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Radiolarian assemblages of Middle and Late Jurassic to early Late Cretaceous (Cenomanian) ages from an olistolith record pelagic deposition within the Bornova Flysch Zone in western Turkey

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Key words. – Jurassic, Cretaceous, Radiolaria, Radiolarites, Bornova Flysch Zone, Turkey.

Abstract. – The Bornova Flysch Zone (BFZ) in NW Anatolia comprises several olistoliths or tectonic slivers, representing various parts of the Izmir-Ankara ocean. Radiolarian assemblages extracted from one of the olistoliths of the BFZ, cropping out along the Sögütlü section, to the NE Manisa city, were studied in detail. The lowermost part of the section contains latest Bajocian – early Callovian radiolarian taxa, followed by radiolarian assemblages indicating Late Jurassic to early Late Cretaceous (Cenomanian) ages. Previous studies reveal that the Izmir-Ankara oceanic basin was initially opened during late Ladinian – early Carnian. The new radiolarian data obtained from this olistolith reveals that relatively condensed, and possibly more or less continuous, pelagic sedimentation took place during the late Middle Jurassic to early Late Cretaceous in a non-volcanic oceanic basin closer to the Tauride-Anatolide platform margin.

Associations de radiolaires d'âge jurassique moyen-supérieur à crétacé supérieur (Cénomanien) issus d'un olistolithe enregistrent une sédimentation pélagique au sein de la zone de Flysch de Bornova en Turquie occidentale

Mots-clés. – Jurassique, Crétacé, Radiolaires, Radiolarites, Zone de Flysch de Bornova, Turquie

Résumé. – La zone de Flysch de Bornova (BFZ) dans le Nord-Ouest de l'Anatolie comprend de nombreux olistolithes ou de lames tectoniques, représentant des différentes parties de l'océan d'Izmir-Ankara. Des associations de radiolaires extraits d'un olistolithe de la BFZ, lequel affleure le long de la coupe de Sögütlü, au NE de la ville de Manisa, ont été étudiés en détail. La partie basale de la coupe contient des radiolaires du Bajocien terminal à Callovien inférieur, suivie par des associations de radiolaires d'âge jurassique supérieur à partie basale du Crétacé supérieur (Cénomanien). Les études précédentes révèlent que le bassin océanique d'Izmir-Ankara a été initialement ouvert durant le Ladinien supérieur – Carnien inférieur. Les nouvelles données de radiolaires obtenues de cet olistolithe révèlent qu'une sédimentation pélagique condensée, et probablement quasi-continue, a eu lieu durant la partie supérieure du Jurassique moyen à la partie basale du Crétacé supérieur dans un bassin océanique non-volcanique lequel était plus proche de la marge de plate-forme Tauride-Anatolide.

INTRODUCTION

The closure of the Neotethyan oceanic branches during the Alpine tectonic epoch in Turkey [e.g. Şengör and Yilmaz, 1981; Göncüoglu *et al.*, 1997; Robertson, 2004] has resulted in the formation of mélange complexes that are now text-book examples. Their formation was due to a combination of tectonic and sedimentary processes; they have been subject of a number of pioneering studies [e.g. Bailey and Mc Callien, 1950], which attempted to understand the details of these events.

Mélange complexes marking former subduction-accretion prisms are junk boxes with products of a number of events formed during the closure of oceanic realms. They include not only huge and continuous successions of oceanic lithosphere (ophiolites s. l.) but also olistoliths of various sizes representing platform margins and metamorphosed sediments. During the advanced stages of oceanic closure, all of these lithologies were transported and deposited in peripheral foreland deposits. The mélange complexes that are situated along the Intra-Pontide, Izmir-Ankara and SE Anatolian suture belts provide excellent examples for both partly preserved or dismembered ophiolitic successions as well as very thick sedimentary deposits of the foreland basins with olistoliths and olistostromes of the accreted material.

The Bornova Flysch Zone (BFZ) (fig. 1) represents this type of rock-units formed in one of the largest basins in NW Anatolia, along the Izmir-Ankara suture belt. It stretches from the Aegean coast for about 250 km towards NE to join the Kütahya-Bolkardag Belt [Göncüoglu *et al.*, 1997, 2003] that surrounds the northern and eastern periphery of the

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Menderes Massif. The BFZ was initially named by Okay and Siyako [1993] to describe a flysch basin, which was formed along a transform plate boundary (Soma Transform Fault) within the Izmir-Ankara ocean. Erdogan [1990] used the name 'Bornova Mélange' for this unit and suggested that the rock units in the area represent remnants of a short-lived (Maastrichtian – Danian) oceanic basin within the Tauride-Anatolide platform.

The BFZ includes a number of S-verging thrust-slices, with a structural thickness of more than 30 km. The dominant rock-type of the 'flysch' is olistostromal clastics with blocks/olistoliths of ophiolites, accretionary prism material (members of an ophiolitic melange and blueschists) and platform margin rocks (mainly carbonates), including continental slope and thinned continental crust. The size of these blocks varies from pebble to boulder size to several kilometres. In a number of recent studies in the central and southern parts of the BFZ [Yaliniz and Göncüoglu, 2005; Tekin *et al*., 2006; Tekin and Göncüoglu, 2007, 2009] we examined the geochemical features of the basalts and their ages based on radiolarians extracted from associated cherts and mudstones. These ages were spot ages, representing a limited time span in the history of the oceanic crust development.

In this study, however, we will report the radiolarian based ages in a single block of radiolarian chert and mudstone that covers a rather large part of the late Middle Jurassic to early Late Cretaceous interval.

GEOLOGICAL SETTING OF THE SÖGÜTLÜ SECTION

The studied section is located in the BFZ to the NE of Manisa city, between the Akhisar and Sindirgi towns (fig. 1). In this area, outcrops of different allochthonous blocks of pelagic sediments, mafic volcanic rocks, ophiolites, blue-and greenschists are observed together with slices of recrystallized carbonates incorporated into the olistostromes. The carbonates are part of the carbonate platform that was developed at the northern margin of the Tauride-Anatolide plate. Fossil data, mainly foraminifers,

