geodiversitas

2020 • 42 • 27

# Late Triassic to Early Jurassic radiolarian, conodont and ammonite assemblages from the Tavuscayiri block, Mersin Mélange, southern Turkey: Time constraints for the T/J boundary and sedimentary evolution of the southern margin of the northern Neotethys

U. Kagan TEKIN, Leopold KRYSTYN, Cengiz OKUYUCU, Yavuz BEDI & Kaan SAYIT

art. 42 (27) — Published on 26 November 2020
www.geodiversitas.com

PUBLICATIONS SCIENTIFIQUES

MUSÉUM NAL HIST NATURELLE

*Geodiversitas* est indexé dans / Geodiversitas *is indexed in:*
– Science Citation Index Expanded (SciSearch®)
– ISI Alerting Services®
– Current Contents® / Physical, Chemical, and Earth Sciences®
– Scopus®

*Geodiversitas* est distribué en version électronique par / Geodiversitas *is distributed electronically by:*
– BioOne® (http://www.bioone.org)

Les articles ainsi que les nouveautés nomenclaturales publiés dans *Geodiversitas* sont référencés par / *Articles and nomenclatural novelties published in* Geodiversitas *are referenced by:*
– ZooBank® (http://zoobank.org)

***Geodiversitas*** est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
**Geodiversitas** *is a fast track journal published by the Museum Science Press, Paris*

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publish:* ***Adansonia***, ***Zoosystema***, ***Anthropozoologica***, ***European Journal of Taxonomy***, ***Naturae***, ***Cryptogamie*** **sous-sections** ***Algologie***, ***Bryologie***, ***Mycologie, Comptes Rendus Palevol***

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr


ISSN (imprimé / *print*) : 1280-9659/ ISSN (électronique / *electronic*) : 1638-9395

# Late Triassic to Early Jurassic radiolarian, conodont and ammonite assemblages from the Tavuscayiri block, Mersin Mélange, southern Turkey: Time constraints for the T/J boundary and sedimentary evolution of the southern margin of the northern Neotethys

**U. Kagan TEKIN**
Department of Geological Engineering, Hacettepe University, 06800, Beytepe, Ankara (Turkey)
uktekin@hacettepe.edu.tr

**Leopold KRYSTYN**
Department of Palaeontology, Vienna University, Geozentrum, Althanstr. 9, Vienna (Austria)
leopold.krystyn@univie.ac.at

**Cengiz OKUYUCU**
Konya Technical University, Department of Geological Engineering, Konya (Turkey)
okuyucucengiz@gmail.com

**Yavuz BEDI**
General Directorate of Mineral Research and Exploration,
Department of Geological Investigation, 06800 Ankara (Turkey)
yavuzbedi@gmail.com

**Kaan SAYIT**
Middle East Technical University,
Department of Geological Engineering, 06800 Ankara (Turkey)
ksayit@metu.edu.tr

Submitted on 25 May 2019 | accepted on 23 October 2019 | published on 26 November 2020

urn:lsid:zoobank.org:pub:1A437774-B5BE-49F2-8DEF-D46F2790484A

Tekin U. K., Krystyn L., Okuyucu C., Bedi Y. & Sayit K. 2020. — Late Triassic to Early Jurassic radiolarian, conodont and ammonite assemblages from the Tavuscayiri block, Mersin Mélange, southern Turkey: Time constraints for the T/J boundary and sedimentary evolution of the southern margin of the northern Neotethys. *Geodiversitas* 42 (27): 493-537. https://doi.org/10.5252/geodiversitas2020v42a27. http://geodiversitas.com/42/27

ABSTRACT
The Mersin Mélange (northwest of Mersin city) includes a variety of large sedimentary blocks/tectonic slices of Palaeozoic and Mesozoic origins. Of these, the latter represents facial and tectonostratigraphic counterparts of the Beysehir-Hoyran Nappes (remnants of the northern Neotethys). The Tavuscayiri Block, located at the center of the mélange and close to the Orbuklukeli hill, is one of such Mesozoic occurrences, with a continuous pelagic sequence from the Upper Triassic to Lower Jurassic. At the Orbuklukeli hill, a succession of middle Norian to Toarcian age has been precisely dated, which starts with conodont assemblages for the Norian and Rhaetian and includes radiolarians for the upper Rhaetian. An acidic tuff layer corresponds to the T-J boundary, which passes above to an increasingly dominating chert-bearing limestone series, marking a gradually deepening-upward of the sequence. The early Hettangian radiolarians are poorly represented, but diverse and well-preserved radiolarians have been retrieved from the middle Hettangian to the Pliensbachian. A total of eighty-five taxa, including fourteen new species, have been determined. In addition to these, one new genus (*Praeudalia* Tekin, n. gen.) has been described from the Rhaetian part of the section. The top of the section is represented by nodular limestones in Ammonitico rosso facies, including a diverse

KEY WORDS
Pelagic assemblages, radiolarian, conodont, southern Turkey, ammonite dating, Late Triassic-Early Jurassic, correlation, Taurides, new genus, new species.

Toarcian ammonite fauna. All lithologies of the Orbuklukeli section along the Tavuscayiri Block can be correlated with the previously described lithologies of the Kayabasi Group/Formation in the Bozkir Unit, and Gülbahar/Gümüslü units in the Lycian Nappes.

**RÉSUMÉ**

*Assemblages de radiolaires, conodontes et ammonites du Trias supérieur au Jurassique inférieur du bloc de Tavuscayiri, Mélange de Mersin, Turquie: contraintes de temps pour la frontière T/J et évolution sédimentaire de la marge sud de la Néotethys du nord.*

Le Mélange de Mersin (au nord-ouest de la ville de Mersin) comprend une diversisté de grands blocs sédimentaires et d'écailles tectoniques d'origines paléozoïque et mésozoïque. Parmi ceux-ci, ces derniers présentent des moulages faciaux et tectonostratigraphiques des nappes de Beysehir-Hoyran (vestiges de la Néotethys du nord). Le bloc Tavuscayiri, situé au centre du Mélange de Mersin, près de la colline d'Orbuklukeli, constitue l'une de ces occurrences mésozoïques, avec une séquence pélagique continue du Trias supérieur au Jurassique inférieur. Sur la colline d'Orbuklukeli, une succession d'âges allant du Norien moyen au Toarcien a été datée avec précision. Elle commence par des assemblages de conodontes pour le Norien et le Rhétien et comprend des radiolaires pour le Rhétien supérieur. Une couche de tuf acide correspond à la limite T-J, qui passe au-dessus d'une série de calcaires à chert de plus en plus dominante, marquant un approfondissement progressif de la séquence. Les radiolaires de l'Hettangien inférieur sont peu représentés, mais un assemblage diversifié et bien conservé de radiolaires a été retrouvé de l'Hettangien moyen au Pliensbachien. Au total, quatre-vingt-cinq taxons, dont quatorze espèces nouvelles, ont été identifiés. De plus, un genre nouveau, *Praeudalia* Tekin, n. gen., est décrit dans la partie qui concerne le Rhétien. Le sommet de la section est représenté par des calcaires nodulaires du faciès Ammonitico rosso, comprenant une faune diversifiée d'ammonites du Toarcien. Tous les niveaux de la coupe Orbuklukeli du bloc Tavuscayiri peuvent être corrélées avec ceux décrits précédemment du groupe/formation Kayabasi, dans l'unité Bozkir et dans les unités Gülbahar/Gümüslü, des nappes lyciennes.

**MOTS CLÉS**
Assemblages pélagiques,
radiolaire,
conodonte,
Turquie du sud,
datation des ammonites,
Trias supérieur-
Jurassique inférieur,
corrélation,
Taurides,
genre nouveau,
espèces nouvelles.

## INTRODUCTION

The end-Triassic mass-extinction is one of the big "five mass extinctions", which caused at least "50 % of genus loss in different realms" (Raup & Sepkoski 1982; Sepkoski 1994; Deenen *et al.* 2010). Due to very low sea-level at the end of the Triassic, depositional gaps exist in the continental shelves in many areas (Hallam 1990, 1997; Hallam & Wignall 1997), with steady transgressions only from the Lower Jurassic (Hettangian-Sinemurian) onwards (Longridge *et al.* 2007). Finding not only complete but also facially continuous stratigraphic sections from the Triassic to Lower Jurassic is therefore very crucial (Longridge *et al.* 2007).

Pelagic fossil assemblages, especially radiolarians of this time interval, have been researched since the 1980s. Compared to the Jurassic, the Rhaetian radiolarians are relatively rarely described from Austria (Kozur & Mostler 1981), United States (Yeh 1989; Orchard *et al.* 2007a), Fareast Russia (Bragin 1991), China (Yang & Mizutani 1991; Ziabrev *et al.* 2004; Yeh & Yang 2006), British Columbia, Canada (Carter 1993; Carter & Hori 2005; Longridge *et al.* 2007), Phillippines (Yeh & Cheng 1996), Japan (Sugiyama 1997; Carter & Hori 2005), Turkey (Tekin 1999, 2002b; Uzuncimen *et al.* 2011), Italy (Bazzucchi *et al.* 2005), Hungary (Palfy *et al.* 2007), Baja California Sur, Mexico (Orchard *et al.* 2007b), Nicaragua (Baumgartner *et al.* 2008) and Montenegro (Crne *et al.* 2011). On the other hand, the researches on the Early Jurassic (Hettangian to Pliensbachian) radiolarians have been carried out in many regions – e.g. the Franciscan Complex, United States (Pessagno & Blome 1980; Pessagno & Whalen 1982); Turkey (Pessagno & Poisson 1981; De Wever 1981a, b, c, 1982a, b; Tekin 2002a; Celik 2010; Tekin *et al.* 2012; Robertson *et al.* 2016); Mexico (Whalen & Pessagno 1984; Whalen & Carter 2002); Japan (Igo & Nishimura 1984); Kishida & Hisada 1985; Sato *et al.* 1986; Sugiyama 1997; Kashigawi 1998; Kashigawi *et al.* 2005; Carter & Hori 2005); British Columbia, Canada (Carter *et al.* 1988; Tipper *et al.* 1991; Carter *et al.* 1998; Cordey 1998; Carter & Hori 2005; Longridge *et al.* 2007); New Zealand (Spörli & Aita 1988; Spörli *et al.* 1989); Germany (Kozur & Mostler 1990); Japan (Hori 1990; Sugiyama 1997; Carter & Hori 2005; Shibutani & Hori 2008); Russian Fareast (Bragin 1991); China (Yang & Mizutani 1991; Yeh & Yang 2006; Xu *et al.* 2019); Montenegro (Goričan 1994; Crne *et al.* 2011); Argentina (Pujana 1996); Phillippines (Yeh & Cheng 1998); Austria (Gawlick *et al.* 2001; O'Dogherty & Gawlick 2008); Peru (Suzuki *et al.* 2002); Italy (Bertinelli *et al.* 2004; Bertinelli & Marcucci 2011); Hungary (Palfy *et al.* 2007) and cosmopolitan by Goričan *et al.* (2006).

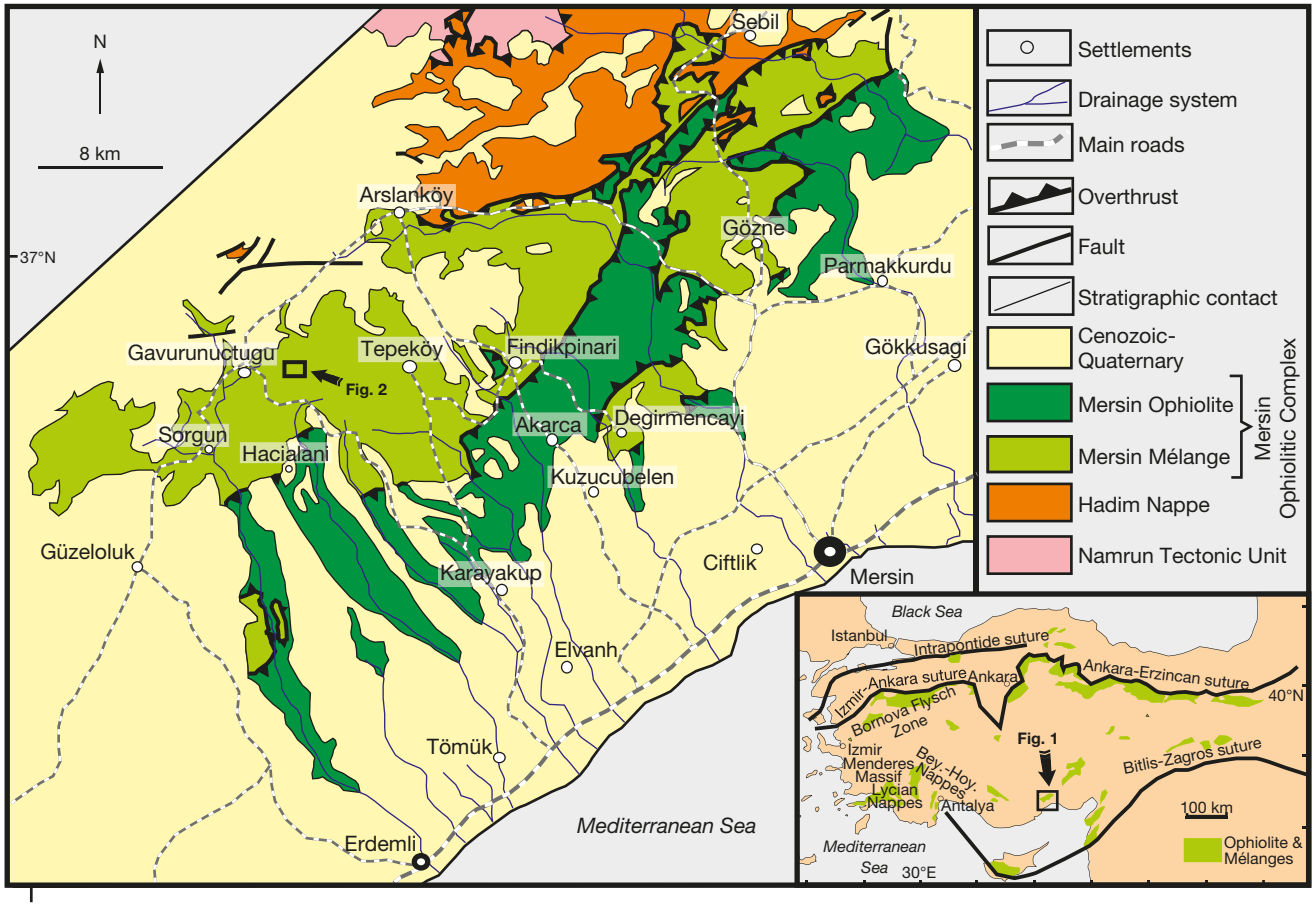



FIG. 1. — Geological base map showing the distribution of the Mersin Ophiolitic Complex and surrounding tectonic units in the northwest of Mersin city, southern Turkey (revised after Senel 2002 and Alan *et al.* 2007). For a detailed geological sketch of the Orbuklukeli section, see Fig. 2. Inset: Distribution of ophiolites and mélanges in Turkey with the location of Fig. 1.

