Anatolia (Turkey). Turkish Journal of Earth Sciences, 13: 15-36.

Garcia-Garmilla, F., Özer, S., Sarı, B., 2004. Cathodoluminescence and metamorphism in rudist shells from the Upper Cretaceous marbles of Menderes Masif (western Turkey). Geogaceta, 36: 167-170.

Gessner, K., Ring, U., Passchier, C.W., Güngör, T., 2001. How to resist subduction: evidence for large-scale out-of-sequence thrusting during Eocene collision in western Turkey. Journal of the Geological Society (London), 158: 769–784.

Görür, N., Tüysüz, O., 2001. Cretaceous to Miocene Palaeogeographic evolution of Turkey: Implications for hydrocarbon potential. Journal of Petroleum Geology, 24 (2), 1-28.

Güngör, T., Erdoğan, B., 2001. Tectonic significance of the Mesozoicmafic volcanic rocks in the Menderes Massif, west Turkey. International Journal of Earth Sciences, 89: 874-882.

Konak, N., Akdeniz, N., Öztürk, E.M., 1987. Geology of the South of Menderes Massif, IGCP Project 5: Guide Book field excursion western Anatolia, Turkey. Mineral Research and Exploration Institute of Turkey Publication, 42-53.
Okay, A.İ., 1989. Geology of the Menderes Massif and the Lycian nappes South of Denizli, western Taurides. Mineral Research and Exploration Bulletin, 109: 37-51.
Okay, A.İ., 2001. Stratigraphic and metamorphic inversions in the central Menderes Massif: a new structural model. International Journal of Earth Sciences, 89: 709-727.
Oberhänsli, R., Partzsch, J.H, Candan. O and Çetinkaplan, M., 2001, First occurrence of Fe-Mg-carpholite documenting a high-pressure metamorphism in metasediments of the Lycian Nappes, SW-Turkey. Int. Journal of Earth Sciences. 89: 867-873.
Özer, S., 1988. Description de quelques rudistes à canaux dans le Cénomanien de Turquie. Géologie méditerranéenne, 15: 159-167.
Özer, S., 1993. Upper Cretaceous rudists from the Menderes Masif. Bulletin of the Geological Society of Greece (Proceedings of the 6th Congress of the Geological Society of Greece, 1990), 28, 3: 55-73
Özer, S., 1998. Rudist-bearing Upper Cretaceous metamorphic sequences of the Menderes Massif (western Turkey). Masse, J.-P.; Skelton, P.W.: (eds.), Quatrième Congrès International sur les Rudistes, Geobios, Mémoire spécial, 22: 235-249.
Özer, S., 1999. Occurrence of the genus *Distefanella* Parona (rudist, Bivalvia) in the Cenomanian beds of Western Turkey. Géologie méditerranéenne, 26: 67-77.
Özer, S., 2002. New rudist localities from the Menderes Metamorphic Masif, western Turkey. Sixth International Congress on Rudists, Rovinj 2002,Abstracts and Excursion Guidebook, 46.
Özer, S., 2006. Upper Cretaceous carbonate platforms with rudists of Turkey, biostratigraphic and palaeobiogeographic significance. Réunion Spécialisée de la Société Géologique de France ‹‹ Histoire et dynamaque des plates-formes carbonatées et de leurs biotas durant le Phanérozoïque›› Journées Jean Philip, 18&19 mai 2006, Université de Provence, Aix-Marseiile I, Livret des Résumés, 32, (conférencier invité).
Özer, S., Sarı, B., 2008. First evidence of the Upper Turonian rudist-bearing marbles in the metamorphic Menderes Massif, Muğla area, western Turkey. Biostratigraphic importance and depositional features, (in preparation).
Özer, S., Sözbilir, H., 2003. Presence and tectonic significance of Cretaceous rudist species in the so-called Permo-Carboniferous Göktepe Formation, centralMenderes metamorphic masif, western Turkey. International Journal of Earth Sciences, 92: 97-404.
Özer, S., Sözbilir, H., Özkar, İ.,Toker, V., Sarı, B., 2001. Stratigraphy of Upper Cretaceous-Palaeogene sequences in the southern and eastern Menderes Massif (western Turkey). International Journal of Earth Sciences, 89: 852-866.
Özer, S., Sarı, B., Özkar-Öngen, İ., Toker, V., 2007. Rudist, Foraminifera and Nanoplankton biostratigraphy of the Upper Cretaceous-Lower Tertiary sequence of the Menderes Massif: An approach to the age of the metamorphism and relation of the rock units. Colloquim of the Menderes Massif, Expanded Abstracts, 44-50, İzmir.
Özkaya, İ., 1990. Origin of Lycian nappes, SW Tukey. Tectonophysics, 177: 367-379.
Poisson, A., 1977. recherches géologiques dans les Taurides Occidentales (Turquie). PhD Thesis, Universté Paris-Sud (Orsay), 795pp.
Poisson, A., 1985. The extension of the Ionian trough into the southwestern Turkey. In: Dixon J.E. and Robertson A.H.F. (eds), The geological evolution of the eastern Mediterranean. Geol. Soc. London, Spec. Publ., 17: 241-249.
Régnier, J.-L., Ring, U., Passchier, C. W., Güngör, T., Gessner, K., 2003. Contrasting metamorphic evolution of metasediments from the Çine and Selimiye nappes in the southern Anatolide belt, western Turkey. J. Metamorph. Geol., 21: 699 – 721.
Rimmelé, G., Oberhänsli, R., Goffé, B., Jolivet, L., Candan, O., Çetinkaplan, M., 2003. First evidence of high-pressure metamorphism in the "Cover Series" of the southern Menderes Massif. Tectonic and metamorphic implications for the evolution of SW Turkey. Lithos, 71: 19-46.
Ring, U., Gessner, K., Güngör, T., Passchier, C.W., 1999. The Menderes Massif of western Turkey and the Cycladic Massif in the Aegean-do they really correlate? Journal of Geological Society, London, 156: 3-6.

Ring, U., Willner, A., Lackmann, W., 2001. Nappe stacking and clockwise versus anticlockwise pressure-temperature paths: An example from the Menderes nappes of western Turkey. Am. J. Sci., 301:912 – 944.

Ring, U., Will, T., Glodny, J., Kumerics, C., Gessner, K., Thomson, S., Güngör, T., Monie´, P., Okrusch, M., Drüppel, K., 2007. Early exhumation of high-pressure rocks in extrusion wedges: Cycladic blueschist unit in the eastern Aegean, Greece, and Turkey. Tectonics, 26: 2, TC2001.

Sánchez, V., 1981. Hippuritidae y Radiolitidae (Bivalvia). Catálogo de especies, Universidad Autónoma de Barcelona, Publicaciones de Geología, 15: 228 p.

Sarı, B., 2006. Foraminifera-Rudist biostratigraphy, Sr-C-Isotope stratigraphy and microfacies analysis of the Upper Cretaceous sequences of the Bey Dağları Autochthon (western Taurides, Turkey). PhD Thesis, Dokuz Eylül University, İzmir, 436 pp.

Sarı, B., Özer, S., 2008. Upper Cretaceous rudist biostratigraphy of the Bey Dağları Carbonate Platform, Western Taurides, SW Turkey. Geobios (in pres).

Sarı, B., Steuber, T., Özer, S., 2004. First record of Upper Turonian rudists (Mollusca, Hippuritoidea) in the Bey Dağları carbonate platform, Western Taurides (Turkey): taxonomy and strontium isotope stratigraphy of *Vaccinites praegiganteus* (Toucas, 1904). Cretaceous Research, 25: 235-248.

Schuiling, R. D., 1962. On petrology, age and structure of Menderes migmatic complex (SW Turkey), General Directorate of Mineral Research and Exploration Institute of Turkey Bulletin, 58: 71-84.

Steuber, T., 2002. A palaeontological database of rudist bivalves (Mollusca: Hippuritoidea, Gray,1848). http://www.paleotax.de/rudists/

Şengör, A.M.C., Satır, M., Akkök, R., 1984. Timing of tectonic events in the Menderes Massif, western Turkey: implications for tectonicevolution and evidence for Pan-African basement in Turkey, Tectonics, 3: 693-707.

2. BEY DAĞLARI CARBONATE PLATFORM

Regional geological setting and reconstruction of the Bey Dağları carbonate platform

The Bey Dağları Autochthon, which is approximately 150 km long oriented NE-SW from Kaş to Isparta (Fig. 8) represents a segment of a Mesozoic Tethyan platform on which carbonate accumulation persisted from the Triassic to the early Miocene. This segment was overthrusted by the Antalya nappes in the east and by the Lycian nappes in the northwest, and is partially exposed in the Göcek window (Özgül, 1976; Poisson, 1977; Farinacci and Köylüoğlu, 1982; Naz et al., 1992; Robertson, 1993). During the Mesozoic time, the autochthonous unit was part of a larger crustal fragment of the African palaeomargin which can be traced in the Taurides and Zagrides to the east, and the Hellenides, Dinarides and Apennines to the west (Şengör and Yılmaz, 1981; Farinacci and Köylüoğlu, 1982).