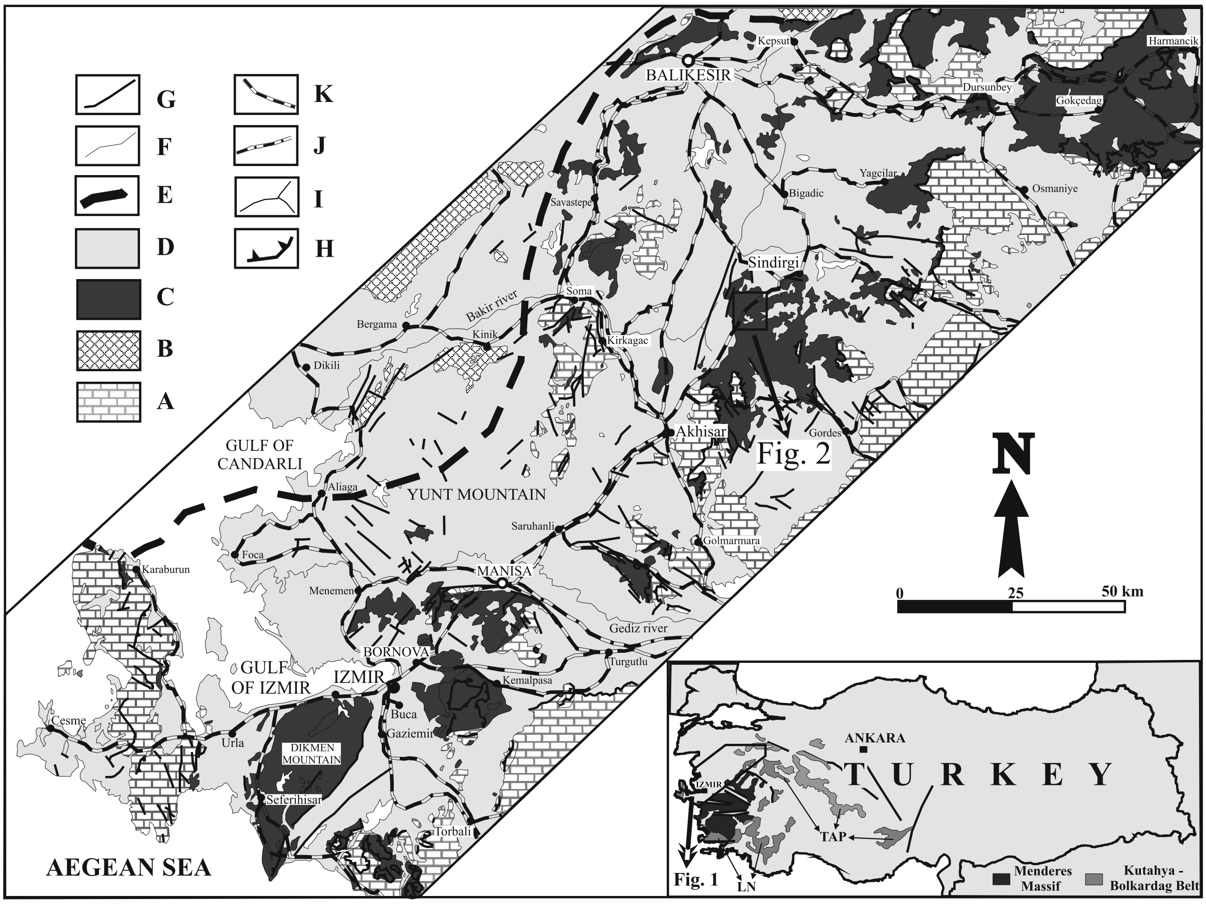


FIG. 1. – Simplified geological map of the Bornova Flysch zone (simplified after Konak [2002]). A. Paleozoic-Mesozoic carbonate sequences of the Tauride-Anatolide platform; B. Sakarya composite terrane; C. Ophiolites and ophiolitic mélange complexes of the Izmir-Ankara suture belt; D. Eocene to Recent rock units; E. Boundary between Sakarya and Tauride-Anatolide units; F. Stratigraphic contact; G. Fault; H. Thrust; I. Drainage system; J. Railway; K. Highway. The inset map displays geographical distribution of the Menderes Massif and the Kütahya Bolkardag belt and the locality of the figure 1. Abbreviations: TAP: The Tauride Anatolide platform, LN: The Lycian Nappes [after Göncüoglu, 2011].

FIG. 1. – *Carte géologique simplifiée de la zone de Flysch de Bornova (simplifiée d'après Konak [2002]).* A. *Séries paléozoïques-mésozoïques carbonatées de la plate-forme Tauride-Anatolide;* B. *Terrane exotique de Sakarya;* C. *Ophiolites et mélanges ophiolitiques de la zone de suture d'Izmir-Ankara;* D. *unités d'âge éocène à récent;* E. *Limite entre les unités de Sakarya et de Tauride-Anatolide;* F. *Contact stratigraphique;* G. *Faille;* H. *Chevauchement;* I. *Système hydrographique;* J. *Chemin de fer;* K. *Autoroute. La carte intérieure présente la distribution géographique du massif de Menderes et de la ceinture de Kütahya Bolkardag, ainsi que l'emplacement de la figure 1. Abréviations : TAP : plate-forme de Tauride Anatolide, LN : les nappes Lyciennes [d'après Göncüoglu, 2011].*

indicate a Norian to Late Jurassic depositional age for the platform [Göncüoglu *et al.*, 2003]. In the autochthonous successions, the carbonates are conformably covered by an alternation of red cherty limestones, micritic limestones and mudstones indicating that the platform has submerged. The onset of this pelagic deposition is variable (late Middle Jurassic to late Early Cretaceous) along the Kütahya-Bolkardag Belt (fig. 1, inset map). In the Bornova area, the oldest ages obtained are Early Cretaceous. To the east of the BFZ in the Kütahya area, pelagic carbonates are transitional to radiolarian cherts with red and green mudstone interlayers [Göncüoglu *et al.*, 2003], which in turn are followed by turbiditic clastics with olistostromes. The latter includes pebbles of blueschists and peridotites and was interpreted as the transition from slope-deep basin to foreland deposition due to the arrival of the ophiolitic nappes from the closing Izmir-Ankara Ocean in the north. In the BFZ, Konuk [1977] reported Campanian to Danian depositional ages at this transitional zone, whereas the calciturbiditic intercalations in the same interval yielded in Kütahya area Maastrichtian fossils [Göncüoglu *et al.*, 2003]. In the BFZ, the platform carbonates and their pelagic cover sometimes occur as olistoliths within the olistostromal sediments that include a large number of chert blocks, together with blocks of oceanic rocks. The size of the chert blocks varies between a few centimeters to 2 km.

The Sögütlü section is measured in such an olistolith, situated at the northwestern bank of the Cemal creek, along the road to the Sögütlü village (Balikesir J20d1 quadrangle, between 43.36.227 N/5.88.954 E and 43.36.272 N/5.89.045 E UTM coordinates) from which the name of the section is derived (fig. 2).

The total thickness of the section is 75.5 meters. At the bottom and top of the section cherts are bounded by small faults (figs. 2, 3) against conglomeratic olistostromes with brown to red turbiditic mudstone intercalations. The basal and central part of the section is represented by alternation of red to green, medium to thick-bedded chert and mudstone. Some thin-bedded chert beds can be observed at the bottom of the section. Red colored units dominate over