The Mersin Mélange in southern Turkey includes many blocks and tectonic slices of different origins (Tekin *et al.* 2016a). Some of the mega-blocks within the Mersin Mélange consist of Triassic-Jurassic lithologies (Moix *et al.* 2011; Tekin *et al.* 2016a). One of these is the Tavuscayiri Block, originally discussed briefly by Parlak & Robertson (2004) and later named/described by Masset & Moix (2004) and Moix *et al.* (2007, 2011). The Tavuscayiri block at the Orbuklukeli Tepe ("tepe" means "hill" in English) is a well-exposed and complete Upper Triassic to Lower Jurassic pelagic rock suite, which allows complete documentation of the Norian to Liassic history for the northern Pisidian Taurus of more than 500 km in length. Hence, the results are particularly important for the reconstruction of a part of the Early Mesozoic sedimentary evolution of a specific southern margin segment of the northern Neotethys branch (Izmir-Ankara Ocean *sensu* Sengör & Yilmaz 1981 or the Huglu-Pindos Ocean *sensu* Moix *et al.* 2008). This further forms a basis for a more advanced comparison and correlation of previously described, often isolated and/or tectonized, and – as can be demonstrated – incomplete rock series of the Lycian and Beysehir-Hoyran Nappes in a greater region between the cities Burdur and Mersin.

Main objectives of this study thus are: 1) to date the pelagic successions in this mega-block using pelagic assemblages (radiolarians, conodonts, and ammonoids); 2) to compare especially the radiolarian fauna with previously described zonations and studies; and 3) to make correlations between this succession and the pelagic successions that are previously described from the Taurides.

## GEOLOGICAL FRAMEWORK

Detailed biostratigraphical and petrological studies on the ophiolitic mélanges (Raymond, 1984) as remnants of paleo-oceans is crucial, especially on mobile belts such as Turkey, which reflects a complex history of Neotethyan oceans (Sengör & Yilmaz 1981; Göncüoglu *et al.* 1997; Robertson *et al.* 2007; Sayit *et al.* 2017; Tekin *et al.* 2019).

To the northwest of Mersin city in southern Turkey, two different units (the Mersin Mélange and a well-developed ophiolitic body (Mersin Ophiolite) with its sub-ophiolitic metamorphic sole constitute a large tectonic body called the Mersin Ophiolitic Complex (Parlak & Robertson 2004; Moix *et al.* 2007, 2011; Fig. 1). The Mersin Mélange is a typical sedimentary mélange composed of

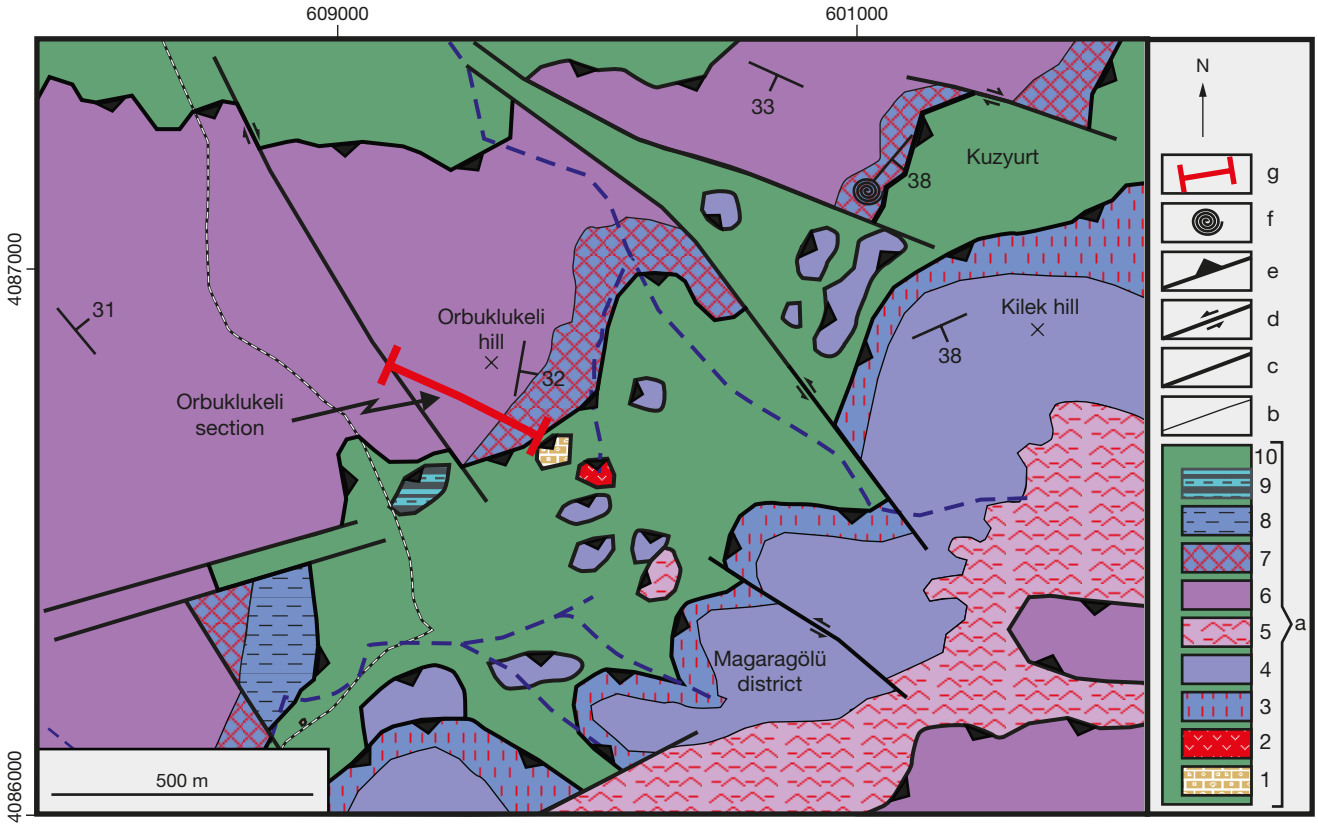



FIG. 2. — Detailed geological map of the Orbuklukeli hill surroundings, northwest of Mersin city (after Tekin *et al.* 2016a). Key: **a**, Mersin Mélange; **1**, Middle Permian brecciated limestone; **2**, Middle Triassic basic volcanic rocks; **3**, Upper Triassic conglomerate, sandstone, and silt-claystone; **4**, Upper Triassic massive platform limestone; **5**, Upper Triassic alternating tuff, tuffite with limestone; **6**, Upper Triassic cherty limestone; **7**, Lower Jurassic alternating chert and limestone (including Ammonitico rosso facies); **8**, Middle-Upper Jurassic radiolarite and mudstone; **9**, Lower Cretaceous alternating chert and mudstone; **10**, Undifferentiated mélange (mainly matrix); **b**, Stratigraphic contact; **c**, Fault; **d**, Strike-slip fault; **e**, Thrust; **f**, Toarcian ammonite fauna near the Kuzyurt region; **g**, Section location (revised after Tekin *et al.* 2016a).

a deformed olistostromal matrix with different sliding blocks of oceanic and continental origins (Tekin *et al.* 2016a). According to the recent studies based on different fossil groups (mainly radiolarians) on this mélange (Moix *et al.* 2007, 2011; Tekin *et al.* 2016a, b; Sayit *et al.* 2017; Okuyucu *et al.* 2018, Forel *et al.* 2019; Tekin *et al.* 2019; Okuyucu *et al.* 2020), the ages of the sedimentary blocks and slices in the mélange vary between the Early Carboniferous (late Tournaisian) to early Late Cretaceous (Turonian), whereas the age of the matrix is Late Cretaceous. Previous studies on the geological characteristics of this mélange were discussed briefly in the recent papers by Tekin *et al.* (2016b), Sayit *et al.* (2017), Okuyucu *et al.* (2018), and Tekin *et al.* (2019). These studies suggested that the lithologies of the Mersin Mélange are equivalent to those from the Beysehir-Hoyran Nappes (Gutnic *et al.* 1968; Brunn *et al.* 1970, 1971) and the certain parts of the Lycian Nappes (Moix *et al.* 2013).

Based on the studies related to the pelagic blocks/tectonic slices in the Mersin Mélange, continuous successions of Late Triassic-Early Jurassic age on the Tavuscayiri mega-block have been studied along the Orbuklukeli section in this study. Detailed characteristics of this section are discussed in the following section.

## PROPERTIES AND CHARACTERISTICS OF THE ORBUKLUKELI SECTION

The section is located to approximately 8 km northeast of Sorgun village and NWW of Mersin city in southern Turkey, lying on the Silifke O32-a2 quadrangle sheet (between 36°55'17"N, 34°13'30"E and 36°55'12"N, 34°13'41"E; Figs 1 and 2). The base and top are tectonically truncated; the base is confined by a strike-slip fault, while the top is terminated by a thrust fault (Fig. 2).

The total thickness of the section is 170 meters, and it can be subdivided into two main parts traceable along the southwestern flank of the Orbuklukeli hill (Figs 3; 4A). The lower part of the section is characterized by thin- to medium-, rarely thick-bedded, gray-colored limestones with gray-colored chert nodules (Fig. 4B, C) or interlayers (Fig. 4D). Particularly at the basal part of the section, several medium-bedded, gray to beige-colored, brecciated limestone bodies with rare gray-colored chert nodules are present (Fig. 4E-G) and may indicate seismicity-induced slumping and redeposition. Identical situations have been described by Moix *et al.* (2007) from a more westerly located section on the Tavuscayiri block. This seems to be common evidence of ongoing syn-sedimentary tectonic activity in the late Late Triassic, following the middle

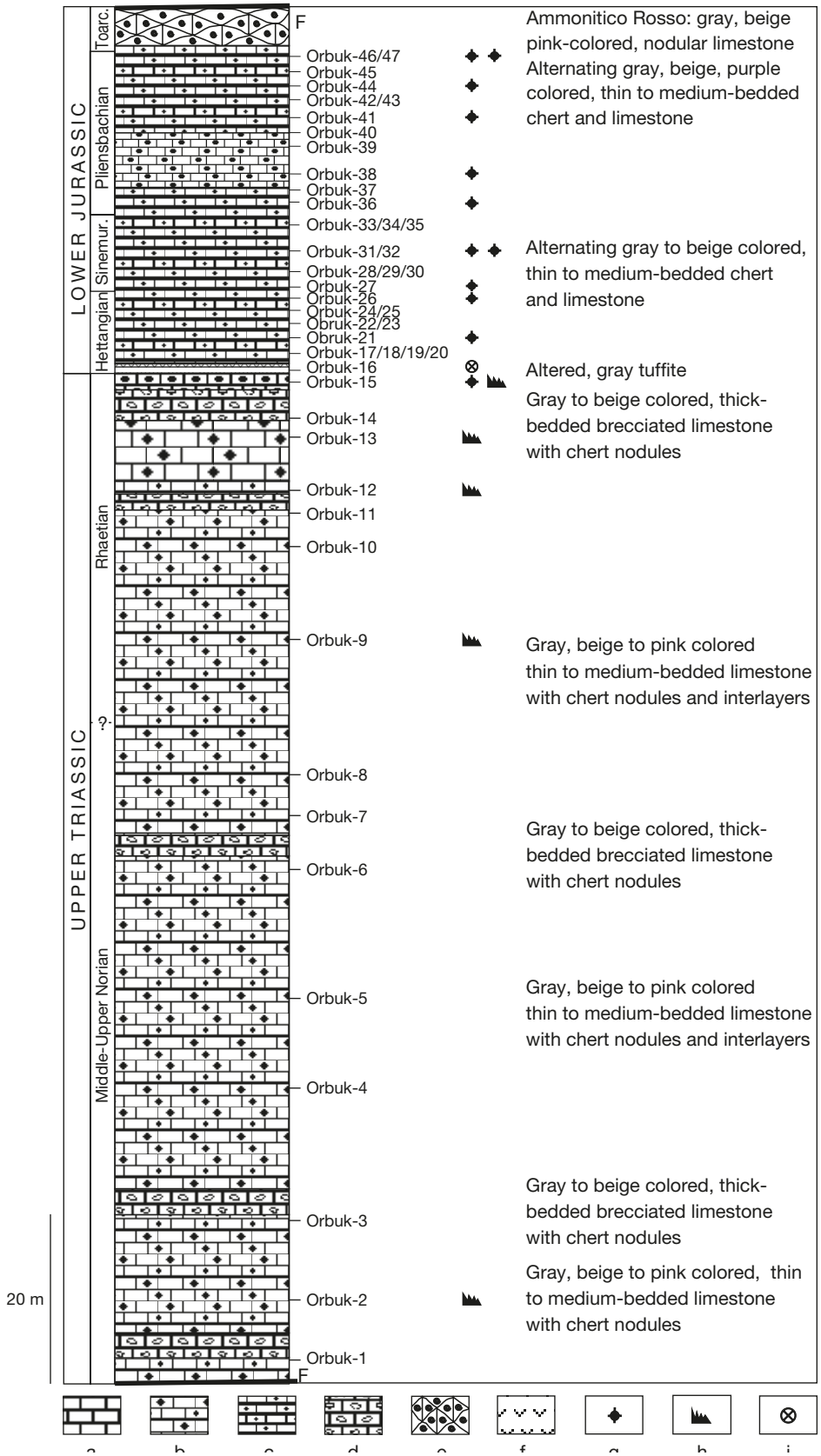



FIG. 3. — Columnar section of the Orbuklukeli section and sampling points. Key: **a**, Limestone; **b**, Limestone with chert nodules; **c**, Alternating chert and limestone with chert nodules; **d**, Brecciated limestone; **e**, Nodular limestone with ammonites; **f**, Tuffite; **g**, Radiolarian occurrence; **h**, Conodont occurrence; **i**, Tuffite sample. Abbreviations: **Sinemur**., Sinemurian; **Toar**., Toarcian.

to early Late Carnian massive volcanic episode. Fifteen samples (from Orbuk-1 to Orbuk-15) have been collected from the 130 meters-thick Upper Triassic part of the section (Fig. 3). As the chert nodules and interlayers are mainly diagenetic (secondary), no radiolarians were obtained from the most levels. Diverse radiolarians could be obtained only from the uppermost part (sample Orbuk-15; Fig. 3). Five samples (Orbuk-2, Orbuk-9, Orbuk-12, Orbuk-13, and Orbuk-15) yielded conodonts indicating middle Norian to Rhaetian ages (Fig. 3).