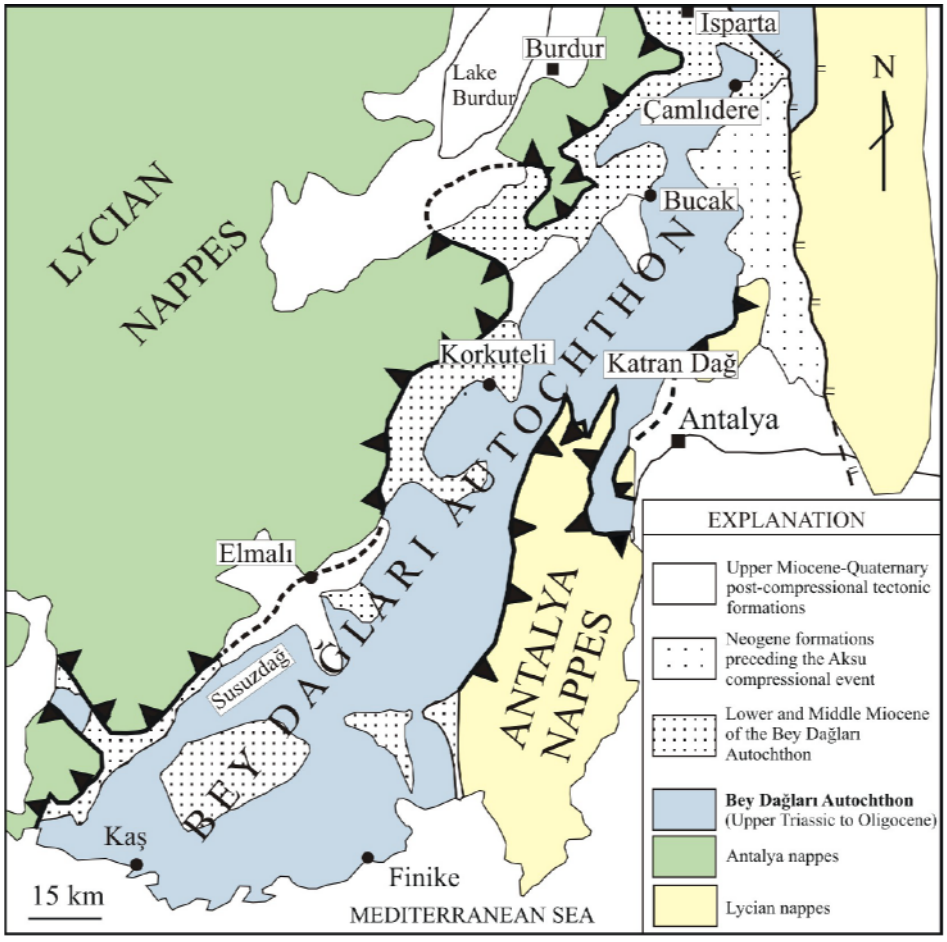

Fig. 8. Main tectonic belts of the western Taurides (simplified from Poisson et al., 1984)

The Bey Dağları carbonate platform (BDCP) was one of the many Mesozoic Tethyan carbonate platforms initiated as a result of flooding of blocks, which had rifted from the northern margin of Gondwana during Mid-Late Triassic (following Late Permian-Early Triassic rifting) throughout the southern part of the Eastern Mediterranean region (Robertson, 2002). The BDCP passed through the entire predictible geodynamic spectrum of the Wilson cycle: rifting, drifting, transtension, transpression, and collision (Bosellini, 1989) and it is reconstructed as an isolated carbonate platform (Fig. 9), which was the southernmost representative of the girdle of intraoceanic platforms extending from the western Mediterranean to the eastern Mediterranean Neotethys during the Late Cenomanian (Dercourt et al., 2000).

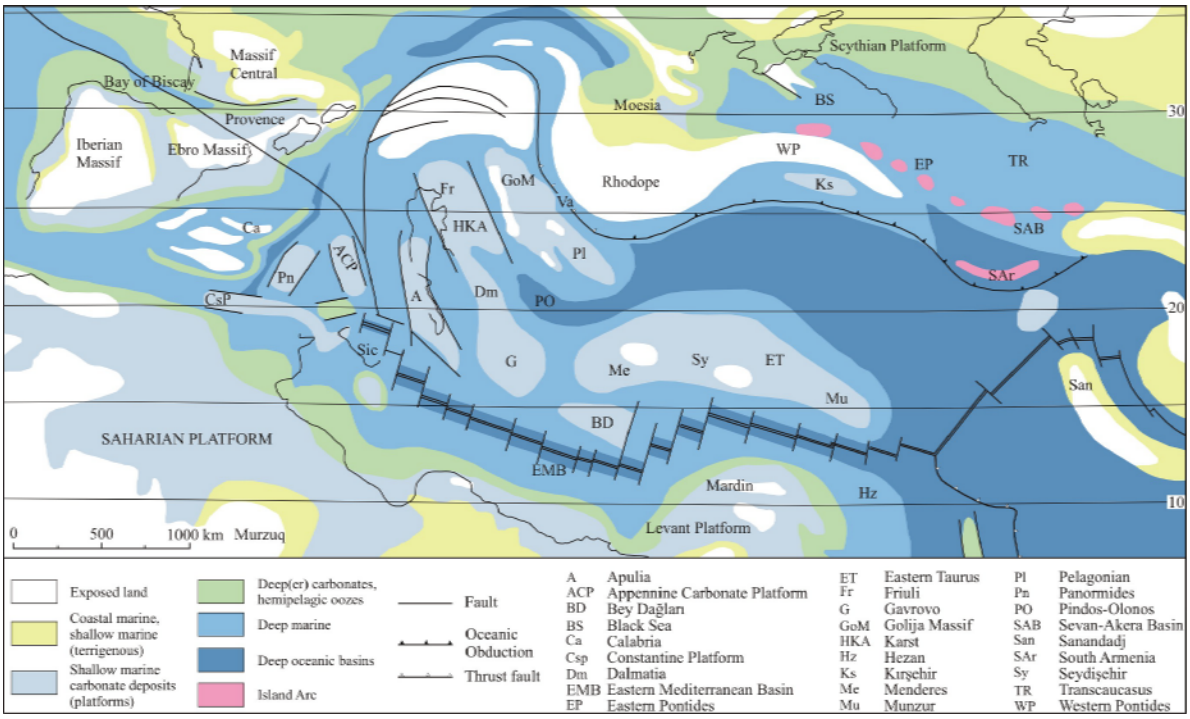

Fig. 9. Late Cenomanian palaeogeography of the Mediterranean Tethys (simplified and modified from Dercourt et al., 2000). The Bey Dağları is restored as an isolated carbonate platform surrounded by pelagic basins.

The Bey Dağları Autochthon was under the effect of different tectonic regimes during the Late Cretaceous, which is the time of intense tectonic movements in this critical area of eastern Mediterranean. Late Cretaceous tectonic activities are thought to be responsible for the drowning of carbonate platforms, opening of small oceanic basins and collision of different tectonic units. Many studies have shown that the Upper Cretaceous sequences are characterized by breaks in deposition and important facies variations in both neritic and pelagic carbonates (Poisson, 1977; Gutnic et al., 1979; Farinacci and Köylüoğlu, 1982; Farinacci and Yeniay, 1986; Özkan and Köylüoğlu, 1988; Naz et al., 1992; Sarı, 1999; Sarı and Özer, 2001, 2002; Sarı et al., 2004, 2008; Sarı, 2006a, 2006b, 2008).

Upper Cretaceous litho-biostratigraphy

The Upper Cretaceous sequences of the Bey Dağları Autochthon are divided into three geographical areas (southern, eastern and northern areas) as they show different biotic and sedimentary characteristics possibly related to the different evolutionary history. They present important biotic and facies changes and include sedimentary breaks related to the evolution and drowning of the platform.

The Upper Cretaceous sequence of the Susuzdağ area (southern part) is represented mainly by the neritic limestones of the Bey Dağları Autochthon, which have two rudist associations (Figs. 10,11). The lower association is mainly made up of hippuritids, small-sized hippuritids and radiolitids (hippuritid-radiolitid lithosome) and corresponds to the Santonian-Campanian. The upper association is represented by abundant *Joufia* and *Gorjanovicia* (*Joufia-Gorjanovicia* lithosome) and indicates a late Campanian-Maastrichtian age (Sarı, 2006b; Sarı and Özer, 2008).

The oldest rudist assemblages yieding a middle-late Cenomanian age are observed in the Eastern (Katran Dağ) area (caprinid lithosomes) (Figs. 10,11). The lower part of the Karain sequence is dominated by caprinids while the upper part is dominated by ichthyosarcolitids (Özer, 1988; Sarı, 2006b; Sarı and Özer, 2008). The benthonic foraminifera assemblage also confirm this age (Sarı, 2006b; Sarı et al., 2008).