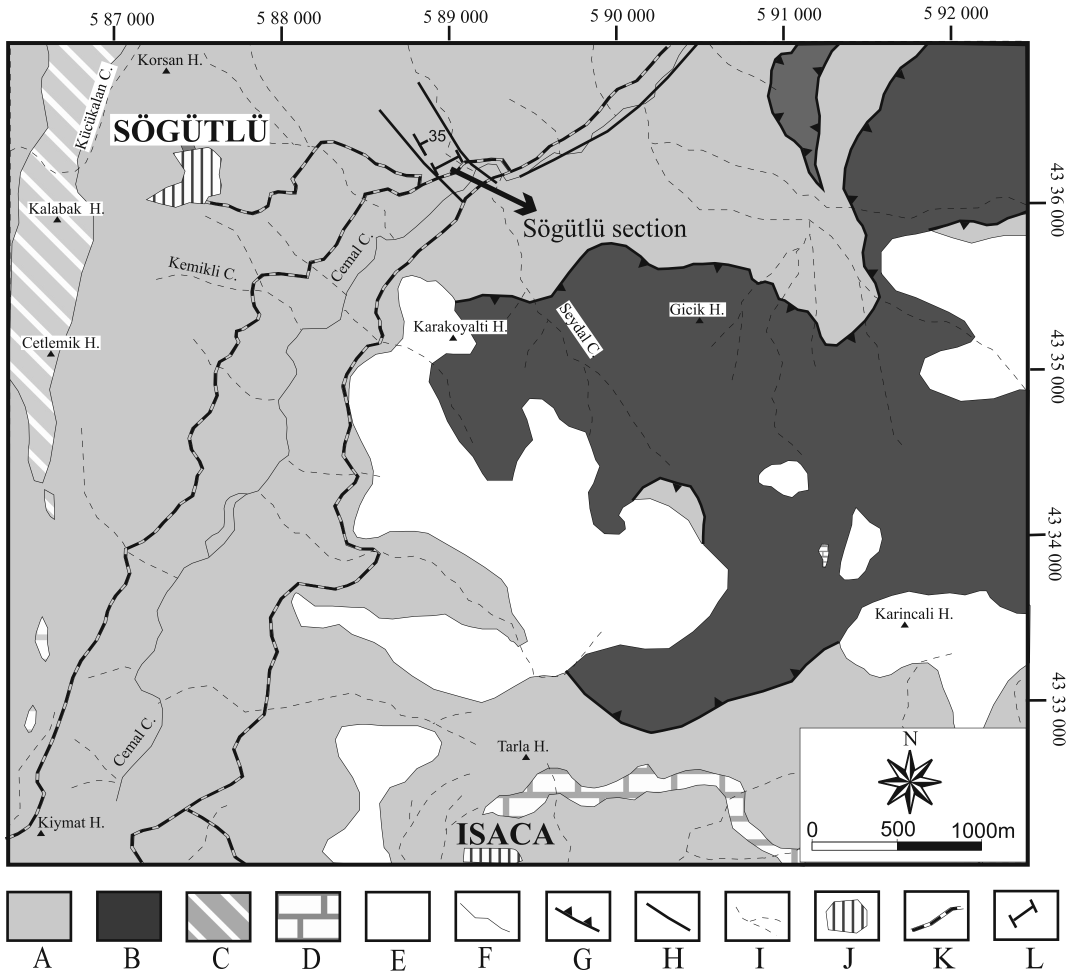


FIG. 2. – Geological map of the Bornova Flysch zone at the northeast of Manisa City and the locality of the Sögütlü section. Explanations: A. Undifferentiated mélange, B. Mafic, ultramafic, volcanic olistoliths in mélange, C. Radiolarite-pelagic limestone olistoliths in mélange, D. Recrystallized platform carbonates slices and blocks in mélange, E. Post-Mesozoic rock units, F. Stratigraphic contact, G. Thrust, H. Fault, I. Drainage system, J. Settlement, K. Main road, L. Section location [revised after Konak *et al.*, 1980; Cakmakoglu and Vural, 1998].

FIG. 2. – *Carte géologique de la zone de Flysch de Bornova au nord-ouest de la ville de Manisa et localisation de la coupe de Sögütlü. Explications :* A. *Mélange non-différencié,* B. *Olistolithes de roches mafiques, ultramafiques et volcaniques dans un mélange,* C. *Olistolithes de calcaires pélagiques-radiolarites dans un mélange,* D. *Blocs et écailles de calcaires de plate-forme recristallisés dans un mélange,* E. *Unités de roches post-mésozoïques,* F. *Contact stratigraphique,* G. *Chevauchement,* H. *Faille,* I. *Système hydrographique,* J. *Village,* K. *Route principale, localisation de la coupe [révisé d'après Konak* et al.*, 1980 ; Cakmakoglu et Vural, 1998].*

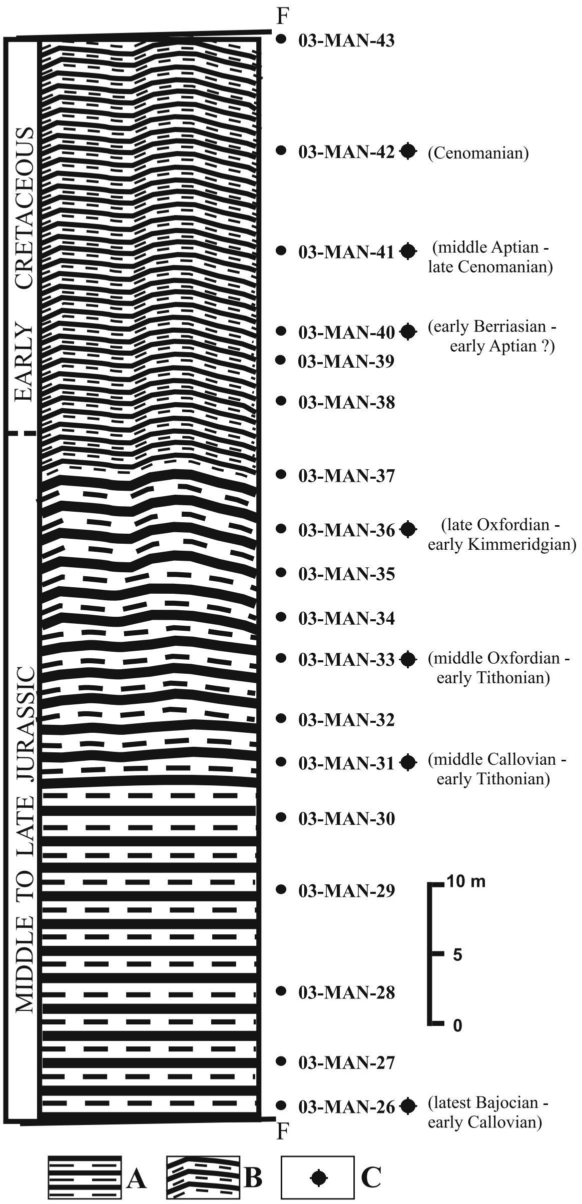


FIG. 3. – Log of the Sögütlü section and sample locations. A. Red to green, medium to thick-bedded chert and mudstone alternation, B. Intensely folded, red to green, thin to medium-bedded chert and mudstone alternation, C. Radiolarian occurrence.

FIG. 3. – *Log de la coupe de Sögütlü et position des échantillons étudiés. Explications:* A. *Radiolarites rouges-vertes,* B. *Radiolarites rouges-vertes, intensément plissées,* C. *Présence de radiolaires.*

the green colored ones (fig. 4A). From this part, eleven samples (03-Man-26 to 03-Man-36) were collected for radiolarian determinations.

Higher up in the section, alternation of intensely folded, red to green, thin to medium-bedded chert and mudstone have been encountered (figs. 3, 4B). The amount of mudstones amount increases towards the upper part of the section and green colored units dominate this time over the red-colored ones (fig. 4B). For Radiolaria determinations, this part (fig. 3) of the section proved to be the most productive.

DATING OF RADIOLARIAN ASSEMBLAGES

Eighteen samples have been collected along the Sögütlü section; seven of them (03-Man-26, 31, 33, 36, 40, 41 and 42) yielded diverse and determinable radiolarian faunas (fig. 3). All chert samples were processed with diluted hydrofluoric acid (5-10% HF) following the Pessagno and Newport's [1972] method.