The upper 40 meters-thick section interval differs in the lithological characteristics (Fig. 4H, I). It starts with a green tuffite layer overlain by thin-bedded, gray-colored limestones with chert nodules (Fig. 4I). These lithologies are followed by thin-bedded, gray-colored limestone alternating with thin, gray-colored chert layers towards the upper part (Fig. 4J, K). Thin- to medium-bedded, gray- or red- to purple-colored limestones with red-colored chert interlayers become the dominant lithologies close to the uppermost part of the section (Fig. 5A-C). Although a total of 31 samples (from Orbuk-17 to Orbuk-47) were collected from this part, radiolarian assemblages were obtained only from 11 chert layers (Orbuk-21, Orbuk-26, Orbuk-27, Orbuk-31, Orbuk-32, Orbuk-36, Orbuk-38, Orbuk-41, Orbuk-44, Orbuk-46, and Orbuk-47), ranging from the middle Hettangian to late Pliensbachian (Fig. 3). The top of the exposed section consists of brownish red-colored, nodular limestones showing typical features of Ammonitico rosso facies (Fig. 5D). A 5 meters-thick level of Ammonitico rosso of the Orbuklukeli section contains rare ammonite fauna, which is early to early Late Toarcian in age based on a very rich and diverse ammonite fauna (Fig. 5E-J) collected along strike of this facies 850 meters to the NE around Kuzyurt (Fig. 2). This facies is in a faulted contact to the matrix of the mélange (Fig. 5K, L).

## BIOCHRONOLOGY

### Material and Methods

Samples were processed by two different acid solutions. Since most of the Upper Triassic part of the section does not contain radiolarians in its chert layers, limestones were processed for conodonts by using formic acid (5-10%). All residues after this process underwent heavy liquid separation using SPT (Sodium Polytungstate) to concentrate the conodonts. By these methods, conodont assemblages were obtained from 5 samples (Orbuk-2, Orbuk-9, Orbuk-12, Orbuk-13, and Orbuk-15) and determined by Leopold Krystyn, Vienna, Austria. Together with the conodonts, a diverse assemblage of pyritized radiolarians was only retrieved from sample Orbuk-15 (Fig. 3).

To extract radiolarian assemblages, all chert samples from the Lower Jurassic part of the Orbuklukeli section were processed with diluted hydrofluoric acid (5-10 % HF) following Dumitrica's (1970) and Pessagno & Newport's (1972) methods. No Radiolaria were obtained from the pelagic limestone layers. Although a total of thirty-two samples (samples from Orbuk-16 to Orbuk-47) were etched with HF acid, radiolarian assemblages could be obtained from 11 samples (Orbuk-21, Orbuk-26, Orbuk-27, Orbuk-31, Orbuk-32, Orbuk-36, Orbuk-38, Orbuk-41, Orbuk-44, Orbuk-46, and Orbuk-47; Fig. 3).

Radiolarian faunas are described in detail in the last chapter. Determination and description of the radiolarian assemblages were done by U. Kagan Tekin, Ankara, Turkey. All holotypes and paratypes of radiolarians in this study are stored in the Palaeontological Collection of the Department of Geological Engineering, Hacettepe University, Ankara.

Ammonites from the Ammonitico rosso limestone were collected and determined by Leopold Krystyn, Vienna, Austria. A more detailed study is planned for a forthcoming paper.

## DATING AND COMPARISON OF DIFFERENT ASSEMBLAGES

As mentioned before, the Orbuklukeli section is separated lithologically and biostratigraphically into two distinct parts, characterized by the Late Triassic and Early Jurassic ages, respectively.

### Late Triassic

The 130 meters-thick Upper Triassic part is mainly composed of gray to beige-colored, thin- to medium-bedded limestone with chert nodules/layers and some brecciated limestone interlayers. The processed samples delivered conodonts, but no Radiolaria were recovered except for the topmost sample Orbuk-15. Orbuk-2 is the first conodont-bearing sample with *Epigondolella* sp. cf. *E. postera* Kozur & Mostler, 1971 (Fig. 13N), indicating a middle Norian age (Kozur & Mostler 1971; Table 1) 10 meters above the section base (Fig. 3).

Over the next 80 meters, no conodont could be recovered, but the interval should span the middle to upper Norian and at least half of the Rhaetian according to the sample Orbuk-9 which contains *Misikella hernsteini* (Mostler, 1967) (Fig. 13P) and *M. rhaetica* Mostler, 1978 (Fig. 13U). A middle Rhaetian age is still recorded 25 meters above in the sample Orbuk-12, again with *Misikella hernsteini, M. rhaetica*, and *Hindeodella* sp. (Kozur & Mock 1974; Mostler *et al.* 1978; Krystyn 2008; Table 1). Finally, the samples Orbuk-13 and, especially, Orbuk-15 contain *Misikella posthernsteini* Kozur & Mock, 1974 (Fig. 13Q-T), and *M. ultima* Kozur & Mock, 1991 (Fig. 13V-X), indicating for the last 15 meters till the very top a latest Rhaetian age (Krystyn 2008).

The sample Orbuk-15 contains, beside conodonts, pyritized radiolarians, e.g. *Betraccium kennecottense* Carter, 1993 (Fig. 6A), *B. perilense* Carter, 1993 (Fig. 6B), *Pantanellium fosteri* Pessagno & Blome, 1980 (Fig. 6G), *Serilla tledoensis* (Carter, 1993) (Fig. 7X, Y), *Ferresium* sp. cf. *F. teekwoonense* Carter, 1993 (Fig. 9U), *Canoptum merum* Pessagno & Whalen, 1982 (Fig. 11Q), and *C. rhaeticum* Kozur & Mostler, 1981 (Fig. 12A, B). Also, new radiolarian taxa – e.g. *Praeudalia rhaetica* Tekin, n. gen., n. sp. (Fig. 7A-D), *Canoptum cephalobulbosum* Tekin, n. sp. (Fig. 11K-O), *C. productum* Tekin,


Fig. 4. — Field photographs of the Orbuklukeli section: **A**-**G**, Upper Triassic part of the section; **A**, General view of the Orbuklukeli section around Orbuklukeli hill, view from southwest to northeast; **B**, Basal part of the section represented by medium to thick-bedded, gray-colored limestones with chert nodules; **C**, Medium-bedded, gray to yellow-colored limestones with chert nodules where sample Orbuk-3 was collected, overlain by meter-thick mass-flow bed; **D**, Thin to medium-bedded, gray to beige-colored limestones of sample Orbuk-10 with thin-bedded, gray-colored chert interlayers; **E**, Medium-bedded, gray to beige-colored, brecciated limestones with rare gray-colored chert nodules and beds where sample Orbuk-12 was obtained; **F**, Brecciated limestones with pyritized chert and limestone pebbles from where sample Orbuk-13 was collected; **G**, The upper part of the Upper Triassic sequence of the section representing by thin to medium-bedded, gray to beige-colored, locally brecciated limestones with chert nodules; **H**, The upper part of the limestones with chert nodules of Late Triassic age followed by Early Jurassic chert-rich platy limestone; **I**, The boundary between Upper Triassic limestones with chert nodules, tuffite layer and thin-bedded, chert-rich limestone of Early Jurassic age; **J**, Basal part of the Lower Jurassic sequence characterized by alternating thin-bedded, gray-colored limestone and thin-bedded, gray-colored chert from where samples from Orbuk-16 to Orbuk-20 have been collected; **K**, Alternating thin-bedded, gray-colored limestone, and thin-bedded, gray-colored chert corresponding to the level of sample Orbuk-30. Abbreviation: **T.**, Tuffite.

TABLE 1. — Distribution of radiolarian and conodont taxa in samples from Orbuklukeli section. Three zonation schemes (Carter 1993 for Rhaetian part, Carter *et al.* 1998 for Hettangian-Sinemurian part and Carter *et al.* 2010 for Pliensbachian part of the Orbuklukeli section) were applied to this study. Abbreviation: **M.N.**, Middle Norian.

| Age | Upper Triassic | | | | | Lower Jurassic | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MN | Rhaetian | | | | Hettangian | | Sinemurian | | | Pliensbachian | | | | | |
| Radiolarian zones (Ua) | | | | | 16-27 | ?1-3 | 4-7 | 11 | | 14-15 | 3-4-?5 | | | | 10-22 | |
| Samples | Orbuk-2 | Orbuk-9 | Orbuk-12 | Orbuk-13 | Orbuk-15 | Orbuk-21 | Orbuk-26 | Orbuk-27 | Orbuk-31 | Orbuk-32 | Orbuk-36 | Orbuk-38 | Orbuk-41 | Orbuk-44 | Orbuk-46 | Orbuk-47 |
| **Conodonta** | | | | | | | | | | | | | | | | |
| *Epigondolella* sp. cf. *E. postera* Kozur & Mostler, 1971 | × | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| *Misikella hernsteini* (Mostler, 1967) | – | × | × | – | – | – | – | – | – | – | – | – | – | – | – | – |
| *Misikella rhaetica* Mostler, 1978 | – | × | × | – | – | – | – | – | – | – | – | – | – | – | – | – |
| *Hindeodella* sp. | – | – | × | – | – | – | – | – | – | – | – | – | – | – | – | – |
| *Misikella posthernsteini* Kozur & Mock, 1974 | – | – | – | × | × | – | – | – | – | – | – | – | – | – | – | – |
| *Misikella ultima* Kozur & Mock, 1991 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| **Radiolaria** | | | | | | | | | | | | | | | | |
| *Betraccium kennecottense* Carter, 1993 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Betraccium perilense* Carter, 1993 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Pantanellium fosteri* Pessagno & Blome, 1980 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Praeudalia rhaetica* Tekin, n. gen., n. sp. | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Serilla tledoensis* (Carter, 1993) | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Ferresium* sp. cf. *F. teekwoonense* Carter, 1993 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Canoptum cephalobulbosum* Tekin, n. sp. | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Canoptum productum* Tekin, n. sp. | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Canoptum rarum* Tekin, n. sp. | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Canoptum rhaeticum* Kozur & Mostler, 1981 | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – | – |
| *Canoptum merum* Pessagno & Whalen, 1982 | – | – | – | – | × | ? | ? | × | × | – | – | – | – | – | – | – |
| *Mesosaturnalis artus* (Donofrio & Mostler, 1978) | – | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – |
| *Mesosaturnalis octospinus* Sugiyama, 1997 | – | – | – | – | – | × | – | – | – | – | – | – | – | – | – | – |
| *Thurstonia gibsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – | – |
| *Pantanellium kluense* Pessagno & Blome, 1980 | – | – | – | – | – | – | × | × | – | – | – | – | – | – | – | – |
| *Farcus* sp. A | – | – | – | – | – | – | × | × | – | – | – | – | – | – | – | – |
| *Pantanellium tanuense* Pessagno & Blome, 1980 | – | – | – | – | – | – | × | × | × | – | – | – | – | – | – | – |
| *Pantanellium freboldi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | × | × | × | – | – | – | – | – | – | – |
| *Novamuria impensa* (Whalen & Carter *in* Carter, Whalen & Guex, 1998) | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – | – |
| *Praehexasaturnalis poultoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – | – |
| *Acanthotetrapaurinella kennecottensis* (Carter *in* Longridge, Carter, Smith & Tipper, 2007) | – | – | – | – | – | – | × | × | ? | × | – | – | – | – | – | – |
| *Tetrapaurinella sphaerica* Tekin, n. sp. | – | – | – | – | – | – | × | × | × | × | – | – | – | – | – | – |
| *Charlottea elegantissima* Tekin, n. sp. | – | – | – | – | – | – | × | × | ? | × | – | – | – | – | – | – |
| *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler, 1978) | – | – | – | – | – | – | × | × | × | × | – | – | – | – | – | – |
| *Trexus dodgensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | × | × | ? | × | – | – | – | – | – | – |
| *Paurinella liassica* Tekin, n. sp. | – | – | – | – | – | – | × | × | ? | × | – | – | – | – | – | – |
| *Pantanellium giganteum* Tekin, n. sp. | – | – | – | – | – | – | × | × | × | ? | × | – | – | – | – | – |
| *Praehexasaturnalis tetraradiatus* Kozur & Mostler, 1990 | – | – | – | – | – | – | × | × | × | × | ? | ? | × | × | – | – |
| *Udalia primaeva* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Orbiculiformella* sp. A | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Danubea* sp. A | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Laxtorum obscurum* Tekin, n. sp. | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Atalantica* sp. A | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Farcus* sp. B | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Bipedis helenae* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – | – |
| *Droltus laseekensis* Pessagno & Whalen, 1982 | – | – | – | – | – | – | – | × | × | – | – | – | – | – | – | – |
| *Thurstonia minutaglobus* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – |
| *Udalia dennisoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – |
| *Droltus hecatensis* Pessagno & Whalen, 1982 | – | – | – | – | – | – | – | × | × | × | – | – | – | – | – | – |
| *Canoptum striatum* (Kozur & Mostler, 1990) | – | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – |