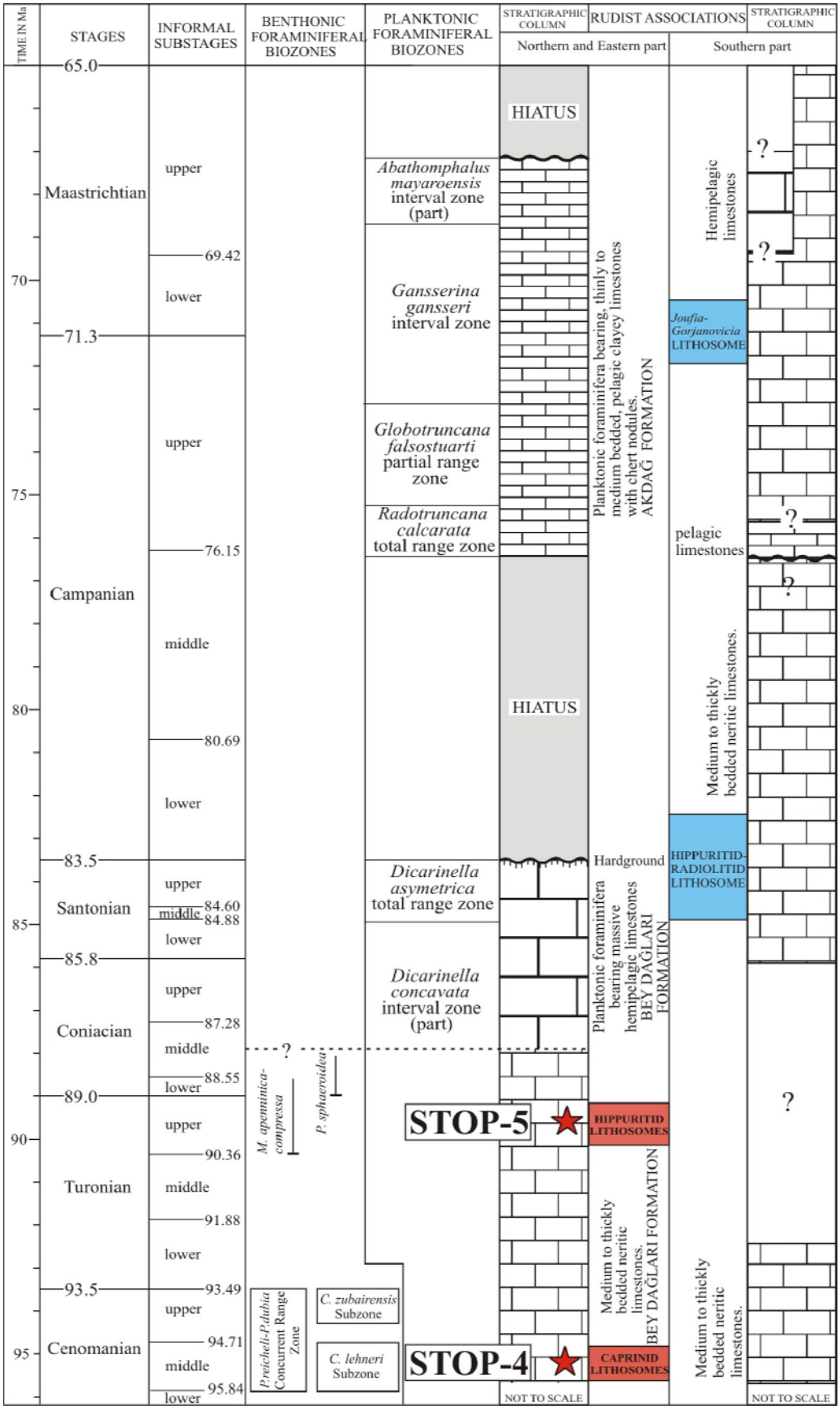

Fig. 10. Synthesized lithostratigraphic column of the Upper Cretaceous sequences of the Bey Dağları carbonate platform, plotted against the planktonic foraminiferal and benthonic foraminiferal biozonation and rudist associations (after Sarı, 2006b; Sarı, 2008; Sarı et al., 2008). Time table was adapted from Gradstein et al. (1994). The figure shows the stratigraphic positions of the two rudist lithosomes, which will be visited during the field trip.

The Bey Dağları Formation in the northern part of the autochthon can be divided into two parts. The approximately 700-m-thick middle Cenomanian-Coniacian inner platform-peritidal carbonates form the basal part and are capped with the 26-m-thick Coniacian-Santonian hemipelagic limestones that form the upper part. The 100-m-thick upper Campanian - upper Maastrichtian Akdağ Formation comprises planktonic foraminifera-bearing pelagic limestones and disconformably overlies the different stratigraphic levels of the Bey Dağları Formation along a prominent hardground or erosional surface. The Palaeogene pelagic marls and limestone-conglomerates disconformably rest over the various stratigraphic levels of the Upper Cretaceous sequence (Fig. 10).

The neritic part of the Bey Dağları Formation is generally made up of grey-cream coloured, locally bituminous, mainly medium- to thickly (30-100 cm) but locally thinly or massively-bedded limestones. The neritic limestones mainly accumulated in a platform interior environment without any terrestrial input. The lower part of the platform limestones (middle-upper Cenomanian) is represented by relatively rich benthonic foraminiferal assemblages, while the upper part (Turonian-Coniacian) contains poor assemblages. These data correlate well with the other Mediterranean successions. *P. reicheli-P. dubia* Concurrent Range Zone is defined from the middle-upper Cenomanian platform limestones. The biozone includes *C. lehneri* Subzone and *C. zubairensis* Subzone, which correspond to the middle Cenomanian and upper Cenomanian respectively. The first occurrences of *M. apenninica-compressa* and *P. sphaeroidea* indicate the late Turonian and the Coniacian respectively (Sarı, 2006b; Sarı et al., 2008) (Fig. 10).The uppermost part of the neritic succession in the northern part of the autochthon is also characterized by the abundance of rudist bivalve *Vaccinites praegiganteus* (Toucas) (hippuritid lithosomes). The lithosomes can be traced patchily throughout the northernmost part of the autochthon as a key level (Fig. 11). Analysis of the geochemically well-preserved low-Mg calcite of shells of *Vaccinites praegiganteus* (Toucas) for $^{87}Sr/^{86}Sr$ values has yielded a late Turonian age (mean numerical age: 89.1-90.1 Ma) (Sarı et al., 2004).

The C-isotope stratigraphy of the neritic limestones of the Yörükalan section in the Korkuteli area allows the recognition of the Cenomanain-Turonian interval, which is evidenced by a distinct positive excursion in the C-isotope curve and corresponds to the well-known global oceanic anoxic event (OAE-2) that occurred at the Cenomanian-Turonian boundary interval (Sarı, 2006b). The detection of the event in the platform limestones is important to fix the Cenomanian-Turonian boundary as the biostratigraphic data at this particular interval are generally poor (both rudist and benthonic foraminifera associations).

The neritic limestones are capped with massive hemipelagic limestones, which form the upper part of the formation (Fig. 10). The hemipelagic limestones are massive, cream-coloured and fractured, and contain sparse planktonic foraminifera and abundant calcispheres. The neritic and hemipelagic limestones are similar in appearance (i.e., textures on broken, fresh surface are the same) and therefore cannot be differentiated from each other in the field. The maximum thickness of the hemipelagic level was measured from the Kocaboğaz Dere section and is 23 m. Two planktonic foraminiferal biozones are established for the hemipelagic limestones: the *Dicarinella concavata* Interval Zone and *Dicarinella asymetrica* Total Range Zone, which suggest a Coniacian-Santonian age (Sarı, 2006a, 2006b; Sarı, 2008) (Fig. 10).

The upper Campanian-upper Maastrichtian Akdağ Formation disconformably overlies various stratigraphic levels of the Bey Dağları Formation along a prominent surface (hardground or erosional surface) (Fig. 10). The Akdağ Formation is mainly composed of thin- to medium-bedded (8-10 cm), locally thick-bedded (30-100 cm), planktonic foraminifera-bearing, grey-cream-coloured, cherty limestones. The pelagic limestones in some sections have fine pebble and sand-size intraclasts derived from the different stratigraphic levels of the underlying pelagic, hemipelagic and neritic limestones. The formation has a 100-m maximum thickness that varies laterally. These limestones are generally distinctly-bedded and have abundant brown and grey-coloured chert nodules and interlayers throughout. The limestones of the Akdağ Formation are a planktonic foraminifera-bearing biomicrite texture. Examination of the planktonic foraminiferal assemblages of the pelagic limestones of the

Akdağ Formation has yielded four biozones, in ascending order, *Radotruncana calcarata* Total Range Zone, *Globotruncana falsostuarti* Partial Range Zone, *Gansserina gansseri* Interval Zone and *Abathomphalus mayaroensis* Interval Zone (Sarı, 2006a, 2006b, 2008) (Fig. 10). Palaeogene pelagic marls forming the base of the Tertiary sequence, locally begin with a thin pelagic limestone-conglomerates and disconformably overlie various stratigraphic levels of the Upper Cretaceous sequence.

The examination of the planktonic foraminifera has yielded the recognition of the two main sedimentary breaks within the Upper Cretaceous pelagic sequence. Lower to middle Campanian and uppermost Maastrichtian-middle Palaeocene are absent in all measured stratigraphic sections except for the Çamlıdere area, from where we do not have enough data (Fig. 10).

Rudist associations of the BDCP

Four rudist lithosomes are observed throughout the Upper Cretaceous platform limestones of the Bey Dağları Autochthon (Figs. 10,11):

1) the middle-upper Cenomanian caprinid lithosomes are observed in the Katran Dağ area,
2) the upper Turonian hippuritid lithosomes are mainly detected in the Korkuteli area and can be traced patchily throughout the northern part of the autochthon as a key level,
3) the Santonian-Campanian hippuritid-radiolitid lithosome and
4) the upper Campanian-Maastrichtian *Joufia-Gorjanovicia* lithosome are determined from the Susuzdağ area.

The aim of this field trip is to visit the middle-upper Cenomanian caprinid lithosomes and the upper Turonian hippuritid lithosomes in this part of the excursion (Figs.10,11).

FIELD TRIP ITINERARY

DAY-1: June 27th, 2008

Stop-4: Katran Dağ area (caprinid lithosomes)

The oldest rudist assemblages (caprinid lithosomes) are observed in the Katran Dağ area (Fig. 11). The medium to thick or massive-bedded neritic limestones of the Yağcaköy Formation are represented by abundant occurrences of caprinids and ichthyosarcolitids (caprinid lithosomes). This area is unique locality in the autochthon as it has a rich caprinid fauna.

Two sections were measured from the Katran Dağ area. The Karain section includes a rich caprinid assemblages throughout the 120-m-thick succession (Figs. 12-14). The lower part of the sequence is dominated by caprinids, which are accompanied by gastropods, corals and non-rudist bivalves, while the upper part is dominated by ichthyosarcolitids. Many rudists are observed as transported and broken shell fragments, which indicates at least intermittent wave action. The Yağca section has the similar caprinid-bearing neritic limestones at the lower part, which is disconformably overlain by blocky pelagic sediments of the Karakirse Formation (Figs. 15,16). The rudist assemblages of the Karain and Yağca sections are the same and comprise *Ichthyosarcolites bicarinatus* (Gemmellaro), *Ichthyosarcolites triangularis* Desmarest, *Caprina schiosensis* Boehm, *Neocaprina gigantea* Plenicar, *Schiosia* cf. *schiosensis* Boehm, *Sphaerucaprina woodwardi* Gemmellaro, *Durania* sp., *Radiolites* sp. and *Sauvagesia* sp. (Fig. 14). Similar associations are widespread in the Mediterranean region and were reported from the Cenomanian and the upper Cenomanian of Bosnia-Herzegovina (Sliskovic, 1968), the Cenomanian of Croatia (Polsak and Mamuzic, 1969), the lower Cenomanian of France (Bilotte, 1985), the Cenomanian of Greece (Accordi et al., 1989), the Cenomanian and the upper Cenomanian of Italy (Cherchi et al., 1993), the Cenomanian of Romania (Lupu, 1992) and the Cenomanian of Slovenia (Plenicar, 1963). Similar assemblages were also documented from the middle-upper Cenomanian of Katran Dağ (Özer, 1988) and Serinhisar (Denizli) (Özer, 1998) in Turkey. The obtained rudist fauna

suggest a middle-late Cenomanian age. Likewise, the rather poor benthonic foraminifera assemblages also indicate that the age of the middle-upper part of the succession is middle-late Cenomanian (Sarı et al., 2008).