Diverse radiolarian assemblages (fig. 5) were obtained from sample 03-Man-26 at the basal part the Sögütlü section (Pl. I, figs. 1-11). Many taxa (e.g. *Hexasaturnalis nakasekoi, Mirifusus fragilis* s. l., *Spinosicapsa helvetica, Eucyrtidiellum unumaense* s. l. and *Palinandromeda praecrassa)* in the fauna indicate a Middle Jurassic age [Yao, 1979; Baumgartner, 1984; Baumgartner *et al.*, 1995]. Due to the occurrence of *Ristola altissima major*, the age of the radiolarian fauna from sample 03-Man-26 can be assigned to the latest Bajocian – early Callovian [UAZ 5-7 based on the zonal scheme of Baumgartner *et al.*, 1995].

Higher in the section, sample 03-Man-31 yielded relatively diverse and moderately-preserved radiolaria (fig. 5; pl. I, figs. 12-18). The presence of the two well-known taxa (*Parapodobursa spinosa* and *Cinguloturris carpatica*) in the fauna clearly points to a middle Callovian – early Tithonian age [Ozvoldova, 1979; Dumitrica and Mello, 1982; UAZ 8-11 based on the zonal scheme of Baumgartner *et al.*, 1995].

Less diverse and well to moderately-preserved radiolarian fauna (fig. 5) have been determined from the sample 03-Man-33 in the section (Pl. II, figs. 1-6). For this fauna, although two well-known taxa (*Ristola altissima altissima* and *Transhsuum* sp. cf. *T. brevicostatum*) indicate the middle and late Jurassic time interval, its age can be

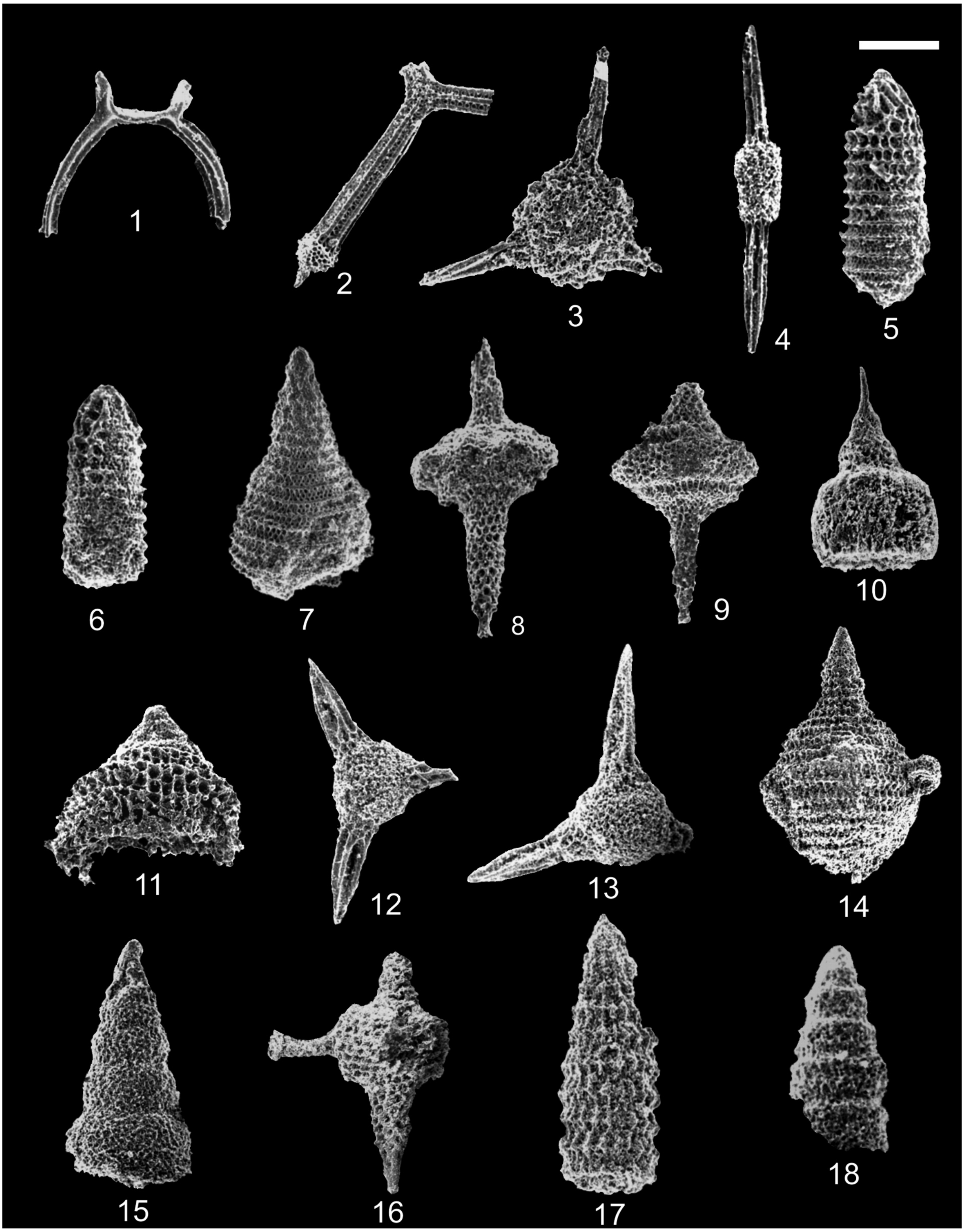
PLATE I. – Scanning electron micrographs of the Middle to Late Jurassic radiolarians from the Sögütlü stratigraphic section, Bornova Flysch Zone, western Turkey. Radiolarians shown in figures 1-11 are from sample 03-Man-26 whereas 12-18 are from the sample 03-Man-31.

PL. I. – *Photos prises au microscope électronique à balayage des radiolaires du Jurassique moyen à supérieur de la coupe Sögütlü, zone de Flysch de Bornova, Turquie occidentale. Les radiolaires illustrés dans les figures 1-11 sont extraits de l'échantillon 03-Man-26, alors que ceux des fig. 12-18 de l'échantillon 03-Man-31.*

fig. 1. *Hexasaturnalis nakasekoi* DUMITRICA and DUMITRICA-JUD, scale bar = 115 µm.
fig. 2. *Tritrabs ewingi* s. l. (PESSAGNO), scale bar = 140 µm.
fig. 3. *Acastea diaphorogona* s. l. (FOREMAN), scale bar = 150 µm.
fig. 4. *Archaeospongoprunum* sp., scale bar = 125 µm.
fig. 5-6. *Ristola altissima major* BAUMGARTNER and DE WEVER, scale bar for both figures = 120 µm.
fig. 7. *Mirifusus fragilis* s. l. BAUMGARTNER, scale bar = 140 µm.
fig. 8-9. *Spinosicapsa helvetica* (RÜST), scale bar for both figures = 135 µm.
fig. 10. *Eucyrtidiellum unumaense* s. l. (YAO), scale bar = 50 µm.
fig. 11. *Palinandromeda praecrassa* (BAUMGARTNER), scale bar = 140 µm.
figs. 12-13. *Triactoma jonesi* (PESSAGNO), scale bar for both figures = 110 µm.
fig. 14. *Mirifusus dianae dianae* (KARRER), scale bar = 170 µm.
fig. 15. *Spongocapsula palmerae* PESSAGNO, scale bar = 120 µm.
fig. 16. *Spinosicapsa spinosa* (OZVOLDOVA), scale bar = 130 µm.
fig. 17. *Transhsuum brevicostatum* (OZVOLDOVA), scale bar = 80 µm,
fig. 18. *Cinguloturris carpatica* DUMITRICA and MELLO, scale bar = 70 µm.