TABLE 1. — Continuation.

| Age | Upper Triassic | | | | | Lower Jurassic | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MN | Rhaetian | | | | Hettangian | | Sinemurian | | | Pliensbachian | | | | | |
| Radiolarian zones (Ua) | | | | | 16-27 | ?1-3 | 4-7 | 11 | | 14-15 | 3-4-?5 | | | | 10-22 | |
| Samples | Orbuk-2 | Orbuk-9 | Orbuk-12 | Orbuk-13 | Orbuk-15 | Orbuk-21 | Orbuk-26 | Orbuk-27 | Orbuk-31 | Orbuk-32 | Orbuk-36 | Orbuk-38 | Orbuk-41 | Orbuk-44 | Orbuk-46 | Orbuk-47 |
| **Radiolaria (continuation)** | | | | | | | | | | | | | | | | |
| *Bipedis hannai* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | ? | × | – | – | – | – | – | – |
| *Canoptum columbiaense* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | × | ? | × | × | × | – | – | – | – |
| *Praehexasaturnalis merici* Tekin, 2002 | – | – | – | – | – | – | – | × | ? | ? | ? | ? | ? | ? | × | × |
| *Pseudoacanthocircus* sp. B | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – | – |
| *Orbiculiformella pulchra* Tekin, n. sp. | – | – | – | – | – | – | – | – | × | × | – | – | – | – | – | – |
| *Tozerium orbuklukeliense* Tekin, n. sp. | – | – | – | – | – | – | – | – | × | × | – | – | – | – | – | – |
| *Stauroacanthocircus* ? *poetschensis* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | × | ? | ? | × | – | – | – | – |
| *Stauroacanthocircus dickinsoni* (Yeh, 1989) | – | – | – | – | – | – | – | – | × | ? | ? | ? | ? | ? | ? | × |
| *Gorgansium alpinum* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Orbiculiformella* ? *trispina trispina* (Yeh, 1987) | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Charlottea johnsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Palaeosaturnalis blomei* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Stauroacanthocircus* sp. A | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Droltus eurasiaticus* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Droltus* sp. aff. *D. eurasiaticus* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Laxtorum breve* Tekin, n. sp. | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Atalantria emmela* (Cordey & Carter, 1996) | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Pseudoeucyrtis aquila* (Whalen & Carter *in* Carter, Whalen & Guex, 1998) | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Pseudoeucyrtis busuangaensis* (Yeh & Cheng, 1998) | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Farcus graylockensis* Pessagno, Whalen & Yeh, 1986 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Saitoum* sp. aff. *S. triumphense* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Saitoum* sp. A | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Ares sutherlandi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Bipedis douglasi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – | – |
| *Beatricea sanpabloensis* (Whalen & Carter, 2002) | – | – | – | – | – | – | – | – | – | × | × | – | – | – | – | – |
| *Anaticapitula anatiformis* (De Wever, 1982) | – | – | – | – | – | – | – | – | – | × | ? | × | – | – | – | – |
| *Thurstonia timberensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998 | – | – | – | – | – | – | – | – | – | × | ? | ? | ? | ? | × | × |
| *Udalia infrequens* Tekin, n. sp. | – | – | – | – | – | – | – | – | – | – | × | – | – | – | – | – |
| *Orbiculiformella callosa* (Yeh, 1987) | – | – | – | – | – | – | – | – | – | – | × | ? | × | – | – | – |
| *Cyclastrum scammonense* Whalen & Carter, 2002 | – | – | – | – | – | – | – | – | – | – | × | ? | ? | × | – | – |
| *Paronaella grahamensis* Carter *in* Carter, Cameron & Smith, 1988 | – | – | – | – | – | – | – | – | – | – | × | × | × | × | ? | × |
| *Palaeosaturnalis liassicus* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | × | – | – | – | – |
| *Palaeosaturnalis schaafi* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | × | – | – | – | – |
| *Pseudoacanthocircus mediospinosus* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | × | ? | × | – | – |
| *Palaeosaturnalis subovalis* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | × | ? | × | – | – |
| *Paronaella tripla* De Wever, 1981 | – | – | – | – | – | – | – | – | – | – | – | – | × | – | – | – |
| *Charlottea* sp. A | – | – | – | – | – | – | – | – | – | – | – | – | × | × | – | – |
| *Gorgansium gongyloideum* Kishida & Hisada, 1985 | – | – | – | – | – | – | – | – | – | – | – | – | × | × | – | – |
| *Tozerium* sp. A | – | – | – | – | – | – | – | – | – | – | – | – | × | × | – | – |
| *Crucella mirabunda* Whalen & Carter, 2002 | – | – | – | – | – | – | – | – | – | – | – | – | – | × | – | – |
| *Pseudoacanthocircus mocki* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | – | – | × | – | – |
| *Pseudoacanthocircus troegeri* Kozur & Mostler, 1990 | – | – | – | – | – | – | – | – | – | – | – | – | – | × | – | – |
| *Emiluvia prisca* Tekin, n. sp. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | × | × |
| *Katroma ninstintsi* Carter *in* Carter, Cameron & Smith, 1988 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | × | × |
| *Crucella mijo* De Wever, 1981 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | × |

n. sp. (Fig. 11R-U), and *C. rarum* Tekin, n. sp. (Fig. 11V-X) were obtained from this sample (Table 1). Although some of the taxa are long-ranging (e.g. *Betraccium perilense*, *Pantanellium fosteri* and *Canoptum rhaeticum* (upper Norian to Rhaetian) and *Canoptum merum* (Rhaetian to lower Sinemurian) according to Pessagno & Blome (1980), Kozur & Mostler (1981), Pessagno & Whalen (1982), Carter (1993), Sugiyama (1997), Tekin (1999), three of the taxa (*Betraccium*

*kennecottense*, *Serilla tledoensis* and *Praeudalia rhaetica* Tekin, n. gen., n. sp. previously described as Spumellaria gen. et sp. indet. B by Carter (1993) have shorter ranges and are only known from the Rhaetian strata (Carter 1993; Tekin 1999; Fig. 14). *Serilla tledoensis* and *Betraccium kennecottense* also co-occur in the strata, corresponding to the upper Rhaetian (UA16-27 of Carter 1993). They can be correlated with the assemblages 2c-2d belonging to the upper *Proparvicingula moniliformis* Zone, and assemblage 3 belonging to the *Globolaxtorum tozeri* Zone. This age assignment fits well with the conodont dating (Fig. 14).

### Early Jurassic

A 1-2 cm-thick, thin, and fine-grained green- colored acidic tuffite layer is located directly above the last conodont-bearing sample Orbuk-15 (Figs 3; 4I). Thus, the Triassic/Jurassic boundary is tentatively assigned to the ash layer.

Two meters above this level, the first radiolarian-bearing sample (Orbuk-21) contains many sponge spicules and only some saturnalids – e.g. *Mesosaturnalis artus* (Donofrio & Mostler, 1978) (Fig. 10B, C) and *M. octospinus* Sugiyama, 1997 (Fig. 10D, E). This situation would be explained by a relatively shallower basin at the base of the Jurassic. *Mesosaturnalis artus* is known from the upper Norian to the upper Pliensbachian (Donofrio & Mostler 1978; Yang & Mizutani 1991; Sugiyama 1997) and *M. octospinus* from from the upper Norian strata in Japan (Sugiyama 1997), but the stratigraphic ranges of these species are not currently confirmed from other regions. Although the radiolarian assemblage of the sample Orbuk-21 is not age significant, an early to middle Hettangian (UA1-3) age corresponding to *Canoptum merum*, *Pseudoeucyrtis aquila* (Whalen & Carter *in* Carter, Whalen & Guex, 1998) and lower part of *Pantanellium browni* Zone of Carter *et al.* (1998) is presumably assigned due to its stratigraphic position above the late Rhaetian and 5 meters below the sample Orbuk-26 of middle to late Hettangian age (Fig. 14).

The Sample Orbuk-26, located 7.5 meters above the tuffite, contains a more diverse radiolarian fauna (e.g. *Thurstonia gibsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 7K-M), *Pantanellium freboldi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 6H-J), *P. kluense* Pessagno & Blome, 1980 (Fig. 6P), *P. tanuense* Pessagno & Blome, 1980 (Fig. 6Q, R), *Novamuria impensa* (Whalen & Carter *in* Carter, Whalen & Guex, 1998) (Fig. 6S-U), *Acanthotetrapaurinella kennecottensis* (Carter *in* Longridge, Carter, Smith & Tipper, 2007) Group (Fig. 8A-H), *Praehexasaturnalis poultoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 10H, I), *P. tenuispinosus* (Donofrio & Mostler, 1978) (Fig. 10J, K), *P. tetraradiatus* Kozur & Mostler, 1990 (Fig. 10L, M), *Trexus dodgensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 11G-J) and *Farcus* sp. A (Fig. 12T, U) (Table 1). Many of these species were also found in Orbuk-27, Orbuk-31, and stratigraphically younger samples (Table 1). Additionally, new radiolarian taxa – e.g. *Pantanellium giganteum* Tekin, n. sp. (Fig. 6K-O), *Paurinella liassica* Tekin, n. sp. (Fig. 8I-O), *Tetrapaurinella sphaerica* Tekin, n. sp. (Fig. 8P-V) and *Charlottea elegantissima* Tekin, n. sp. (Fig. 9J-L) were determined from this sample. Of these taxa, the FAD of *Pantanellium freboldi* is recorded in UA4 (Carter *et al.* 1998), whereas *Thurstonia gibsoni* has its last occurrence in UA7 (Carter *et al.* 1998). Based on this, and on the previous studies by Tekin (2002a), Hori *et al.* (2004), Goričan *et al.* (2006), a middle to late Hettangian age corresponding to upper part of the *Pantanellium browni* and lower part of the *Crucella hettangica* Zone (Carter *et al.* 1998; Fig. 14) is assigned to the sample Orbuk-26.

New faunal elements appear with sample Orbuk-27, including the FAD of some taxa – e.g. *Udalia dennisoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 7E), *U. primaeva* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 7H-J), *Thurstonia minutaglobus* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 7N), *Orbiculiformella* sp. A (Fig. 9H), *Danubea* sp. A (Fig. 9I), *Praehexasaturnalis merici* Tekin, 2002 (Fig. 10F-G), *Droltus hecatensis* Pessagno & Whalen, 1982 (Fig. 11C), *Droltus laseekensis* Pessagno & Whalen, 1982 (Fig. 11D-F), *Canoptum columbiaense* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 11P), *C. striatum* (Kozur & Mostler, 1990) (Fig. 12C), *Atalantria* sp. A (Fig. 12O), *Farcus* sp. B (Fig. 12V), *Bipedis hannai* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 13J-L) and *B. helenae* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 13M). A similar assemblage also occurs in the sample Orbuk-31 (Table 1). In addition, both Orbuk-27 and Orbuk-31 include three new species – e.g. *Orbiculiformella pulchra* Tekin, n. sp. (Fig. 9A-E), *Tozerium orbuklukeliense* Tekin, n. sp. (Fig. 9P-R) and *Laxtorum obscurum* Tekin, n. sp. (Fig. 12K, L). According to Carter *et al.* (1998), two taxa within these assemblages are stratigraphically highly important: *Droltus laseekensis* with the FAD in UA11 and *Pantanellium tanuense* with the last appearance in UA11. Based on this fact, an early Sinemurian age is assigned to the samples Orbuk-27 and Orbuk-31, corresponding to the upper part of the *Crucella hettangica* Zone of Carter *et al.* (1998; Fig. 14).

Moreover, many radiolarian taxa – e.g. *Gorgansium alpinum* Kozur & Mostler, 1990 (Fig. 6C, D), *Beatricea sanpabloensis* (Whalen & Carter, 2002) (Fig. 6V), *O.* ? *trispina trispina* (Yeh, 1987) (Fig. 9F, G), *Charlottea johnsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 9M, N), *Palaeosaturnalis blomei* Kozur & Mostler, 1990 (Fig. 9V), *Stauroacanthocircus* sp. A (Fig. 10R), *Droltus eurasiaticus* Kozur & Mostler, 1990 (Fig. 10X, Y), *Droltus* sp. aff. *D. eurasiaticus* (Fig. 11A, B), *Atalantria emmela* (Cordey & Carter, 1996) (Fig. 12M, N), *Pseudoeucyrtis aquila* (Whalen & Carter *in* Carter, Whalen & Guex, 1998) (Fig. 12P, Q), *Pseudoeucyrtis busuangaensis* (Yeh & Cheng, 1998) (Fig. 12R), *Farcus graylockensis* Pessagno, Whalen & Yeh, 1986 (Fig. 12S), *Saitoum* sp. aff. *S. triumphense* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Figs 12Y; 13A), *Saitoum* sp. A (Fig. 13B), *Ares sutherlandi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 13F, G), and *Bipedis douglasi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 13H, I) first appear and are only found in the sample Orbuk-32 (Table 1). In addition to them, one new species (*Laxtorum breve* Tekin, n. sp.) was also found. As two well-known species (*Atalantria emmela* and *Ares sutherlandi*) first appear in UA14 while three species (*Charlottea johnsoni*,