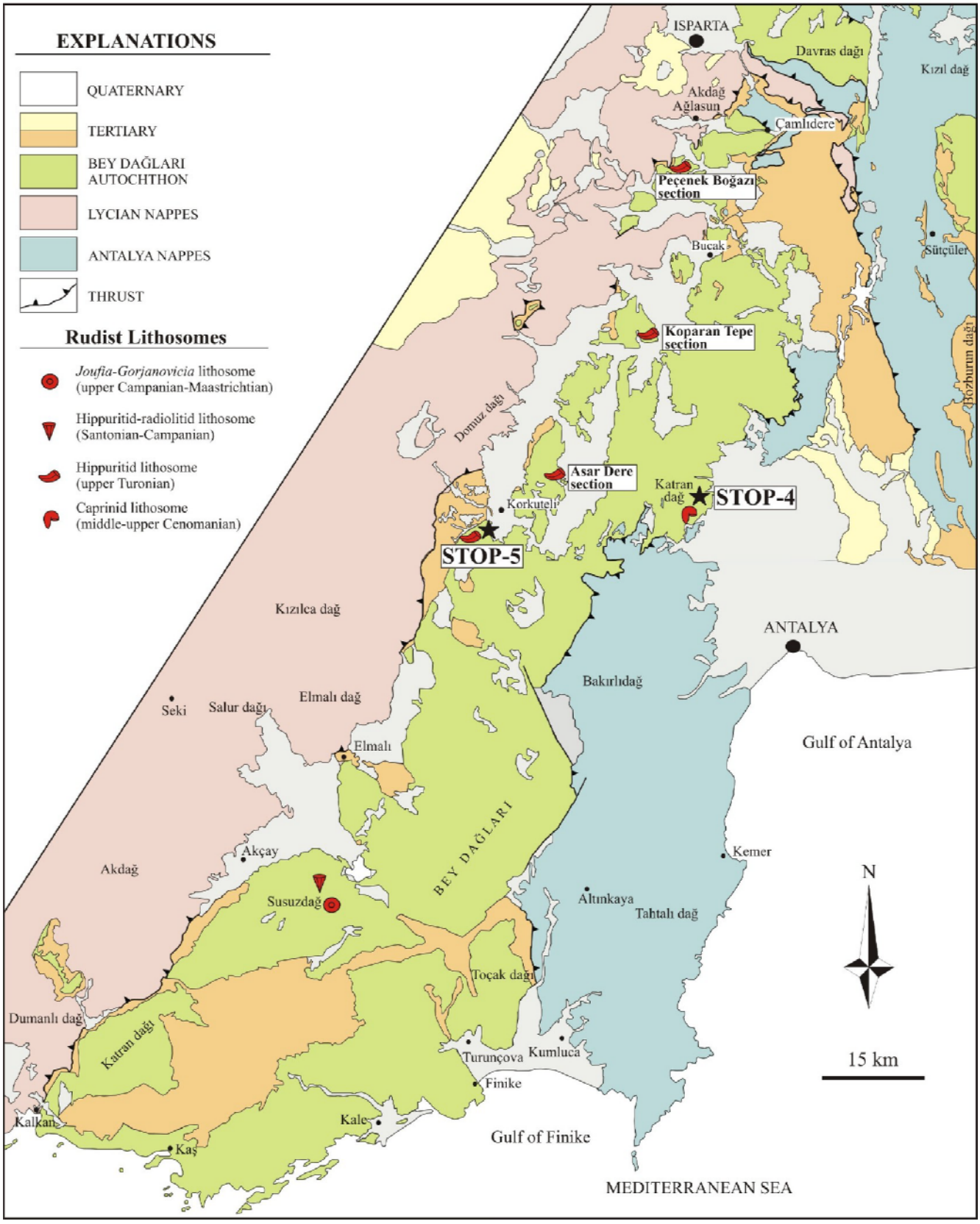

Fig. 11. Simplified geological map of the western Taurides showing distribution of the Upper Cretaceous rudist lithosomes and location of the field trip stops (modified after Şenel, 1997 and Sarı 2006b).

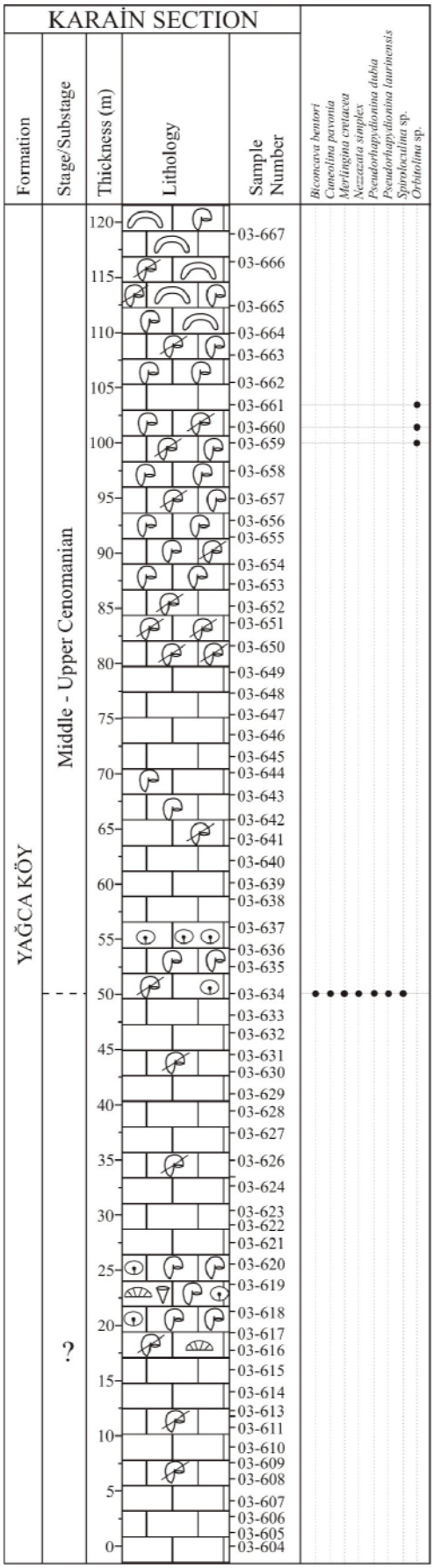

Fig. 12. Karain measured stratigraphic section (after Sarı, 2006b; Sarı and Özer, 2008)

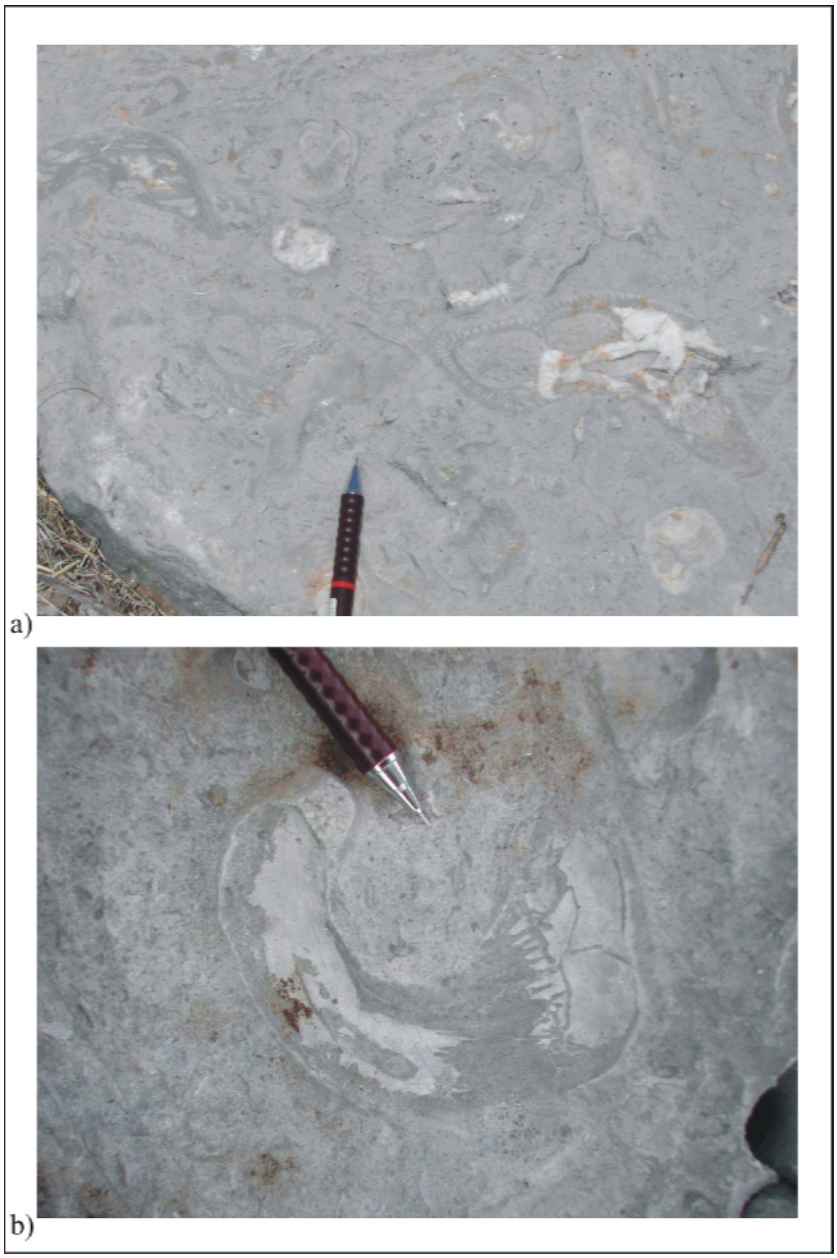

Fig. 13. Outcrop photographs showing the massively-bedded neritic limestones of the Karain section, which is represented by abundance of caprinids and rare ichthyosarcolitids (caprinid lithosomes), which are associated with corals and gastropods at particular levels. a) Rudists are mostly found as broken shell fragments, b) Whole sections of rudists also present locally (after Sarı, 2006b).