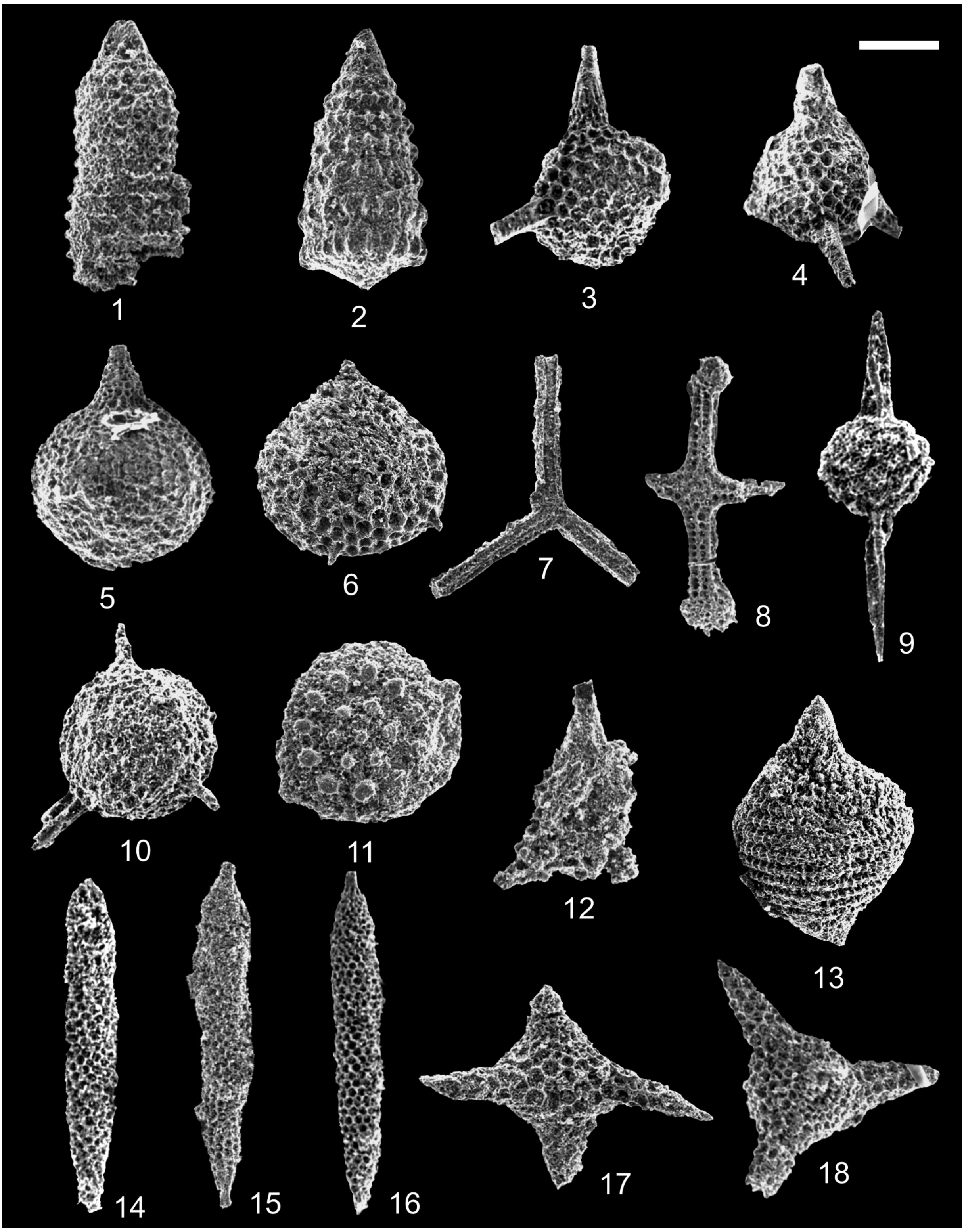
assigned as middle Oxfordian – early Tithonian [Ozvoldova, 1979; Baumgartner *et al.*, 1980; UAZ 9-11 based on the zonal scheme of Baumgartner *et al.*, 1995] with respect to the presence of *Fultacapsa sphaerica.*

Sample 03-Man-36, taken from the central part of the section, yielded diverse and age diagnostic radiolarians (fig. 5; pl. II, figs. 7-18). Some taxa (*Tritrabs hayi* and *Tetraditryma pseudoplena*) in the fauna are only known from Middle and Late Jurassic strata, other taxa (*Acastea umbilicata, Mirifusus dianae minor, Pseudoeucyrtis reticularis* and *Parapodocapsa amhitreptera)* are determined from Upper Jurassic and Lower Cretaceous strata [Pessagno, 1977; Baumgartner, 1980; Matsuoka and Yao, 1985; Baumgartner *et al.*, 1995]. Taking into consideration



the LAD of *Tritrabs hayi* and FAD of *Acaeniotyle umbilicata,* sample 03-Man-36 can be assigned to the UAZ 10 of Baumgartner *et al*. [1995] and thus correlated with the late Oxfordian – early Kimmeridgian.

Three samples (samples 03-Man-40, 41, 42) from the upper part of the section include radiolarian faunas. The radiolarian faunas of sample 03-Man-40 are less-diverse and poorly-preserved (fig. 5; pl. III, fig. 1-3), with a limited number of determinable taxa; *Acaeniotyle umbilicata* is a long range species (late Oxfordian to early Aptian), while the presence of *Archaeodictyomitra* sp.cf. *A. lacrimula* and *Thanarla brouweri* may suggest a possible



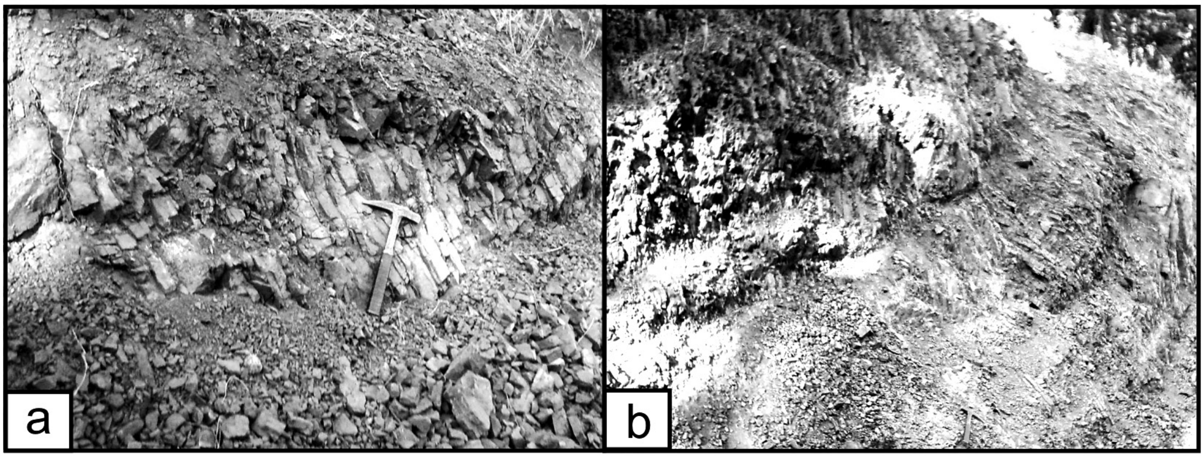


FIG. 4. – A. Photograph showing the red to green, medium to thick-bedded chert and mudstone alternation at the central part of the Sögütlü section where samples 03-Man-30 to 03-Man-34 were obtained, B. View from the upper part of the Sögütlü section showing the intensely folded, red to green, thin to medium-bedded chert and mudstone alternation where samples 03-Man-37 to 03-Man-40 were taken.
FIG. 4. – A. *Photographies montrant des radiolarites rouges-vertes de la partie centrale de la coupe de Sögütlü d'où les échantillons 03-Man-30 à 03-Man-34 ont été obtenus,* B. *Regard de la partie supérieure de la coupe de Sögütlü laquelle montre des radiolarites rouges-vertes intensément plissées et d'où viennent les échantillons 03-Man-37 à 03-Man-40.*

Early Cretaceous (early Berriasian – early Aptian) age [Jud, 1994; Baumgartner *et al.*, 1995; Dumitrica *et al.*, 1997; Hori, 1999] for this sample.