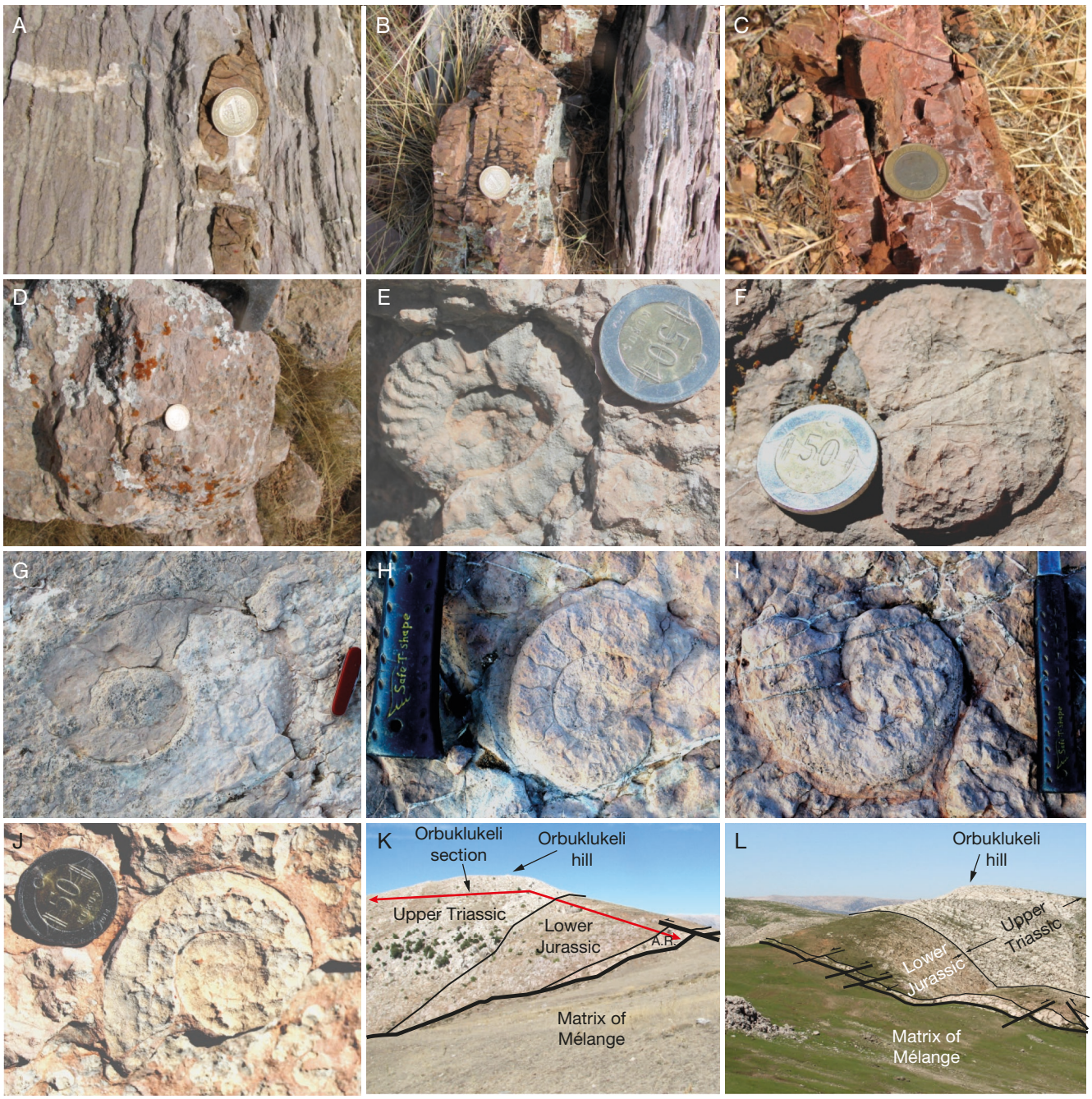



Fig. 5. — Field photographs from the Lower Jurassic part of the section: **A**, Thin to medium-bedded, gray, red to purple-colored limestones with red-colored chert interlayers from where the sample Orbuk-39 was collected; **B**, Alternating thin-bedded, purple-colored limestone, and thin-bedded, red-colored chert corresponding to the level of sample Orbuk-42; **C**, Thin-bedded, red-colored cherts with thin-bedded, purple-colored limestone interlayers of the sample point Orbuk-45; **D**, General view of purple-colored, nodular limestones showing typical features of Ammonitico Rosso facies from the top of the section; **E-J**, Different ammonite taxa from the Ammonitico rosso facies in the section place and Kuzyurt region to the 850 m NE of section place (**E**, *Pseudomercaticeras* sp.; **F**, phylloceratid; **G**, **H**, **J**, ? harpoceratid; **I**, lytoceratid); **K**, General view from southwest to northeast showing section location; **L**, General view from southeast to northwest showing the eastern side of Orbuklukeli hill. Abbreviation: **A.R.**, Ammonitico rosso.

*Pseudoeucyrtis aquila* and *Bipedis hannai*) have the last occurrence in UA15, the sample Orbuk-32 is assigned to UA14-15 belonging to the *Parahsuum simplum* Zone of Carter *et al.* (1998). The chronostratigraphic assignment of this sample is also the early Sinemurian (Fig. 14; Table 1).

Higher up in the section, radiolarians are not present in the following 6 meters (samples Orbuk-33, Orbuk-34, and Orbuk-35). This interval is assumed to correspond to the upper Sinemurian and to be coeval to the radiolarian assemblages of the *Canutus rockfishensis/Wrangellium thurstonense* and *Jacus* ? *sandspitensis* Zones of Carter *et al.* (1998) because it is followed by the sample Orbuk-36 with again a diverse fauna (Table 1) containing taxa, such as *Cyclastrum scammonense* Whalen & Carter, 2002 (Fig. 7S, T) and

*Orbiculiformella callosa* (Yeh, 1987) (Fig. 8W-Y) only known from the lower Pliensbachian strata (Yeh 1987a; Carter *et al.* 1988; Whalen & Carter 2002; Carter *et al.* 2010). It also includes one new species (*Udalia infrequens* Tekin, n. sp.; Fig. 7F, G). The samples Orbuk-38, Orbuk-41 and Orbuk-44 contain similar radiolarian assemblages to the sample Orbuk-36 (Table 1). Within the radiolarian fauna of these four samples, *Paronaella grahamensis* Carter *in* Carter, Cameron & Smith, 1988 (Fig. 7U, V) first appears in UA3, while the last appearance datum of *Praehexasaturnalis tetraradiatus* (Fig. 10L, M) is in UA4 and that of *Charlottea* sp. A *sensu* Whalen & Carter, 2002 (Fig. 9O) in UA5 based on the zonal scheme of Carter *et al.* (2010). This interval is therefore assigned to the lowermost Pliensbachian (UA3-4 of Carter *et al.* 2010 and UA5 cannot be excluded) corresponding to the *Canutus tipperi*/*Katroma clara* Zone of Carter *et al.* (2010) (Table 1; Fig. 14). Of interest may be the finding of a single large ammonite of the lower Pliensbachian genus *Platypleuroceras* within the upper chert-rich, gray-red limestone at a level corresponding approximately to the sample Orbuk-41. This specimen confirms the radiolarian-based dating of this interval and is found 2.1 km southwest of the section (36°55'28"N, 34°14'9"E; Fig. 2), about 10 meters below the Ammonitico rosso.

The last two productive radiolarian samples (Orbuk-46 and Orbuk-47) (Table 1) contain *Emiluvia prisca* Tekin, n. sp. (Fig. 6W-Y), *Thurstonia timberensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 7O), *Crucella mijo* De Wever, 1981 (Fig. 7P), *Paronaella grahamensis* (Fig. 7U, V), *Praehexasaturnalis merici* (Fig. 10F, G), *Stauroacanthocircus dickinsoni* (Yeh, 1989) (Fig. 10N, O) and *Katroma ninstintsi* Carter *in* Carter, Cameron & Smith, 1988 (Fig. 13C-E) (Table 1). Within this assemblage, *Crucella mijo* appears first in UA10 corresponding to the upper Lower Pliensbachian, while the LAD of *Katroma ninstintsi* is in UA23, in the upper Pliensbachian, according to Carter *et al.* (2010). The ages of the last two samples from the chert with limestone interval are the late Early to late Pliensbachian, following zonal scheme of Carter *et al.* (2010) (Table 1; Fig. 14). The overlying *c.* 5 meters thick Ammonitico rosso is poor in fossils at the Orbuklukeli hill except some worn specimens of *Calliphylloceras* sp. However, 850 m along strike to the NE of this facies (36°55'28"N, 34°14'9"E; Fig. 2), the limestone produced quite a rich fauna of over 60 ammonoid specimens. Since most of them were fragmentary and somewhat in bad preservation as internal molds, the determination generally allowed a generic, and only in rare cases a specific attribution. The in-situ findings included nearly exclusively phylloceratids except for a single *Nodicoeloceras* sp. from the topmost bed. The common occurrence of Phylloceratoceae (*c.* 50%) highlights the Mediterranean character of the fauna consisting of *Phylloceras nilssoni* (Hebert, 1866), *Meneghiniceras lariense* (Meneghini, 1875), *Lytoceras* sp., *Nodocoeloceras* sp., *Harpoceras* sp., *Pseudomercaticeras* sp., *Grammoceras* cf. *fallaciosum* (Bayle, 1878) and *Polyplectus discoides* (Zieten, 1831), and prove an early to early Late Toarcian age.

## CORRELATION OF THE TAVUSCAYIRI SUCCESSION TO THE PREVIOUSLY DESCRIBED UNITS IN THE TAURIDES

According to Masset & Moix (2004) and Moix *et al.* (2007), the sequence of the Tavuscayiri Block starts with brecciated beds, followed by conglomerates and sandstones. This sequence is followed by the shallow-water carbonates of early Carnian age. This limestone sequence is overlain by a deepening upward sequence of ammonitico rosso facies, and tuffites with pelagic limestone interlayers of middle to early/middle Late Carnian age (Tekin *et al.* 2016a). Related to a regression event over tuffites, limestone with sponge spicules is deposited at the type locality of the Tavuscayiri Block in the upper Upper Carnian (Moix *et al.* 2007; Tekin *et al.* 2016a). Higher in the sequence, this part is followed by pelagic limestones with several debris flows and calciturbidites in the Norian. Although it was claimed that this limestone is overlain by a chert sequence of Bathonian age according to Moix *et al.* (2007), the recent study by Tekin *et al.* (2016a) clearly reveals the presence of the Upper Triassic pelagic limestones (Norian-Rhaetian) with debris flows, and overlying pelagic limestone and chert sequence of Early Jurassic age (Hettangian-Sinemurian). At the NW continuation of the type locality of the Tavuscayiri Block, the upper part of the sequence of this block is studied in detail in this paper.

Detailed studies performed by Tekin *et al.* (2016a) on the blocks within the Mersin Mélange reveal that the sequence of middle Late Carnian to late Pliensbachian age is characterized by two different lithological characteristics (pelagic carbonate rocks and platform carbonates).

The pelagic/hemi-pelagic rock units (mainly pelagic radiolarian limestones, radiolarian cherts, tuffites etc.) of middle Late Carnian to late Pliensbachian age from the Orbuklukeli sequence in the Tavuscayiri Block can be correlated with the Kayabasi Group/Formation in the Bozkir Unit described by Özgül (1976, 1984, 1997), and the Gülbahar and Gümüşlü units in the Lycian Nappes by Brunn *et al.* (1970, 1971) and Poisson (1977). The Kayabasi Group (Özgül 1976) and the Kayabasi Formation of the Korualan Group in the Bozkir Unit (Özgül 1997) are composed of partly platform, mainly hemi-pelagic and pelagic sequences (dolomites, shale, limestones with chert nodules, and radiolarian limestones) of Late Triassic age. In addition to this unit, the Gülbahar Unit in the Lycian Nappes includes calcarenites, pelagic/hemi-pelagic limestones, and radiolarites of mainly Late Triassic to Early Jurassic age (Poisson 1977). Similar to these units, the Gümüslü Unit in the Lycian Nappes, including pelagic micritic limestones with detritic inputs of Early Jurassic age, can be correlated with the sequence in the Orbuklukeli sequence (Brunn *et al.* 1970, 1971; Poisson 1977).

On the other hand, we also observed some blocks with platform carbonates rich in megalodontid-type bivalves of middle Late Carnian to Norian age during the studies on the Mersin Mélange, and the age of these blocks could be

as young as the Early Jurassic. The carbonates deposited in shallow-water conditions of the Late Triassic-Early Jurassic age in the Taurides were previously called the Gencek Limestone in the Beysehir-Hoyran Nappes (Brunn *et al.* 1970, 1971); the Domuzdag Unit in the Lycian Nappes (Poisson 1977), the Gencek Group in the Bozkir Unit (Özgül 1976, 1984), and subsequently the Sogucak Limestone in the Bozkir Unit (Özgül 1997). Where the contact relationship is clear, this limestone unit is conformably overlain by the Ammonitico rosso facies of Toarcian age, indicating platform drowning, which is followed by a pelagic sequence (radiolarian cherts and pelagic limestones) of Middle Jurassic-Late Cretaceous age in the Beysehir-Hoyran Nappes (Gutnic & Monod 1968; Brunn *et al.* 1970, 1971). Similar to this classification, the Upper Triassic-Lower Jurassic basal limestones deposited in shallow water environments of the Boyalitepe Group were called the Kuztepe Limestone by Özgül (1997), and these limestones are structurally overlain by the pelagic limestones and cherts of Late Jurassic-Cretaceous age (the Asartepe Limestone) in the Bozkir Unit. Based on this, it is possible to claim that the Gencek Limestone in the Beyşehir-Hoyran Nappes, the Domuzdag Unit in the Lycian Nappes and the basal limestone unit of the Boyalitepe Unit (Kuztepe Limestone of Özgül 1997) in the Beysehir-Hoyran Nappes/Bozkir Unit correspond, in fact, to the same unit, and therefore can be regarded as equivalent to each other.

Our studies on the Mersin Mélange reveal that the neritic and pelagic/hemi-pelagic sequence of middle Late Carnian-late Pliensbachian age is followed by the hemi-pelagic limestones of Toarcian age showing typical features of Ammonitico rosso facies. After that, due to the platform drowning event, the pelagic rock units (e.g. radiolarian cherts, pelagic limestones etc.) were deposited during the Middle Jurassic-Upper Cretaceous time interval in the Talvarliyurt Block (Moix *et al.* 2011; Tekin *et al.* 2016a).