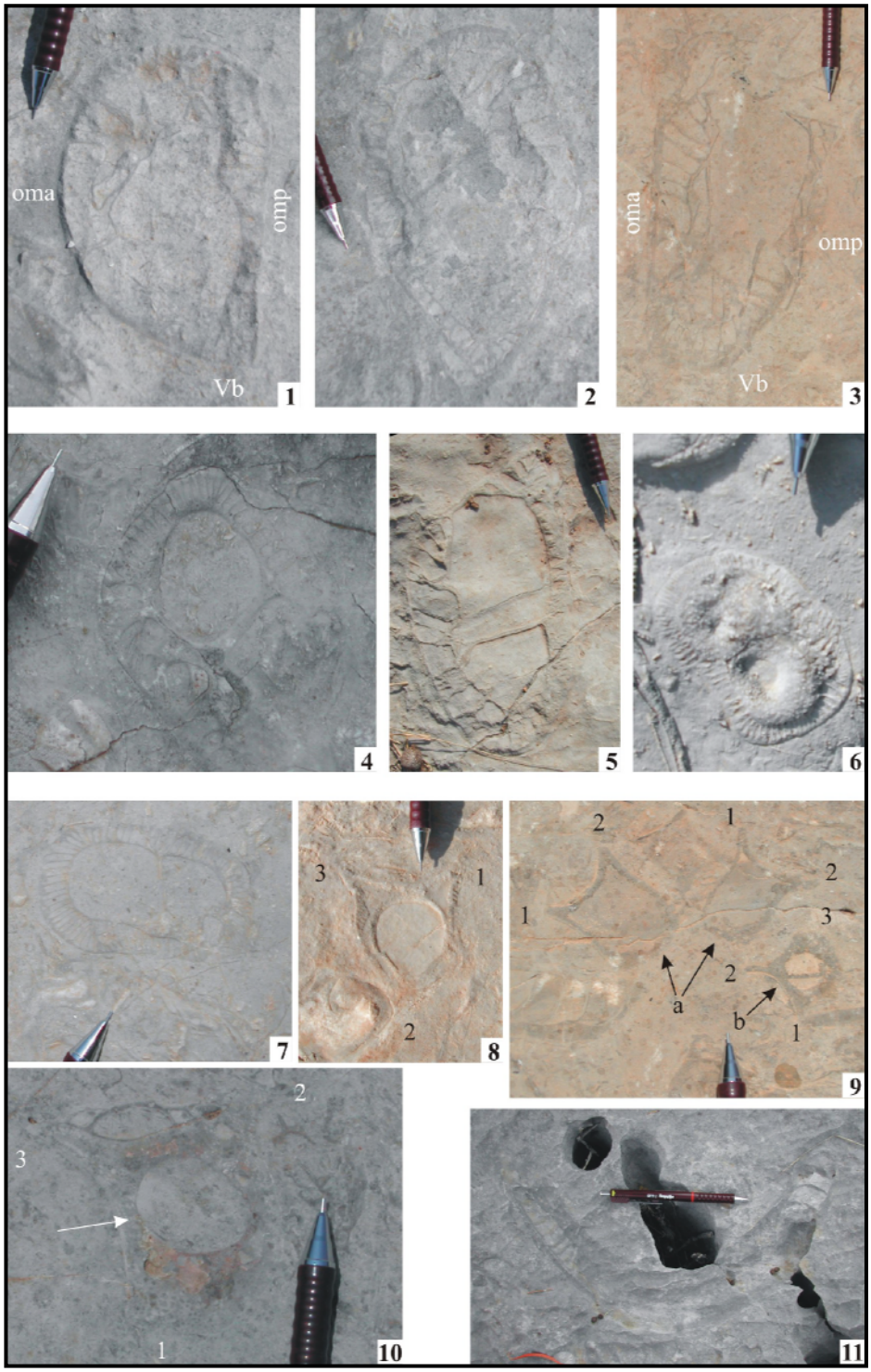

Fig. 14. Outcrop photographs of the caprinid lithosomes in the Karain section. 1, 2, 3. Transverse sections of the right valves of *Neocaprina gigantea* Plenicar. Note the anterior (oma) and posterior (omp) accesory cavities and canals and also the development of external carina (Vb). 4. *Caprina schiosensis* Boehm. Transverse section of the left valve. Note the pallial canals observed as one row of canals comprising fusiform-type canals. 5, 6. *Schiosia* cf. *schiosensis* Boehm. Transverse sections of the left valves. Note the small rounded and fusiform canals. 7. *Caprina schiosensis* Boehm. Transverse section of the left valve. The fusiform canals are typical for the species. 8. *Ichthyosarcolites triangularis* Desmarest. Transverse section of the right valve. 9. a) *Ichthyosarcolites bicarinatus* (Gemmellaro). Transverse section of the right valve. Note the presence of two ridges (1, 2), which are characteristic features of the species. b) *Ichthyosarcolites triangularis* Desmarest. Transverse section of the right valve. 10. *Ichthyosarcolites triangularis* Desmarest. Transverse section of the right valve. Note the rounded and polygonal canal sections (indicated by the arrow). 11. Longitidunal section of the right valve of *Ichthyosarcolites* sp. The shell is curved and loosely coiled. The length of the pencil is 14 cm and the length of the metal part of the pencil is 1.7 cm (after Sarı, 2006b; Sarı and Özer, 2008).

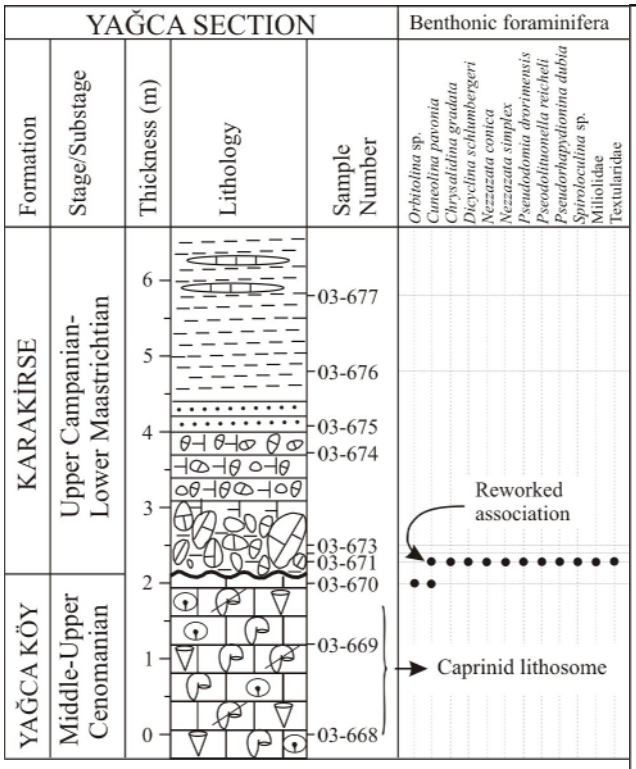

Fig. 15. Yağca measured stratigraphic section (after Sarı, 2006b; Özer and Sarı, 2008).

The caprinid-rich neritic limestones are dominated by winnowed bioclastic rudstone/grainstone microfacies with rich rudist fragments and rare corals and gastropods (Fig. 17a). Coarse bioclastic grains are well-rounded, coated with micrite envelopes and replaced by sparry calcite. The microfacies indicate the dominance of winnowed platform edge environment, where lime mud is removed because of constant wave action, at or above wave base (Wilson, 1975; Flügel, 2004). The rudstone/grainstone microfacies rarely alternate with the following microfacies (Sarı, 2006b):

* coral framestone (Fig. 17b),
* packstone with benthonic foraminifera and rare intraclasts (Fig. 17c),
* floatstone with rudist fragments and intraclasts (Fig. 17d).