A *Nassellaria* dominated radiolarian assemblage was obtained from sample 03-Man-41 (fig. 5; pl. III, fig. 4-9). When considering the FAD of *Stichomitra communis* and LAD of *Obeliscoites perspicuus,* age of the sample is middle Aptian to late Cenomanian corresponding to UAZ 5-19 based on the zonal scheme of O'Dogherty [1994].

A diverse radiolarian fauna in the section was derived from sample 03-Man-42 (fig. 5; pl. III, fig. 10-18). Based on the study of O'Dogherty [1994], *Dactyliosphaera silviae* is the index taxon of the Silviae Zone (Cenomanian, Unitary Assocations 16-19 on the zonal scheme of O'Dogherty [1994]).

DISCUSSION AND CONCLUSIONS

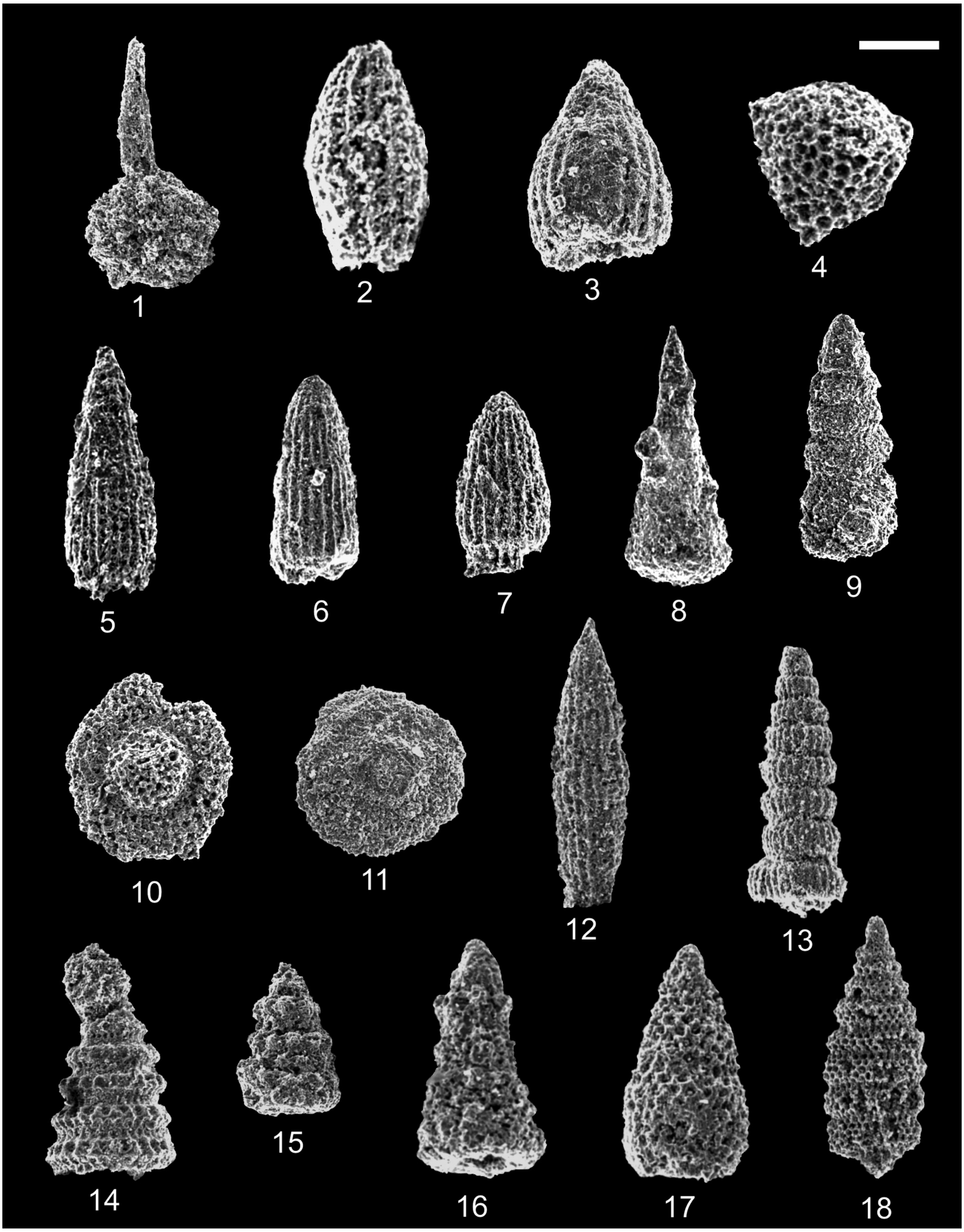
The evolution of the most prominent branch of the Neotethys in the eastern Mediterranean, the Izmir-Ankara-Erzincan ocean, is still not well understood. Especially, the dataset on the timing of the oceanic lithosphere development is fragmentary. Most of the available data on this subject are based on combined research on the age of the radiolarian cherts and the petrological features of associated volcanic rocks [e.g. Göncüoglu *et al.*, 2006b; Aldanmaz *et al.*, 2008]. Figure 6 provides a summary of available age data from different parts of the Izmir-Ankara suture belt. The new data from the Sögütlü section fills some gaps of ocean basin deposition at end Jurassic and mid Early Cretaceous times (fig. 6).