In conclusion, the continuous deposition of the Huglu Limestones including pelagic limestones with chert nodules of Late Triassic to Late Cretaceous age over the Huglu Tuffites as suggested by Brunn *et al.* (1970, 1971) and Özgül (1976, 1984) is disputable and speculative. The findings obtained from the Mersin Mélange in the present study mainly support the idea of a platform drowning event from the Toarcian onward, and the deposition of radiolarian cherts and alternation of radiolarian cherts/pelagic limestones of Toarcian to Late Cretaceous age over the neritic or pelagic/hemi-pelagic rock units of middle Late Carnian-late Pliensbachian age.

## SYSTEMATIC PALEONTOLOGY OF RADIOLARIANS

Holotypes and paratypes of the new taxa are stored at the Paleontology Laboratory of Geological Engineering Department, Hacettepe University, Ankara (Turkey) with catalogue numbers from HU.JMB.0106 to HU.JMB.0163.

Phylum PROTOZOA
Subclass RADIOLARIA Müller, 1858
Order POLYCYSTINA Ehrenberg, 1875
Suborder SPUMELLARIA Ehrenberg, 1838
Superfamily ACTINOMMACEAE Haeckel, 1862
Family PANTANELLIIDAE Pessagno, 1977 emend. Pessagno & Blome (1980)
Subfamily PANTANELLIINAE Pessagno, 1977

### Genus *Betraccium* Pessagno *in* Pessagno, Finch & Abbott, 1979

TYPE SPECIES. — *Betraccium smithi* Pessagno, 1979 by original designation.

#### ***Betraccium kennecottense*** Carter, 1993 (Fig. 6A)

*Betraccium kennecottense* Carter, 1993: 59, 60, pl. 6, figs 10, 14, 19.

*Betraccium* sp. 1 – Carter 1990: pl. 1, fig. 2.

OCCURRENCE. — Upper Triassic, Rhaetian of Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW Mersin city, southern Turkey.

#### ***Betraccium perilense*** Carter, 1993 (Fig. 6B)

*Betraccium perilense* Carter, 1993: 61, pl. 6, figs 5, 6. — Tekin 1999: 98, pl. 12, figs 14-15.

*Betraccium* sp. D – Cheng 1989: 145, pl. 11, fig. 6.

*Betraccium* sp. B – Yeh 1992: 60, pl. 1, fig. 11.

OCCURRENCE. — Upper Triassic, upper Norian-Rhaetian of Busuanga and Uson Islands, Philippines; Queen Charlotte Islands, British Columbia, Canada; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

### Genus *Gorgansium* Pessagno & Blome, 1980

TYPE SPECIES. — *Gorgansium silviesense* Pessagno & Blome, 1980 by original designation.

#### ***Gorgansium alpinum*** Kozur & Mostler, 1990 (Fig. 6C, D)

*Gorgansium alpinum* Kozur & Mostler, 1990: 216, pl. 16, fig. 12. — Tekin 2002a: 179, pl. 1, figs 1-2.

*Gorgansium* sp. A – Igo & Nishimura 1984: pl. 3, figs 18, ?20, ?21, ?23; pl. 4, fig. 8.

OCCURRENCE. — Lower Jurassic, middle Hettangian-lower Sinemurian of Karasawa, Kuzu town, Japan; Bavaria, Germany; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

### *Gorgansium gongyloideum* Kishida & Hisada, 1985
(Fig. 6E, F)

*Gorgansium gongyloideum* Kishida & Hisada, 1985: 116, pl. 1, figs 21-22. — Kishida & Hisada 1986: fig. 4. 4. — Hori 1990: fig. 8, no. 6. — Goričan 1994: 70, pl. 1, fig. 6. — Yeh & Cheng 1998: 12-13, pl. 1, fig. 1. — Tekin 2002a: 179, pl. 1, fig. 4. — Whalen & Carter 2002: 105, pl. 6, figs 3-5, 9-12. — Goričan *et al.* 2006: 170-171, pl. GOR02, figs 1-5.

*Gorgansium* sp. *G.* aff. *morganense* – Whalen & Pessagno 1984: pl. 1, figs 15-16.

*Gorgansium* sp. A – Kishida & Hisada 1985: pl. 4, fig. 8.

*Gorgansium* spp. – Goričan *et al.* 2003: 291, pl. 1, fig. 7.

Occurrence. — Upper Triassic, Rhaetian-Lower Jurassic, middle Toarcian of Japan; northeastern British Columbia, Canada; Baja California Sur, Mexico; Skrile Formation, Slovenia; Budva Zone, Montenegro; Busuanga Island, Philippines; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

## Genus *Pantanellium* Pessagno, 1977

Type species. — *Pantanellium riedeli* Pessagno, 1977 by original designation.

### *Pantanellium fosteri* Pessagno & Blome, 1980
(Fig. 6G)

*Pantanellium fosteri* Pessagno & Blome, 1980: 242, pl. 3, figs 18, 16; Blome 1984: 42, pl. 7, fig. 1; Carter 1993: 64, pl. 7, fig. 1; Hori & Wakita 2004: fig. 5-18.

*Pantanellium fosteri* – Yeh 1989: 61, pl. 11, figs 16, 18.

? *Pantanellium* sp. aff. *P. fosteri* – Carter 1993: 64-65, pl. 7, figs 2, 3.

? *Pantanellium* sp. aff. *P. fosteri* – Sugiyama 1997: 165, figs 43-17.

Occurrence. — Upper Triassic, upper Norian-Rhaetian of Queen Charlotte Islands, British Columbia, Canada; ?Mino Terrane, central Japan; east-central Oregon, United States; central Shikoku, Japan; Mersin Mélange, NW of Mersin city, southern Turkey.

### *Pantanellium freboldi* Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 6H-J)

*Pantanellium freboldi* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 48, pl. 1, figs 17, 21, 27.

*Pantanellium* sp. 1 – Tipper *et al.* 1991: pl. 8, fig. 14.

Occurrence. — Lower Jurassic, middle Hettangian-lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

### *Pantanellium giganteum* Tekin, n. sp.
(Fig. 6K-O)

urn:lsid:zoobank.org:act:5BAC0A8A-3218-48FA-8EB3-E2EEF99333A4

Holotype. — Sample Orbuk-26, HU.JMB.0106 (Fig. 6K).

Paratypes. — HU.JMB.0107 (Fig. 6L), HU.JMB.0108 (Fig. 6M). HU.JMB.0109 (Fig. 6N), HU.JMB.0110 (Fig. 6O).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — From the Latin *giganteum*, giant, due to its big size.

Occurrence. — Lower Jurassic, upper Hettangian-lower Pliensbachian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on five specimens, in µm). — Diameter of the cortical shell along spines: 83-120 (holotype: 120, average: 110.5); Diameter of the cortical shell perpendicular to spines: 110-133 (holotype: 110, average: 117.1); Length of shorter spine: 50-90 (holotype: 80, average: 74.6); Length of longer spine: 120-166 (holotype: 140, average: 147).

Description

Cortical shell large, sphaerical to subsphaerical with large pentagonal and hexagonal pore frames. Pore frames with rounded to subrounded nodes at pore frame vertices. Six to seven pore frames visible both along primary spines and perpendicular to primary spines. Polar spines unequal, three-bladed with rounded, longitudinal ridges and relatively narrow grooves. One polar spine about twice longer than the other polar spine and longer polar spine slightly dextrally twisted.

Remarks

This species differs from *P. freboldi* (Carter *et al.* 1998: 48, pl. 1, figs 17, 21, 27) by having unequal and slightly dextrally twisted polar spines. It differs also from *P. sixi* Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Carter *et al.* 1998: 48) by possessing a larger cortical shell and longer, slightly dextrally twisted polar spines in many cases.

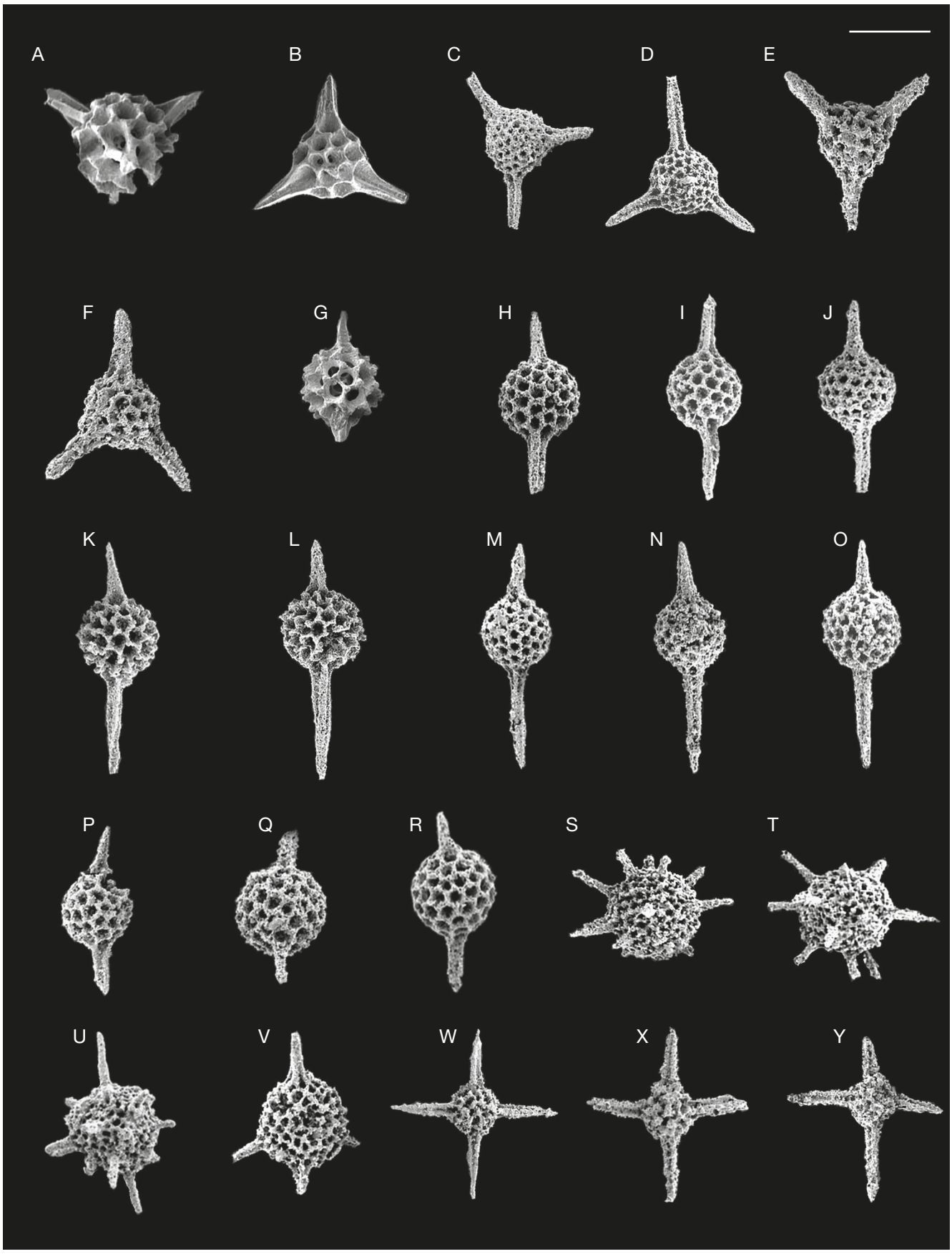
### *Pantanellium kluense* Pessagno & Blome, 1980
(Fig. 6P)

*Pantanellium kluense* Pessagno & Blome, 1980: 243, pl. 4, figs 1, 2, 13, 17, 18, 21-24. — De Wever 1981b: pl. 5, fig. 3; 1982b: 130, 131, pl. 1, figs 10, 11. — Carter *et al.* 1998: 19: 48, pl. 1, figs 5, 22. — Tekin 2002a: 180, pl. 1, fig. 6.

? *Pantanellium* sp. aff. *P. kluense* – Pessagno & Blome 1980: 243, pl. 5, fig. 11. — Sugiyama 1997: 165, fig. 43-16.

Occurrence. — Lower Jurassic, middle Hettangian-upper Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Mino Terrane, central Japan; Gümüslü Unit, Lycian Nappes, Antalya nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Fig. 6. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A**, *Betraccium kennecottense* Carter, 1993, Orbuk-15; **B**, *Betraccium perilense* Carter, 1993, Orbuk-15; **C**, **D**, *Gorgansium alpinum* Kozur & Mostler, 1990, Orbuk-32; **E**, **F**, *Gorgansium gongyloideum* Kishida & Hisada, 1985, Orbuk-41; **G**, *Pantanellium fosteri* Pessagno & Blome, 1980, Orbuk-15; **H**-**J**, *Pantanellium freboldi* Whalen & Carter *in* Carter, Whalen & Guex, 1998; **H**-**I**, Orbuk-27; **J**, Orbuk-31; **K**-**O**, *Pantanellium giganteum* Tekin, n. sp.; **K**, Holotype, Orbuk-26; **L**-**O**, Paratypes; **L**, Orbuk-26; **M**, Orbuk-27; **N**-**O**, Orbuk-31; **P**, *Pantanellium kluense* Pessagno & Blome, 1980, Orbuk-26; **Q**, **R**, *Pantanellium tanuense* Pessagno & Blome,1980; **Q**, Orbuk-26; **R**, Orbuk-27; **S**-**U**, *Novamuria impensa* (Whalen & Carter *in*




Carter, Whalen & Guex, 1998); **S**-**T**, Orbuk-26; **U**, Orbuk-31; **V**, *Beatricea sanpabloensis* (Whalen & Carter, 2002), Orbuk-32; **W**-**Y**, *Emiluvia prisca* Tekin, n. sp.; **W**, Holotype, Orbuk-46; **X**, **Y**, Paratypes; **X**, Orbuk-47; **Y**, Orbuk-46. Scale bar: A, E-J, P-R, 100 µm; B-D, K-L, S-V, 120 µm; X, Y, 170 µm.