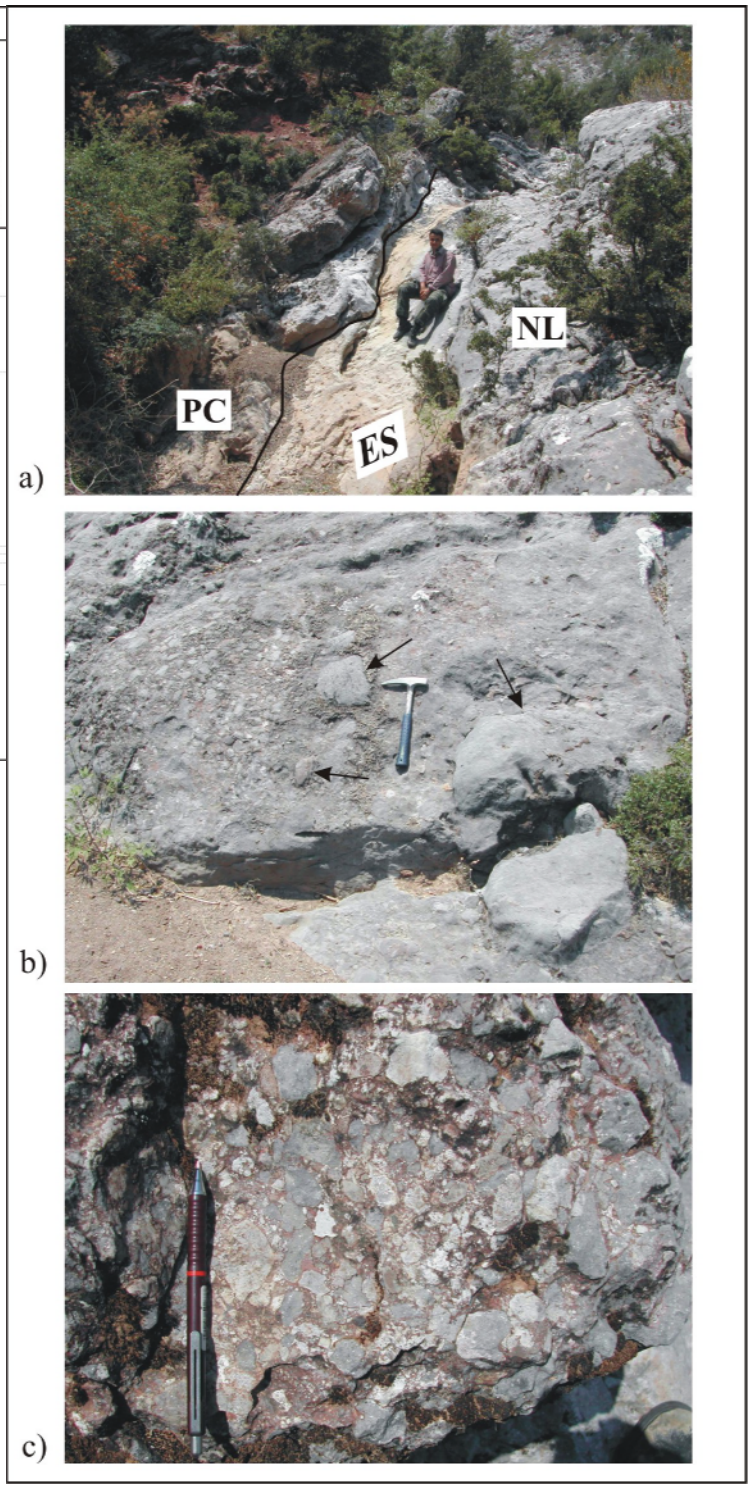

Fig. 16. Three photographs from the Yağca section. a) Contact relationship between the neritic limestones (NL) and the pelagic conglomerates (PC). The pelagic conglomerates of the Karakirse Formation disconformably overlie the massive neritic limestones of the Yağca Köy Formation along an erosional surface (ES). Which indicates an erosion during deposition of the Karakirse Formation. b) The 1-m-thick pelagic conglomerate at the lowermost part of the Karakirse Formation, which includes blocks and big pebbles derived from the different stratigraphic levels of the neritic and hemipelagic limestones. The pebbles have diverse benthonic foraminifera assemblage and are embedded in a pelagic lime mud matrix, which includes scarce planktonic foraminifera (blocks and pebbles are indicated by arrows). c) The overlying pelagic conglomerates, which have small pebbles, embedded in red pelagic matrix. The amount and the size of pebbles decrease towards the top (after Sarı, 2006b).

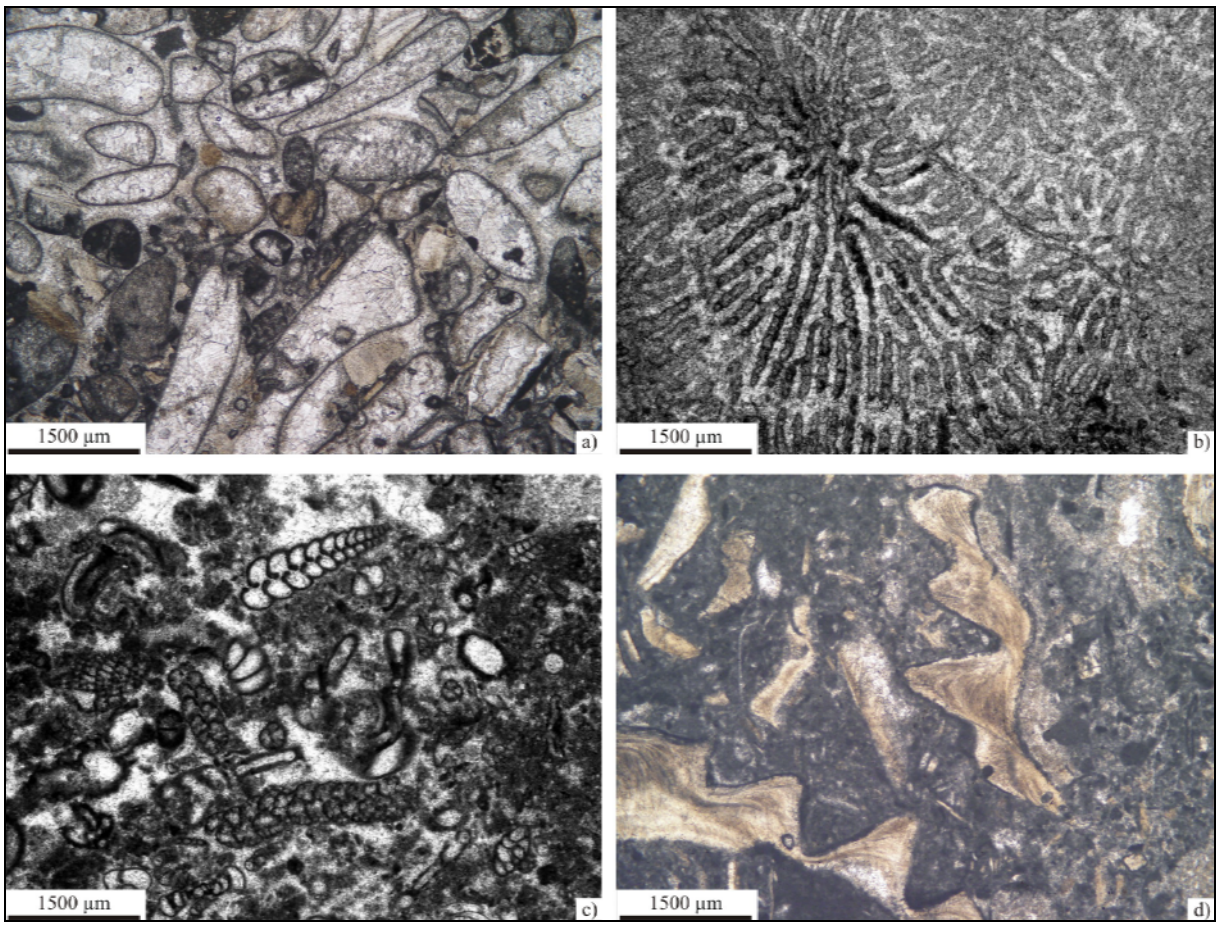

Fig. 17. Microfacies photomicrograps of the neritic limestones of the Karain section (caprinid lithosomes). Explanations of the microphotographs are given in the text (after Sarı, 2006b).

Stop-5: Korkuteli area (hippuritid lithosomes)

The best outcrops of the hippuritid lithosomes are observed in the Korkuteli area (i.e. Kargalıköy and Yörükalan sections) (Figs. 11,18,19). The level in the Korkuteli area is dominated by *Vaccinites praegiganteus* (Toucas), which is associated with small hippuritids and radiolitids. The 20-m-thick lithosome is separated from the underlying well-bedded limestones by its massive structure. Numerous sections of *Vaccinites praegiganteus* (Toucas) are seen in the lower part of the lithosome, many in growth position in the Kargalıköy section (Figs. 18,19). The abundance of *Vaccinites praegiganteus* (Toucas) decreases towards the top of the lithosome, where radiolitids and sparse small hippuritids such as *Hippurites socialis* Douvillé, *Hippuritella resecta* (Defrance) and *Vaccinites inferus* (Douvillé) are observed.The lithosome is also observed in the Yörükalan section and east of Ulucak in the Korkuteli area

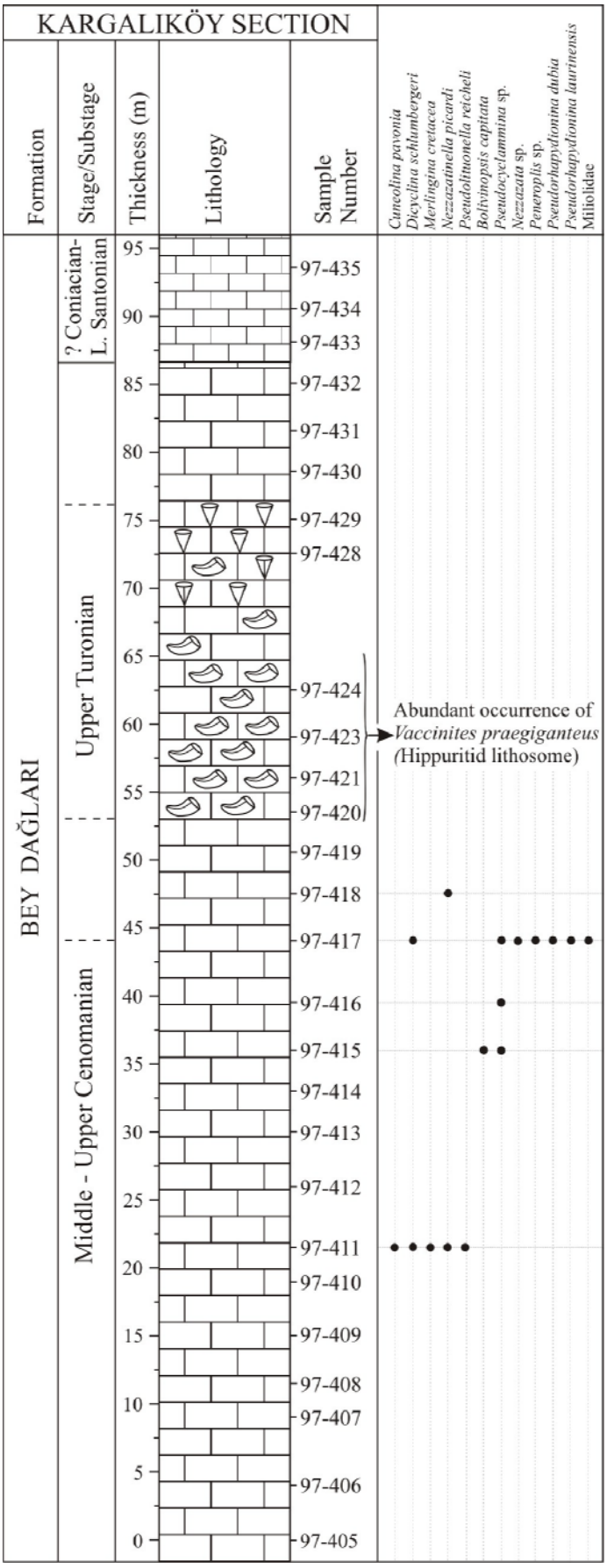

Fig. 18. Kargalıköy measured stratigraphic section (after Sarı, 2006b; Özer and Sarı, 2008).