The new finding also gives some clue on the palaeotectonic setting of the oceanic crust on which the Sögütlü succession was deposited. Considering that the studied succession is devoid of volcanic and volcanoclastic rocks it should have been deposited in a remote location from any voluminous igneous activity. By this, a position in the proximity of the ridge, oceanic islands or island arcs formed by intra-oceanic subduction within the Izmir-Ankara ocean can be excluded. A setting on the overriding plate that was located relatively to the north of the ocean during this

PLATE II. – Scanning electron micrographs of the Late Jurassic radiolarians from the Sögütlü stratigraphic section, Bornova Flysch Zone, western Turkey. Radiolarians shown in figures 1-6 are from sample 03-Man-33, whereas 7-18 are from the sample 03-Man-36.
PL. II. – *Photos prises au microscope électronique à balayage des radiolaires du Jurassique supérieur de la coupe Sögütlü, zone de Flysch de Bornova, Turquie occidentale. Les radiolaires illustrés dans les figures 1-6 sont extraits de l'échantillon 03-Man-33, alors que ceux des fig. 7-18 de l'échantillon 03-Man-36.*
fig. 1. *Ristola altissima altissima* (RÜST), scale bar = 110 µm.
fig. 2. *Transhsuum* sp. cf. *T. brevicostatum* (OZVOLDOVA), scale bar = 100 µm.
fig. 3-4. *Fultacapsa sphaerica* (OZVOLDOVA), scale bar for both figures= 130 µm.
fig. 5. *Sethocaps* sp. A sensu BAUMGARTNER *et al.*, scale bar = 160 µm.
fig. 6. *Palinandromeda* sp. cf. *P. crassa* (BAUMGARTNER), scale bar = 160 µm.
fig. 7. *Tritrabs hayi* (PESSAGNO), scale bar = 180 µm
fig. 8. *Tetraditryma pseudoplena* BAUMGARTNER, scale bar = 170 µm.
fig. 9. *Acaeniotyle umbilicata* (RÜST), scale bar = 130 µm.
fig. 10. *Suna* sp. cf. *S. echiodes* (FOREMAN), scale bar = 110 µm.
fig. 11. *Godia* sp., scale bar = 150 µm.
fig. 12. *Perispyridium* sp., scale bar = 100 µm.
fig. 13. *Mirifusus dianae minor* BAUMGARTNER, scale bar = 165 µm.
fig. 14-16. *Pseudoeucyrtis reticularis* MATSUOKA and YAO, scale bar for all figures= 130 µm.
fig. 17-18. *Parapodocapsa amhitreptera* (FOREMAN), scale bar for both specimens= 125 µm.

intraoceanic subduction can also be excluded, as the generation of supra-subduction-type volcanism commenced already before the late Cenomanian. A setting on the pre-latest Bajocian oceanic crust closer to the Tauride-Anatolide platform-margin is more appropriate, considering also the distribution of the oceanic basins with condensed chert successions in the Tethyan ocean [e.g. Folk and Mc Bridge, 1978; Jenkys and Winterer, 1982].

Such a setting is also in accordance with the depositional ages of pelagic sediments that are present in some slices with coherent successions in the Kütahya-



Bolkardag belt [Göncüoglu *et al.*, 2003], in the Antalya Nappes [Vrielynck *et al.*, 2003] and in the Domuz Dag nappe of the Lycian nappes (fig. 1 inset map), which represent the slope sediments of the Tauride-Anatolide platform [e.g. Brunn *et al.*, 1976]. In both, deposition of condensed pelagic carbonates commences already in early Late Jurassic and continues until Late Cretaceous. The tectonic slices or olistoliths representing the platform-margin sediments in the BFZ [e.g. Okay and Altiner, 2007] and Kütahya Bolkardag Belt [e.g. Göncüoglu *et al.*, 2003] display a similar development with some delay. In both units, Middle and Late Triassic platform carbonates are followed by condensed pelagic siliceous sediments of Late Jurassic– Early Cretaceous age.

Hence, it is concluded that the latest Bajocian to Cenomanian cherts and mudstones represented by the Sögütlü section could have been deposited on the Izmir-Ankara oceanic basin, located just to the north of the coeval condensed pelagic rocks of the Lycian Nappes, representing the slope sediments and the slightly younger pelagic sediments of the Tauride-Anatolide external platform. The distribution and ages of the above-mentioned successions is also the clue for the foundering of the Tauride-Anatolide margin in relation with the foundering of the relatively old and cool Izmir-Ankara oceanic lithosphere.

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Taxa	03-Man-26	03-Man-31	03-Man-33	03-Man-36	03-Man-40	03-Man-41	03-Man-42
Hexasaturnalis nakasekoi DUMITRICA and DUMITRICA-JUD	X						
Tritrabs ewingi s. l. (PESSAGNO)	X						
Acastae diaphorogona s. l. FOREMAN	X						
Archaeospongoprunum sp.	X						
Ristola altissima major BAUMGARTNER and DE WEVER	X						
Mirifusus fragilis s. l. BAUMGARTNER	X						
Spinosicapsa helvetica (RÜST)	X						
Eucyrtidiellum unumaense s. l. (YAO)	X						
Palinandromeda praecrassa (BAUMGARTNER)	X						
Triactoma jonesi (PESSAGNO)		X					
Mirifusus dianae dianae (KARRER)		X					
Spongocapsula palmerae PESSAGNO		X					
Spinosicapsa spinosa (OZVOLDOVA)		X					
Transhsuum brevicostatum (OZVOLDOVA)		X					
Cinguloturris carpatica DUMITRICA		X					
Ristola altissima altissima (RÜST)			X				
Transhsuum sp. cf. *brevicostatum* (OZVOLDOVA)			X				
Fultacapsa sphaerica (OZVOLDOVA)			X				
Sethocapsa sp. A sensu BAUMGARTNER *et al*.			X				
Palinandromeda sp. cf. *P. crassa* (BAUMGARTNER)			X				
Tritrabs hayi (PESSAGNO)				X			
Tetraditryma pseudoplena BAUMGARTNER				X			
Suna sp. cf. *S. echiodes* (FOREMAN)				X			
Perispyridium sp.				X			
Mirifusus dianae minor BAUMGARTNER				X			
Pseudoeucyrtis reticularis MATSUOKA and YAO				X			
Podocapsa amhitreptera FOREMAN				X			
Acaeniotyle umbilicata (RÜST)				X	X		
Godia sp.				X			X
Archaeodictyomitra lacrimula (FOREMAN)					X		
Thanarla brouweri (TAN)					X		
Dorypyle sp.						X	
Archaeodictyomitra sliteri PESSAGNO						X	
Archaeodictyomitra sp. aff. *A. vulgaris* PESSAGNO						X	
Obeliscoites perspicuus (SQUINABOL)						X	
Stichomitra communis SQUINABOL						X	X
Dactyliosphaera silviae SQUINABOL							X
Dictyomitra sp. cf. *D. crassispina* (SQUINABOL)							X
Pseudodictyomitra pentacolensis PESSAGNO							X
Pseudodictyomitra pseudomacrocephala (SQUINABOL)							X
Novixitus sp. cf. *N. mclaughlini* PESSAGNO							X
Amphipyndax conicus NAKASEKO and NISHIMURA							X

FIG. 5. – Occurrence of radiolarian taxa in the Sögütlü section.
FIG. 5. – *Radiolaires présents dans la coupe de Sögütlü.*