***Pantanellium tanuense*** Pessagno & Blome, 1980
(Fig. 6Q, R)

*Pantanellium tanuense* Pessagno & Blome, 1980: 247, pl. 4, figs 3, 4, 24. — Tipper *et al.* 1991: pl. 8, fig. 5. — Goričan 1994: 78, pl. 1, figs 14-18. — Carter *et al.* 1998: 49, pl.1, figs 4, 11, 26. — Bertinelli & Marcucci 2011: 410, pl. 2, fig. 5.

*Ellipsoxiphus tanuense* – Kozur & Mostler 1990: 214, pl.14, figs 10-11.

? *Pantanellium* sp. aff. *P. tanuense* – Spörli & Aita 1988: pl. 4, fig. 2. — Spörli *et al.* 1989: fig. 5, no. 6.

Occurrence. — Lower Jurassic, lowermost Hettangian-lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Bavaria, Germany; Dinarides, Montenegro; ? New Zealand; Gran Sasso, central Apennines, Italy; Mersin Mélange, NW of Mersin city, southern Turkey.

Family Xiphostylidae Haeckel, 1881
emend. Pessagno & Yang *in* Pessagno *et al.* (1989)

Genus *Novamuria* Özdikmen, 2009

Type species. — *Amuria impensa* Whalen & Carter *in* Carter, Whalen & Guex, 1998 by original designation.

***Novamuria impensa***
(Whalen & Carter *in* Carter, Whalen & Guex, 1998)
(Fig. 6S-U)

*Amuria impensa* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 56, pl. 11, figs 2, 3, 6, 23.

Occurrence. — Lower Jurassic, lowermost Hettangian – lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

Superfamily Pyloniacea Haeckel, 1881
emend. Dumitrica (1989)
Subsuperfamily Dactyliospaerilae Squinabol, 1904
emend. De Wever *et al.* (2001)
Family Emiluviidae Dumitrica, 1995

Genus *Beatricea*
Whalen & Carter *in* Carter, Whalen & Guex, 1998

Type species. — *Beatricea christovalensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998 by original designation.

***Beatricea sanpabloensis*** (Whalen & Carter, 2002)
(Fig. 6V)

*Orbiculiformella sanpabloensis* Whalen & Carter, 2002: 109, pl. 1, figs 1-2.

*Orbiculiforma* sp. – Whalen & Pessagno 1984: pl. 1, fig. 18.

*Beatricea sanpabloensis* – Goričan *et al.* 2006: 62, 63, pl. ORB07, figs 1-3.

Occurrence. — Lower Jurassic, lower Sinemurian-lower Upper Pliensbachian of Baja California Sur, Mexico; Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Emiluvia* Foreman, 1973

Type species. — *Emiluvia chica* Foreman, 1973 by original designation.

***Emiluvia prisca*** Tekin, n. sp.
(Fig. 6W-Y)

urn:lsid:zoobank.org:act:7DE81B35-1355-426F-89AC-1AA538F91A9C

Holotype. — Sample Orbuk-46, HU.JMB.0111 (Fig. 6W).

Paratypes. — HU.JMB.0112 (Fig. 6X), HU.JMB.0113 (Fig. 6Y).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — From the Latin: *Prisca*: former, ancient, old-fashioned, due to its old-occurrence.

Occurrence. — Lower Jurassic, middle Lower Pliensbachian-upper Pliensbachian, Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on three specimens, in µm). — Diameter of test: 92-100 (holotype: 100, average: 97.3); Length of spines: 110-130 (holotype: 130, average: 118.6).

Description
Test large, sphaerical to subsphaerical with four spines situated at corners. Very large nodes present at pore frame vertices on the outer layer of cortical shell. Four nodes visible per row. Inner layer of pore frames polygonal (mainly triangular). Spines longer than the diameter of cortical shell and mainly equal, tapering distally, terminated with very sharp end. They are tricarinate with relatively wide ridges and wide grooves.

Remarks
This species can be differentiated from *Emiluvia tuberis* (Carter *et al.* 1998: 41-42, pl. 5, figs 9, 10, 19) by having a sphaerical to subsphaerical cortical shell with large nodes at pore frame vertices.

Genus *Praeudalia* Tekin, n. gen.

urn:lsid:zoobank.org:act:7F321497-E109-4829-94BB-64E5ABB41432

Type species. — *Praeudalia rhaetica* Tekin, n. gen., n. sp.

Etymology. — For the occurrence precedent to *Udalia* Whalen & Carter, 1998.

Occurrence. — Late Triassic, Rhaetian of Queen Charlotte Islands, British Columbia, Canada; El Castillo Mélange, Nicaragua/Costa Rica Border; NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

INCLUDED TAXA. — *Praeudalia rhaetica* Tekin, n. gen., n. sp., Spumellaria gen. and sp. indet. A (*sensu* Tekin 2002b).

DESCRIPTION
Cortical shell includes Pseudoaulophacid structure composed of meshwork of equilateral, triangular pore frames with rounded nodes at vertices. Four spines about similar in length, wide at the base and tapering distally, with sharp ends. Spines coplanar and tetracarinate with very wide grooves adjacent to very narrow ridges.

REMARKS
This genus differs from *Udalia* (*in* Carter *et al.* 1998: 59) by having tetracarinate instead of tricarinate spines.

### *Praeudalia rhaetica* Tekin, n. gen., n. sp.
(Fig. 7A-D)

urn:lsid:zoobank.org:act:018D810C-5979-4B09-AE11-9E56620CF889

Spumellaria gen. and sp. indet. B – Carter 1993: 92, pl. 13, figs 6, 8, 11. — Baumgartner *et al.* 2008: pl. 3, fig. 11.

Spumellaria gen. and sp. indet. A – Tekin 1999: 124, pl. 23, fig. 7.

HOLOTYPE. — Sample Orbuk-15, HU.JMB.0114 (Fig. 7A).

PARATYPES. — HU.JMB.0115 (Fig. 7B), HU.JMB.0116 (Fig. 7C), HU.JMB.0117 (Fig. 7D).

TYPE LOCALITY. — Orbuklukeli section Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — Because of its occurrence in Rhaetian strata.

OCCURRENCE. — Upper Triassic, Rhaetian of Queen Charlotte Islands, British Columbia, Canada; El Castillo Mélange, Nicaragua/Costa Rica Border; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on four specimens, in µm). — Maximum diameter of the cortical shell: 88-110 (holotype: 100, average: 98.5); Length of longest spine: 70-78 (holotype: 70, average: 74.3).

DESCRIPTION

Same as of the genus. Cortical shell disc-shaped, large, wider than the length of four spines.

REMARKS
Same as for the genus. This species differs from another species of *Praeudalia* Tekin, n. gen., illustrated as Gen. et sp. indet. in Tekin (2002b: 428, pl. 3, fig. 12) by possessing a smaller cortical shell and longer primary spines.

## Genus *Udalia*
Whalen & Carter *in* Carter, Whalen & Guex, 1998

TYPE SPECIES. — *Udalia dennisoni* Whalen & Carter, 1998 by original designation.

### *Udalia dennisoni*
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 7E)

*Udalia dennisoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 59, pl. 6, figs 11, 13-14, 17-19, 21-22. — Tekin 2002a: 185, pl. 3, fig. 2. — Bertinelli & Marcucci 2011: 408, pl. 1, fig. 18.

? *Udalia* sp. cf. *U. dennisoni* – Whalen & Carter *in* Carter, Whalen & Guex, 1998: pl. 3, fig. 12.

OCCURRENCE. — Lower Jurassic, middle Hettangian-upper Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Gran Sasso, central Apennines, Italy; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

### *Udalia infrequens* Tekin, n. sp.
(Fig. 7F, G)

urn:lsid:zoobank.org:act:494233BE-DDCB-4D94-A544-572EEF1D94A0

HOLOTYPE. — Sample Orbuk-36, HU.JMB.0118 (Fig. 7F).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — From the Latin: *infrequens*: rare, due its rare occurrence.

OCCURRENCE. — Lower Jurassic, lower Pliensbachian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

PARATYPE. — HU.JMB.0119 (Fig. 7G).

DIMENSIONS (based on two specimens, in µm). — Maximum diameter of cortical shell: 100-110 (holotype: 110, average: 105); Length of longest spine: 80-100 (holotype: 100, average: 90).

DESCRIPTION
Cortical shell small, subrectangular with subplaniform upper and lower surfaces. Outer pore meshwork with triangular to tetragonal pore frames and large nodes at pore frame vertices. Four, needle-like, distally tapering spines situated at each corner and terminated with a sharp end. Length of spines slighly shorter than diameter of the cortical shell.

REMARKS
This species differs from *Udalia primaeva* (Carter *et al.* 1998: 60, pl. 6, figs 8, 12, 15, 16, 20, 23) by possessing larger pore frames on the cortical shell and large nodes at pore frame vertices. Although inner structure of this species is unknown, as specimens have needle-like spines, this species is included to *Udalia* instead of *Emiluvia* Foreman, 1973.

### *Udalia primaeva*
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 7H-J)

*Udalia primaeva* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 60, pl. 6, figs 8, 12, 15, 16, 20, 23. — Tekin 2002a: 189, pl. 3, figs 4-5.

? *Udalia* sp. cf. *U. primaeva* – Whalen & Carter *in* Carter, Whalen & Guex, 1998: pl. 3, fig. 13.

OCCURRENCE. — Lower Jurassic, lower Hettangian-lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW Mersin city, southern Turkey.

Genus *Thurstonia*
Whalen & Carter *in* Carter, Whalen & Guex, 1998

TYPE SPECIES. — *Thurstonia minutaglobus* Whalen & Carter, 1998, by original designation.

***Thurstonia gibsoni***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 7K-M)

*Thurstonia gibsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 42, pl. 6, figs 1-2. — Hori *et al.* 2004: pl. 5, fig. 6. — Goričan *et al.* 2006: 378-379, pl. THU01, figs 1, 2, ?3.

*Thurstonia* sp. aff. *T. gibsoni* – Tekin 2002a: 188, pl. 3, fig. 20.

OCCURRENCE. — Lower Jurassic, lower Hettangian-upper Hettangian of Queen Charlotte Islands, British Columbia, Canada; Guwayza Formation, Oman; Japan; ?Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

REMARKS
Although, this species was reported from slightly younger strata (Pliensbachian) in the Tawi Sadh Member of the Guwayza Formation, Oman (Goričan *et al.*, 2006), the assignment of this specimen is not clear, if we compare it to the holotype. Because of this, we followed the range (middle to upper Hettangian) of this taxon reported by Carter *et al.* (1998).

***Thurstonia minutaglobus***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 7N)

*Thurstonia minutaglobus* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 43, pl. 6, figs 7, 9; pl. 8, figs 2, 5-7, 9-10, 13. — Gawlick *et al.* 2001: pl. 5, fig. 5. — Suzuki *et al.* 2002: 168, 170, fig. 4D.

OCCURRENCE. — Lower Jurassic, lower Hettangian-lower Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; North Peru; Mersin Mélange, NW of Mersin city, southern Turkey.

***Thurstonia timberensis***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 7O)

*Thurstonia timberensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 43, pl. 6, figs 3-5, 10. — Goričan *et al.* 2006: 380-381, pl. THU04, figs 1-8. — Bertinelli & Marcucci 2011: 407, pl. 1, figs 13-14.

Genus spp. – Hattori 1989: pl. 17, figs B, C.

*Beturiella* ? sp. – Nagai 1990: pl. 6, figs 1-2.

*Thurstonia* sp. B – Yeh & Cheng 1998: 11, pl. 8, fig. 8.

OCCURRENCE. — Lower Jurassic, middle Hettangian-middle Toarcian of Japan; Busuanga Island, Philippines; Queen Charlotte Islands, British Columbia, Canada; Oman; Gran Sasso, central Apennines, Italy; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW Mersin city, southern Turkey.

Family HAGIASTRIDAE Riedel, 1967
emend. Pessagno (1971), emend. Baumgartner (1980)

Genus *Crucella* Pessagno, 1971
emend. Baumgartner (1980)

TYPE SPECIES. — *Crucella messinae* Pessagno, 1971 by original designation.

***Crucella mijo*** De Wever, 1981
(Fig. 7P)

*Crucella mijo* De Wever, 1981a: 35, pl. 4, figs 1-2; 1982b: 253, pl. 28, figs 1-3. — Suzuki *et al.* 2002: 176, fig. 7C.

*Crucella* sp. A – Pujana 1996: 136, pl. 1, fig. 14.

OCCURRENCE. — Lower Jurassic, middle Lower Pliensbachian-upper Pliensbachian of Gümüslü Unit, Lycian Nappe, NW of Antalya city and Mersin Mélange, NW Mersin city, southern Turkey; NE British Columbia; Argentina; North Peru.

***Crucella mirabunda*** Whalen & Carter, 2002
(Fig. 7Q, R)

*Crucella mirabunda* Whalen & Carter, 2002: 106, pl. 1, figs 7, 11; pl. 2, figs 1, 8. — Goričan *et al.* 2006: 126-127, pl. CRU14, figs 1-2.

*Crucella* sp. B – Hattori 1987: pl. 4, fig. 8.

*Pseudocrucella* sp. A – Carter *et al.* 1988: 29, pl. 7, figs 8-9.