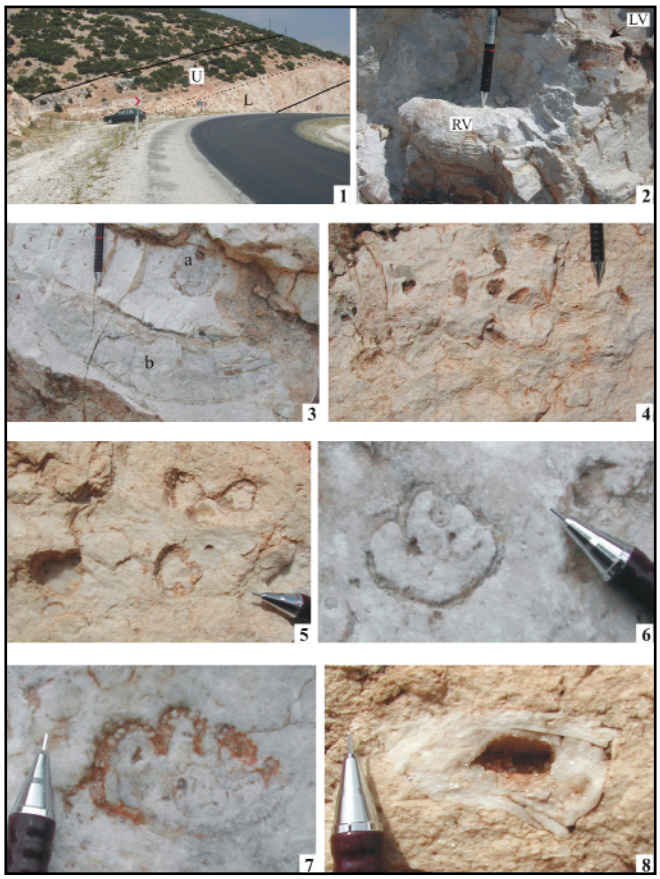

Fig. 19. The hippuritid lithosome in the Kargalıköy section. The lower part of the lithosome (L) is dominated by *V. praegiganteus*, while the upper part (U) is represented by small-sized hippuritids and radiolitids. (Korkuteli-Fethiye roadcut). All the photographs appearing in this figure are outcrop photographs. 1. Outcrop photograph of the hippuritid lithosome in Kargalıköy section (Korkuteli) (the level between two lines). 2. An individual of *V. praegiganteus* in growth position in the lower part of the lithosome. Note that the right (RV) and left valves (LV) are preserved. Many of the specimens have curved right valve. 3. Transverse (a) and oblique longitidunal (b) sections of the right valves of *Vaccinites praegiganteus* (Toucas) in the lower part of the lithosome. Note the closely-spaced fused first (P1) and second (P1) pillars, which is the most diagnostic feature of the species encountered in the Bey Dağları carbonate platform. 4. Sections of small-sized radiolitids and hippuritids, which dominate the upper part of the lithosome. 5. Scattered sections of small-sized hippuritids (*H.* cf. *resecta*) in the upper part of the lithosome. 6, 7. Transverse sections of the right valves of *H. resecta* in the upper part of the lithosome. 8. Longitidunal section of a small radiolitid in the upper part of the lithosome. The length of the pencil is 14 cm and the length of the metal part of the pencil is 1.7 cm (after Sarı, 2006b; Sarı and Özer, 2008).

The hippuritid lithosomes are also detected in the Asar Dere, Koparan Tepe and Peçenek Boğazı sections in the northern part of the autochthon (Fig. 11). The 10-m-thick massive lithosome in the Asar Dere section is very similar to that of the Korkuteli area. The hippuritid lithosomes of the Koparan Tepe and Peçenek Boğazı sections are different in terms of the abundance of *Vaccinites praegiganteus* (Toucas), the thickness of the lithosomes and the individuals constructing the lithosomes. *Vaccinites praegiganteus* (Toucas) and small-sized hippuritids are scarce in the Koparan Tepe section, where radiolitids and *Distefanella* species are common. The rudist fauna comprising *Vaccinites praegiganteus* (Toucas), *Milovanovicia heraki* Polsak, *Distefanella bassanii* Parona, *Biradiolites angulosus* d'Orbigny, *Hippurites socialis* Douvillé and *Hippuritella resecta* (Defrance) indicates the late Turonian (Figs. 19). A similar lithosome was also observed in the middle part of the Peçenek Boğazı section, where a few individuals of *Vaccinites praegiganteus* (Toucas) are associated with a rudist assemblage comprising *Milovanovicia heraki* Polsak, *Distefanella bassanii* Parona, *Biradiolites angulosus* d'Orbigny, *Hippurites socialis* Douvillé and *Hippuritella resecta* (Defrance), which indicates the late Turonian. These data show that the upper Turonian hippuritid lithosomes are present as a marker level in the northernmost part of the autochthon.

The species of the hippuritid lithosomes, especially *Vaccinites praegiganteus* (Toucas), *Vaccinites inferus* (Douvillé), *Hippuritella resecta* (Defrance), *Milovanovicia heraki* Polsak, *Distefanella bassanii* Parona and *Biradiolites angulosus* d'Orbigny generally show a distrubition in the middle-upper Turonian beds of the Mediterranean region (many references in Steuber, 2002). However, they were also found in the Turonian-Coniacian-Santonian and Campanian beds (references in Steuber, 2002).

Numerous specimens of *Vaccinites praegiganteus* (Toucas) have been collected from the hippuritid lithosomes of the Korkuteli area (i.e. Kargalıköy and Yörükalan sections). Analysis of geochemically well-preserved low-Mg calcite of shells of *Vaccinites praegiganteus* (Toucas) for $^{87}Sr/^{86}Sr$ values has yielded a late Turonian age. Details of taxonomic and morphologic studies on *Vaccinites praegiganteus* (Toucas) and the techniques of $^{87}Sr/^{86}Sr$ dating are discussed by Sarı et al. (2004).

Neritic limestones of the Bey Dağları Formation mainly accumulated in a platform interior environment that existed from the middle Cenomanian to the Coniacian. Microfacies analysis of the neritic limestones have indicated peritidal (tidal flat, ponds and channels), subtidal, shelf (restricted circulation), shelf lagoon (open circulation), winnowed edge, organic build up and foreslope environments. The planktonic foraminifera-bearing Coniacian-Santonian massive limestones were deposited in hemipelagic environment. The following microfacies are distinguished belonging to the aforementioned environments. These are the main microfacies and they are transitional and intercalated (Fig. 20):

* Laminated peloidal packstone and fenestral mudstone microfacies (Fig. 20a),
* Alternating cryptalgal and laminated peloidal packstone microfacies,
* Sparse benthonic foraminifera-bearing non-laminated peloidal packstone/grainstone microfacies (Fig. 20b),
* Rich benthonic foraminifera-bearing wackestone/packstone microfacies (Fig. 20c),
* Rudist fragments-bearing packstone microfacies (Fig. 20d) (Sarı and Özer, 2001; Sarı, 2006b).

Neritic limestones of the Bey Dağları Formation are overlain by rare planktonic foraminfera and rich calcisphere-bearing Coniacian-Santonian massive hemipelagic limestones (Fig. 20e). Rich planktonic foraminifera-bearing, well-bedded pelagic limestones of the upper Campanian-upper Maastrichtian Akdağ Formation (Fig. 20f) disconformably rest over the hemipelagic limestones along a hardground or erosional surface.

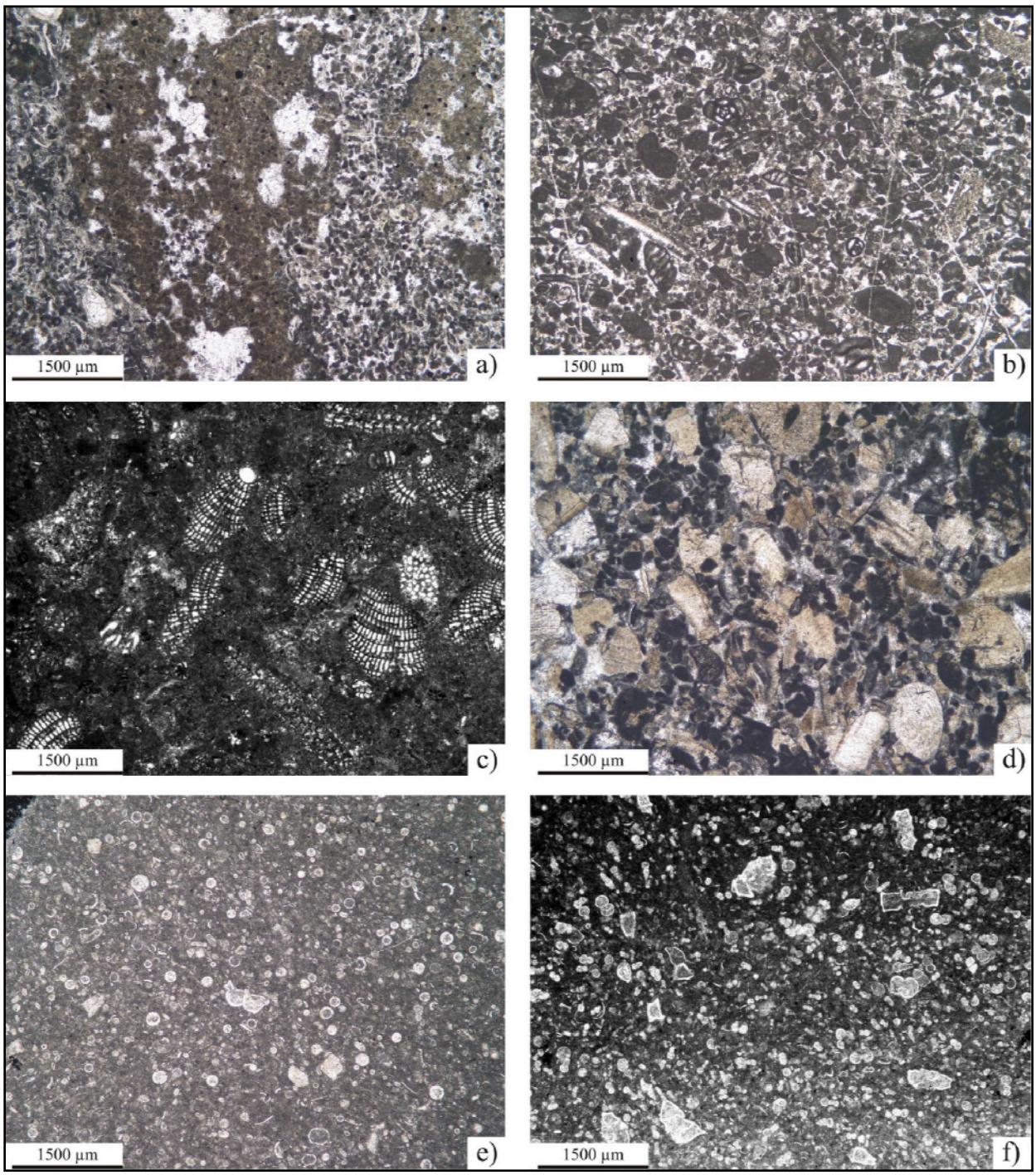

Fig. 20. Microfacies photomicrographs of the Upper Cretaceous limestones of the Korkuteli area. Explanations of the microphotographs are given in the text (after Sarı, 2006b).