◄

PLATE III. – Scanning electron micrographs of the Cretacous radiolarians from the Sögütlü stratigraphic section, Bornova Flysch Zone, western Turkey. Radiolarians shown in figures 1-3 are from sample 03-Man-40, 4-9 are from the sample 03-Man-41, whereas 10-18 are from the sample 03-Man-42.
PL. III. – *Photos prises au microscope électronique à balayage des radiolaires crétacés de la coupe Sögütlü, zone de Flysch de Bornova, Turquie occidentale. Les radiolaires illustrés dans les figures 1-3 sont extraits de l'échantillon 03-Man-40, ceux des fig. 4-9 de l'échantillon 03-Man-41 et enfin ceux des fig. 10-19 de l'échantillon 03-Man-42.*
fig. 1. *Acaeniotyle umbilicata* (RÜST), scale bar = 90 µm.
fig. 2. *Archaeodictyomitra* sp. cf. *A. lacrimula* (FOREMAN), scale bar = 70 µm.
fig. 3. *Thanarla brouweri* (TAN), scale bar = 70 µm.
fig. 4. *Dorypyle* sp., scale bar = 90 µm.
fig. 5. *Archaeodictyomitra sliteri* PESSAGNO, scale bar = 100 µm.
fig. 6-7. *Archaeodictyomitra* sp. aff. *A. vulgaris* PESSAGNO, scale bar = 75 µm.
fig. 8. *Obeliscoites perspicuus* (SQUINABOL), scale bar = 180 µm.
fig. 9. *Stichomitra communis* SQUINABOL, scale bar = 140 µm.
fig. 10. *Dactyliosphaera silviae* SQUINABOL, scale bar = 110 µm.
fig. 11. *Godia* sp., scale bar = 140 µm.
fig. 12. *Dictyomitra* sp. cf. *D. crassispina* (SQUINABOL), scale bar = 85 µm.
fig. 13. *Pseudodictyomitra pentacolensis* PESSAGNO, scale bar = 70 µm.
fig. 14. *Pseudodictyomitra pseudomacrocephala* (SQUINABOL), scale bar = 100 µm.
fig. 15-16. *Novixitus* sp. cf. *N. mclaughlini* PESSAGNO, scale bar = 120 and 90 µm, respectively.
fig. 17. *Amphipyndax conicus* NAKASEKO and NISHIMURA, scale bar = 70 µm.
fig. 18. *Stichomitra communis* SQUINABOL, scale bar = 150 µm.

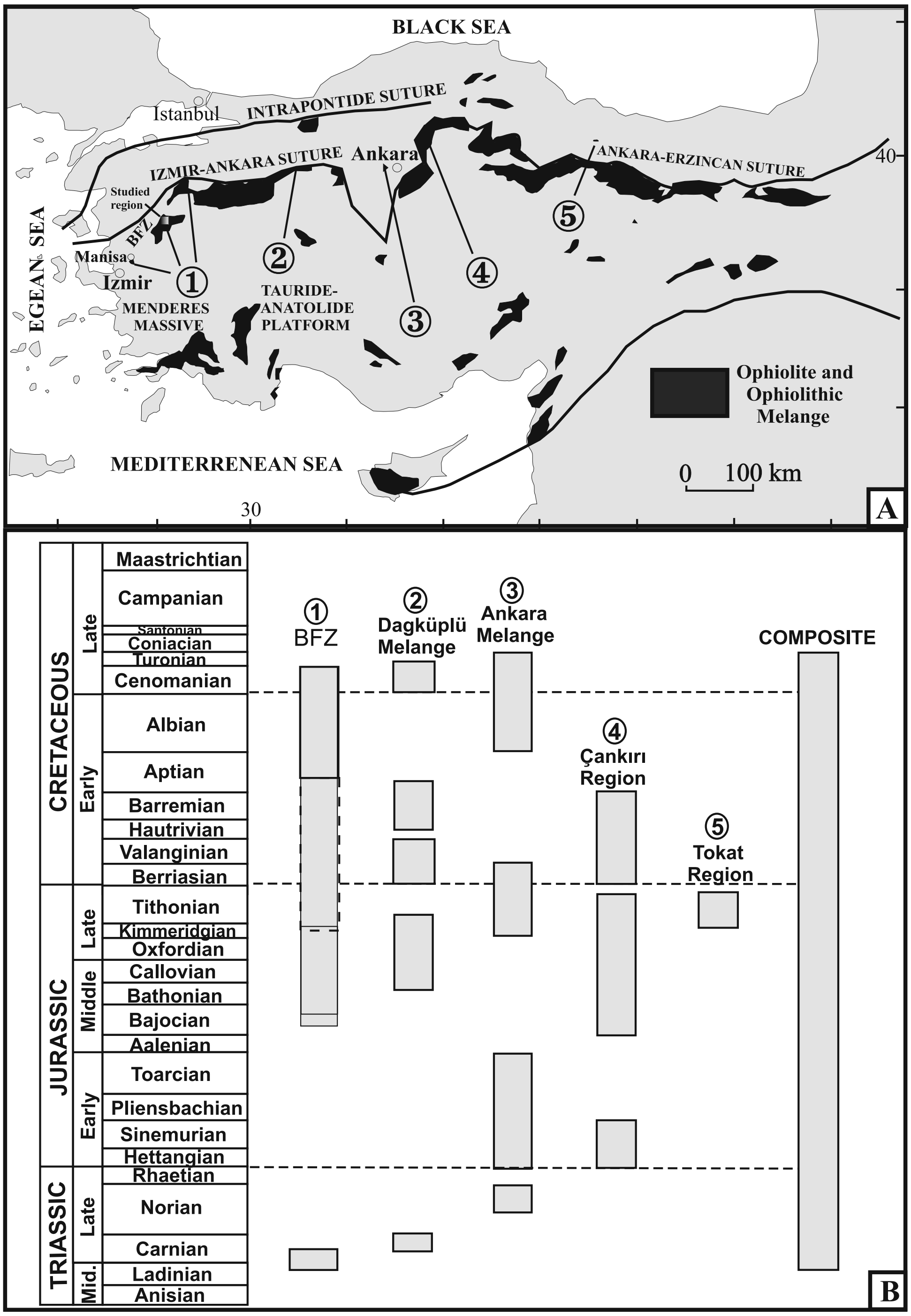

FIG. 6. – A. Suture belts and ophiolite/ophiolitic mélanges in Turkey (compiled after Göncüoglu *et al.*, [1997] and Robertson, [2004]) and locations of radiolarian ages from the Izmir-Ankara-Erzincan suture belt, shaded square indicate the study area, B. Ranges of radiolarian ages from the different parts of the Izmir-Ankara-Erzincan suture belt; 1. The Bornova Flysch Zone from Tekin *et al.* [2006], Göncüoglu *et al.* [2006a], Tekin and Göncüoglu [2007, 2009] and this study, part of the column shown by lines indicate dating in this study (the Sögütlü section); 2. The Dagküplü Mélange from Göncüoglu *et al.* [2000, 2006b, 2010], and Tekin *et al.* [2002]; 3. The Ankara Mélange from Bragin and Tekin [1996], and Tekin [1999]; 4. Cankiri region from Celik [2010], and Üner [2010], 5. Tokat region from Bozkurt *et al.* [1997].

FIG. 6. – A. *Zones de suture et mélanges ophiolitiques/ophiolites en Turquie [d'après Göncüoglu* et al.*, 1997 et Robertson, 2004] et* localités *de terrains datés à l'aide des radiolaires dans la zone de suture d'Izmir-Ankara-Erzincan, la zone ombrée indique la région d'étude,* B. *Répartitions stratigraphiques des datations à radiolaires obtenues des différentes parties de la zone de suture d'Izmir-Ankara-Erzincan*; 1. *Zone de Flysch de Bornova de Tekin* et al. *[2006], Göncüoglu* et al. *[2006a], Tekin and Göncüoglu [2007, 2009] et cette étude (coupe de Sögütlü);* 2. *Mélange de Dagküplü d'après Göncüoglu et al. [2000, 2006b, 2010] et Tekin et al. [2002];* 3. *Mélange d'Ankara de Bragin et Tekin [1996] et Tekin [1999];* 4. *Région de Cankiri de Celik [2010] et Üner [2010],* 5. *Région de Tokat de Bozkurt et al. [1997].*

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