Conclusions

Despite the presence of numerous rudist occurrences throughout the Bey Dağları Autochthon there have been rather scarce studies dealing with the rudist biostratigraphy. As the benthonic foraminiferal assemblages within the Upper Cretaceous platform limestones (especially the post Cenomanian part) are generally poor, the biostratigraphy has to rely on rudist bivalves. Four rudist lithosomes are observed in the Bey Dağları Autochthon. The oldest rudist assemblages (caprinid lithosomes) are observed in the Katran Dağ area. The lithosomes are represented by the abundance of caprinids, which suggest a middle-late Cenomanian age. The accompanying poor benthonic foraminiferal assemblages also indicate the middle-late Cenomanian age. The upper Turonian hippuritid lithosomes are represented by dominance of *Vaccinites praegiganteus* (Toucas). The best outcrops of the lithosomes are observed in the Korkuteli area and they patchily occur throughout the northernmost part of the autochthon between Korkuteli and Çamlıdere as a key level. Two of the lithosomes are detected in the Susuzdağ area, where the Upper Cretaceous successions are represented by shallow-water platform limestones. The hippuritid-radiolitid lithosome from the lowermost part of the sequence is represented by mainly hippuritids and radiolitids, which yield a Santonian-Campanian age. The uppermost part of the section is characterized by the presence of the *Joufia-Gorjanovicia* lithosome. The rudist fauna suggest a late Campanian-Maastrichtian age for the youngest rudist lithosome.

The obtained data from the four rudist lithosomes have provided new information for the Upper Cretaceous biostratigraphy of the Bey Dağları Autochthon. The data have also yielded important information for correlation of the Late Cretaceous tethyan carbonate platforms especially in the eastern and central Mediterranean regions.

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References

Accordi, G., Carbone, F., Sirna, G., 1989. Some affinities between the Ionian Islands and the Apulian Upper Cretaceous rudist facies. In: Battista Carulli, G. (Ed.), Evolution of the Karstic carbonate platform. Relation with other periadriatic carbonate platforms. Memorie della Società geologica Italiana 40, 163-173.

Bilotte, M., 1985. Le Crétacé supérieur des plates-formes est-pyrénéenes. Strata 2, 1-438.

Bosellini, A., 1989. Dynamics of Tethyan carbonate platforms. In: Crevello, P.D., Wilson, J.L., Sarg, J.F., Read, J.F. (Eds.), Controls on carbonate platform and basin development, Society of Economic Palaeontologists and Mineralogists Special Publication 44, 3-13.

Cherchi, A. Ruberti, D., Sirna, G., 1993. Osservazioni biostratigrafiche sul Cretaceo del Matese centro-settentrionale (Italia centrale). Bollettino del Servizio geologico d'Italia Roma 110, 91-110.

Dercourt, J., Gaetani, M., Vrielynck, B., Barrier, E., Biju-Duval, B., Brunet, M.F., Cadet, J.P., Crasquin, S., Sandulescu, M., 2000. Atlas Peri-Tethys. Palaeogeographic Maps. Late Cenomanian, Commission Carte Géologique du Monde-Commission Geological Map of the World, Paris.

Farinacci, A., Köylüoğlu, M., 1982. Evolution of the Jurassic-Cretaceous Taurus Shelf (southern Turkey). Bolletino della Societa Paleontologica Italiana 21, 267-276.

Farinacci, A., Yeniay, G., 1986. Biostratigraphy and event-analysis of the Cenomanian-Maastrichtian carbonates of the Bey Dağları (Western Taurus, Turkey). Geologica Romana 25, 257-284.

Flügel, E., 2004. Microfacies of Carbonate Rocks: Analysis, Interpretation and Application, Springer-Verlag, 976 pp.

Gradstein, F.N., Agterberg, F.P., Ogg, J.G., Hardenbol, J., Van Veen, P., Thiery, J., Huang, Z., 1994. A Mesozoic Time Scale. Journal of Geophysical Research 99, 24,051-24,074.
Gutnic, M., Monod, O., Poisson, A., Dumont, J.F., 1979. Géologie des Taurides occidentales (Turquie). Mémoires de la Société Géologique de France 137, 1-112.

Lupu, D., 1992. Le faciès à rudistes du Cénomanien de Hateg (Carpathes méridionales, Roumanie). Geologica Romana 28, 351-358.
Naz, H., Alkan, H., Erk, S., 1992. Facies and sequence characteristics of the Late Cretaceous-Paleocene drowning on the West Taurus Carbonate Platform, S. W. Türkiye. Proceedings of the 9th Petroleum Congress of Turkey, 121-134.

Özer, S., 1988. Description de quelques Rudistes à canaux dans le Cénomanien de Turquie. Géologie Méditerranéenne 15, 159-167.

Özer, S., 1998. Rudist-bearing Upper Cretaceous metamorphic sequences of the Menderes Massif (western Turkey) In: Masse, J.P., Skelton, P.W. (Eds.), Quatrième Congrès international sur les Rudistes. Geobios, Mémoire spécial 22, 235-249.
Özgül, N., 1976. Torosların bazı temel jeoloji özellikleri. Bulletin of the Geological Society of Turkey 14, 75-87.

Özkan, S., Köylüoğlu, M., 1988. Campanian-Maastrichtian planktonic foraminiferal biostratigraphy of the Beydağları Autochtonous Unit, Western Taurids, Turkey. Middle East Technical University, Journal of Pure and Applied Sciences 21, 377-388.

Plenicar, M., 1963. Caprinidae and the genus Radiolitella from the Upper Cretaceous strata of southwestern Slovenia. Slovenska Akademija Znanosti in Umetnosti, Razred za prirodoslovne in medicinske Vede, Razprave 7, 559-587.
Poisson, A., 1977. Recherches géologiques dans les Taurides occidentals (Turquie). Thèse Doct. d'Etat, Universitié de Paris-Sud, Orsay, 795 pp.

Polsak, A., Mamuzic, P., 1969. Les nouveaux gisements de rudistes dans le Crétacé supérieur des Dinarides externes. Geoloski Vjesnik 22, 229-245.

Robertson, A.H.F., 1993. Mesozoic-Tertiary sedimentary and tectonic evolution of Neotethyan carbonate platforms, margins and small ocean basins in the Antalya Complex, southwest Turkey. International Association of Sedimentologists, Special Publication 20, 415-465.

Robertson, A.H.F., 2002. Overview of the genesis and emplacement of Mesozoic ophiolites in the Eastern Mediterranean Tethyan region. Lithos 65, 1-67.
Sarı, B., 1999. Biostratigraphy of the Upper Cretaceous Sequences in the Korkuteli Area (Western Taurides). MSc Thesis, Dokuz Eylül University, İzmir, 162 pp.
Sarı, B., 2006a. Upper Cretaceous planktonic foraminiferal biostratigraphy of the Bey Dağları autochthon in the Korkuteli Area, Western Taurides, Turkey. Journal of Foraminiferal Research 36, 241-261.
Sarı, B., 2006b. Foraminifera-rudist biostratigraphy, Sr-C-Isotope stratigraphy and microfacies analysis of the Upper Cretaceous sequences of the Bey Dağları autochthon (western Taurides, Turkey). Ph.D Thesis, Dokuz Eylül University, İzmir, 436 pp.
Sarı, B., 2008. Planktonic foraminiferal biostratigraphy of the Coniacian-Maastrichtian sequences of the Bey Dağları Autochthon, western Taurides, Turkey: Thin section zonation. Cretaceous Research (in review).
Sarı, B., Özer, S., 2001. Facies characteristics of the Cenomanian-Maastrichtian sequence of the Beydağları carbonate platform in the Korkuteli area (western Taurides). International Geology Review 43, 830-839.
Sarı, B., Özer, S., 2002. Upper Cretaceous stratigraphy of the Beydağları carbonate platform, Korkuteli area (Western Taurides, Turkey). Turkish Journal of Earth Sciences 11, 39-59.
Sarı, B., Özer, S., 2008. Upper Cretaceous rudist biostratigraphy of the Bey Dağları Carbonate Platform, Western Taurides, SW Turkey. Geobios (in press).

Sarı, B., Steuber, T., Özer, S., 2004. First record of Upper Turonian rudists (Mollusca, Hippuritoidea) in the Bey Dağları carbonate platform, Western Taurides (Turkey): taxonomy and

strontium isotope stratigraphy of *Vaccinites praegiganteus* (Toucas, 1904). Cretaceous Research 25, 235-248.

Sarı, B., Taslı, K., Özer, S., 2008. Benthonic foraminiferal biostratigraphy of the Upper Cretaceous (middle Cenomanian-Coniacian) sequences of the Bey Dağları carbonate platform, western Taurides, Turkey. Turkish Journal of Earth Sciences (in press).

Sliskovic, T., 1968. Biostratigraphie du Crétacé supérieur de l'Herzégovine méridional. Bulletin du Musée de la République Socialiste de Bosnie-Herzégovine à Sarajevo, Sciences naturelles Sarajevo 7, 5-66.

Steuber, T., 2002. *A palaeontological database of rudist bivalves (Mollusca: Hippuritoidea, Gray,1848). http://www.paleotax.de/rudists/*

Şenel, M., 1997. 1/250.000 ölçekli Türkiye Jeoloji Haritaları. No:2 Fethiye Paftası; No: 3 Antalya Paftası; No: 4 Isparta Paftası. Maden Tetkik ve Arama Genel Müdürlüğü, Jeoloji Etüdleri Dairesi, Ankara.

Şengör, A.M.C., Yılmaz, Y., 1981. Tethyan evolution of Turkey: a plate tectonic approach. Tectonophysics 75, 181-241.

Wilson, J.L., 1975. Carbonate facies in geologic history, Springer-Verlag, 428 pp.

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