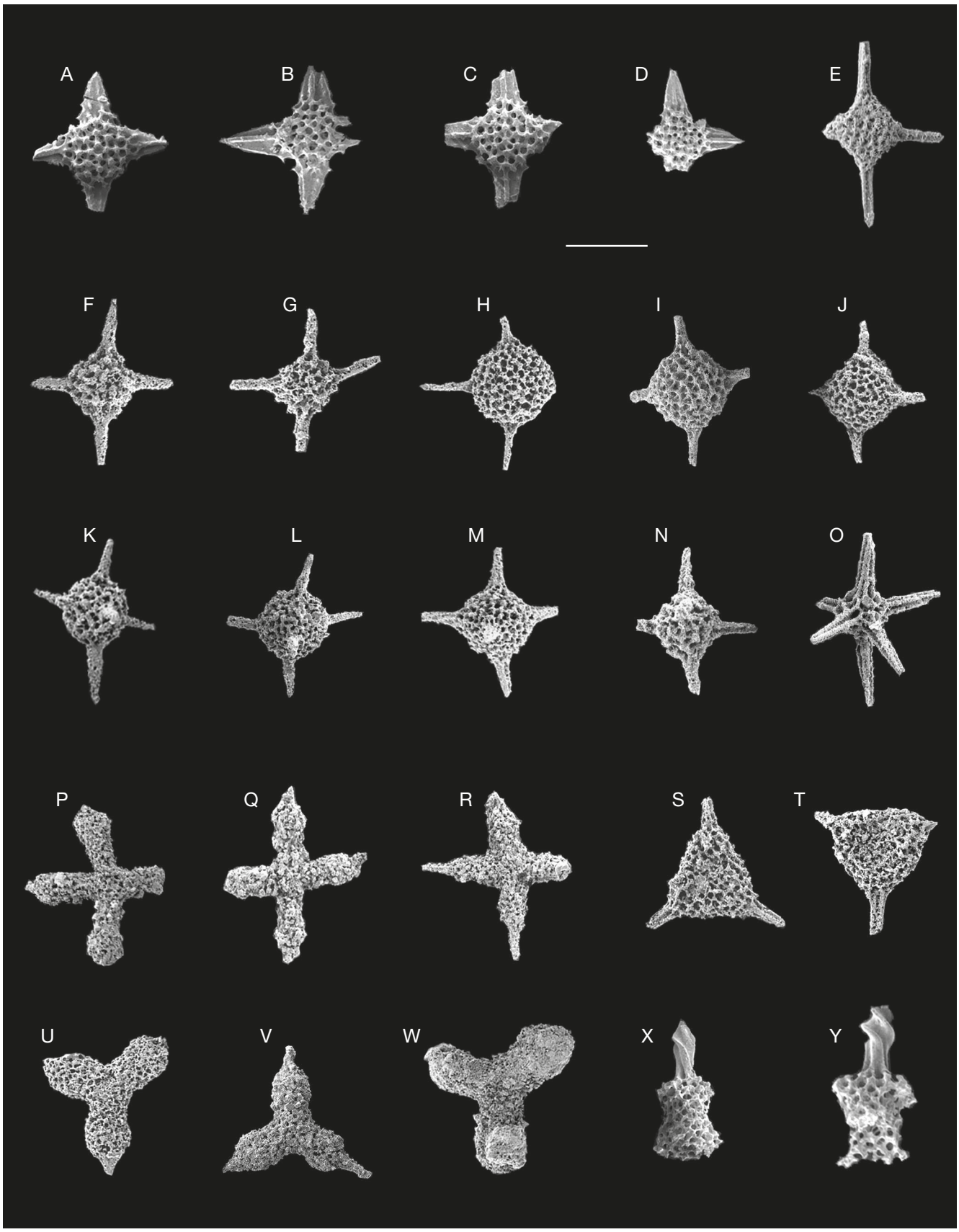
OCCURRENCE. — Lower Jurassic, Pliensbachian-Middle Jurassic, Aalenian of Japan; Baja California Sur, Mexico; Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

Family PATULIBRACHIIDAE Pessagno, 1971
emend. Baumgartner (1980)
Subfamily PATULIBRACCHIINAE Pessagno, 1971
emend. Baumgartner (1980 )

Genus *Cyclastrum* Rüst, 1898

TYPE SPECIES. — *Cyclastrum infundibuliforme* Rüst, 1898 by original designation.

FIG. 7. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A**-**D**, *Praeudalia rhaetica* Tekin, n. gen., n. sp.; **A**, Holotype, Orbuk-15; **B**-**D**, Paratypes, Orbuk-15; **E**, *Udalia dennisoni* Whalen & Carter in Carter, Whalen & Guex, 1998, Orbuk-32; **F**-**G**, *Udalia infrequens* Tekin, n. sp.; **F**, Holotype, Orbuk-36; **G**, Paratype, Orbuk-36; **H**-**J**, *Udalia primaeva* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-27; **K**-**M**, *Thurstonia gibsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-26; **N**, *Thurstonia minutaglobus* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32; **O**, *Thurstonia timberensis* Whalen & Carter *in*




Carter, Whalen & Guex, 1998, Orbuk-46; **P**, *Crucella mijo* De Wever, 1981, Orbuk-47; **Q**-**R**, *Crucella mirabunda* Whalen & Carter, 2002, Orbuk-44; **S**-**T**, *Cyclastrum scammonense* Whalen & Carter, 2002, Orbuk-36; **U**-**V**, *Paronaella grahamensis* Carter *in* Carter, Cameron & Smith, 1988; **U**, Orbuk-36; **V**, Orbuk-38; **W**, *Paronaella tripla* De Wever, 1981, Orbuk-41; **X**, **Y**, *Serilla tledoensis* (Carter, 1993), Orbuk-15. Scale bar: A-D, F-G, K-O, X, Y, 120 µm; E, H-J, P-V, 170 µm; W, 200 µm.

***Cyclastrum scammonense*** Whalen & Carter, 2002
(Fig. 7S, T)

*Cyclastrum scammonense* Whalen & Carter, 2002: 111, pl. 4, figs 3-5, 11-13, 15; pl. 5, figs 1-2, 9. — Goričan *et al.* 2006: 130-131, pl. CYC02, figs 1-4.

? *Orbiculiforma silicatilis* Cordey, 1998: 93, pl. 21, fig. 7, *non* figs 5, 8.

Occurrence. — Lower Jurassic, lower Pliensbachian-Middle Jurassic, Aalenian of Baja California Sur, Mexico; Guwayza Formation, Oman; Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Paronaella* Pessagno, 1971
emend. Baumgartner (1980)

Type species. — *Paronaella solanoensis* Pessagno, 1971 by original designation.

***Paronaella grahamensis***
Carter *in* Carter, Cameron & Smith, 1988
(Fig. 7U-V)

*Paronaella grahamensis* Carter *in* Carter, Cameron & Smith 1988: 40, pl. 11, figs 10-12. — Yeh 2009: 56, pl. 14, figs 1, 5, 9, 22. — Yeh & Pessagno 2013: 89, pl. 16, fig. 3. — Chiari *et al.* 2013: fig. 11.d. — Bragin & Bragina 2017: pl. 3, figs 3-4.

Occurrence. — Lower Jurassic, lower Pliensbachian-Middle Jurassic, Bathonian of Queen Charlotte Islands, British Columbia, Canada; east-central Oregon, United States; Argolis Greece; Amur River, eastern Russia; Mersin Mélange, NW of Mersin city, southern Turkey.

***Paronaella tripla*** De Wever, 1981
(Fig. 7W)

*Paronaella tripla* De Wever, 1981a: 34, pl. 3, figs 5-6; 1982b: 248-249, pl. 25 figs 3, 4. — Goričan *et al.* 2006: 310-311, pl. PAR20, figs 1-4. — O'Dogherty & Gawlick 2008: 75, pl. 1, fig. 26.

*Paronaella* sp. B – Carter *et al.* 1988: 42, pl. 11, fig. 6.

? *Paronaella* sp. aff. *P. tripla* – Tekin 2002a: 181, pl. 1, fig. 14.

Occurrence. — Lower Jurassic, Pliensbachian-middle Jurassic, Aalenian of Queen Charlotte Islands, British Columbia, Canada; Austria; ? Antalya Nappes, NE of Antalya Nappes and Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Serilla* Carter, 2007

Type species. — *Risella tledoensis* Carter, 1993 by original designation.

***Serilla tledoensis*** (Carter, 1993)
(Fig. 7X, Y)

*Risella tledoensis* Carter, 1993: 75-76, pl. 9, figs 10, 11, 13. — Yeh & Cheng 1996: 8, pl. 4, figs 2, 6. — Sugiyama 1997: 186, fig. 50-16. — Tekin 1999: 102, pl. 14, figs 13-14. — Carter & Guex 1999, 191-192, pl. 1, figs 7-9. —Tekin 2002b: 422, pl. 1, fig. 11. — Longridge *et al.* 2007: pl. 1, fig. 7.

Gen. nov. C sp. 1 – Carter 1990: pl. 2, fig. 1.

*Hagiastrum* ? sp. – Bragin 1991: pl. 7, fig. 2.

*Paronaella* sp. B – Yeh 1992: 62, pl. 2, fig. 12.

*Serilla tledoensis* – Carter 2007: 104.

Occurrence. — Upper Triassic, Rhaetian of Kunga and Queen Charlotte Islands, British Columbia, Canada; Fareast Russia, Busunaga Island, Philippines; Mino Terrane, central Japan; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Subfamily Pseudohagiastrinae
Dumitrica & Tekin *in* Dumitrica, Tekin & Bedi, 2013

Genus *Acanthotetrapaurinella* Kozur & Mostler, 2006

Type species. — *Acanthotetrapaurinella variabilis* Kozur & Mostler, 2006, by original designation.

***Acanthotetrapaurinella kennecottensis***
(Carter *in* Longridge, Carter, Smith & Tipper, 2007) Group
(Fig. 8A-H)

*Tipperella kennecottensis* Carter *in* Longridge, Carter , Smith & Tipper, 2007: 163-164, pl. 2, figs 7, 11.

*Spongotrochus* sp. – Carter 1994: pl. 1, fig. 7. — Carter & Hori 2005: pl. 1A, fig. 4; pl. 1B, fig. 4.

*Tozerium nascens* – Tekin 2002a: 189, pl. 4, fig. 1.

*Acanthotetrapaurinella kennecottensis* – Dumitrica *et al.* 2013: 318.

Occurrence. — Upper Triassic, Rhaetian-Lower Jurassic, lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Inuyama Area, Japan; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Remarks

*Acanthotetrapaurinella kennecottensis* Group includes three different morphotypes: **a**. Subtetrahedral test with polygonal pore frames and long primary spines (e.g. *Tipperella kennecottensis* [Longridge *et al.* 2007: only pl. 7, fig. 7; Carter & Hori 2005: pl. 1A, fig. 4; pl. 1B, fig. 4]); **b**. Subtetrahedral test with polygonal pore frames and short primary spines (e.g. *Tipperella kennecottensis* [this study: Fig. 8A-F); and **c**. Subsphaerical to subtetrahedral test with spongy meshwork (e.g. *Spongotrochus* sp. [Carter 1994: pl. 1, fig. 7]; *Tipperella kennecottensis* [Longridge *et al.* 2007: pl.7 fig. 11]; *Tozerium nascens* Whalen & Carter, 1998 [Tekin 2002a: 189, pl. 4, fig. 1]; *Tipperella kennecottensis* [this study: Fig. 8G-H]).

Family Tritrabidae Baumgartner, 1980
Subfamily Intermediellinae
Lahm, 1984 emend. Kozur & Mostler (1994)

Genus *Paurinella* Kozur & Mostler, 1981

Type species. — *Paurinella curvata* Kozur & Mostler, 1981 by original designation.

***Paurinella liassica*** Tekin, n. sp.
(Fig. 8I-O)

urn:lsid:zoobank.org:act:62CCD5EC-6714-425C-B8C7-F7C389C050C5

HOLOTYPE. — Sample Orbuk-27, HU.JMB.0120 (Fig. 8I).

PARATYPES. — HU.JMB.0121 (Fig. 8J), HU.JMB.0122 (Fig. 8K), HU.JMB.0123 (Fig. 8L), HU.JMB.0124 (Fig. 8M), HU.JMB.0125 (Fig. 8N), HU.JMB.0126 (Fig. 8O).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — Due to its occurrence in Liassic strata.

OCCURRENCE. — Lower Jurassic, upper Hettangian-lower Sinemurian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on seven specimens, in µm). — Maximum diameter of test: 114-140 (holotype: 138, average: 131.9); Length of the longest spine: 81-120 (holotype: 100, average: 105).

DESCRIPTION
Shell subsphaerical to subtriangular with slightly inflated outline, convex sides and three primary spines. Shell spongy consisting of numerous concentric layers and many small, polygonal pore frames with subcircular pores. Primary spines long, usually one of them longer than two others, needle-like, tapering gradually distally and terminated with pointed ends. Length of primary spines about equal to diameter of shell or slightly shorter.

REMARKS

This species differs from the Triassic species *Paurinella latispinosa* Kozur & Mostler (1994: 73, pl. 15, fig. 4) by having distally tapering primary spines instead of medially expanded ones.

Family VEGHICYCLIIDAE Kozur & Mostler, 1972

Genus *Tetrapaurinella* Kozur & Mostler, 1994

TYPE SPECIES. — *Tetrapaurinella discoidalis* Kozur & Mostler, 1994 by original designation.

***Tetrapaurinella sphaerica*** Tekin, n. sp.
(Fig. 8P-V)

urn:lsid:zoobank.org:act:C4E6F19D-A746-43DA-9A55-5480C9F33969

HOLOTYPE. — Sample Orbuk-32, HU.JMB.0127 (Fig. 8P).

PARATYPES. — HU.JMB.0128 (Fig. 8Q), HU.JMB.0129 (Fig. 8R), HU.JMB.0130 (Fig. 8S), HU.JMB.0131 (Fig. 8T), HU.JMB.0132 (Fig. 8U), HU.JMB.0133 (Fig. 8V).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — Due its sphaerical cortical shell.

OCCURRENCE. — Lower Jurassic, upper Hettangian-lower Sinemurian of Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on seven specimens, in µm).- Maximum diameter of test: 100-140 (holotype: 138, average: 123.3); Length of the longest spine: 80-100 (holotype: 100, average: 93).

DESCRIPTION
Shell flat to slightly inflated, spongy consisting of several layers around the micropshaere and four primary spines at right angles situated in one plane or, sometimes, slightly inclined (Fig. 8P). Surface of the shell with numerous pores of different size. Primary spines needle-like, subcircular in transverse section, slightly gradually tapering, and pointed.

REMARKS
This species differs from the Triassic species *Tetrapaurinella latispinosa* Kozur & Mostler (1994: 77, pl. 16, fig. 9; pl. 17, figs 4, 6) by possessing a much smaller shell by comparison with primary spines and slightly larger pores.

Subfamily VEGHICYCLIINAE Kozur & Mostler, 1972

Genus *Orbiculiformella* Kozur & Mostler, 1978

TYPE SPECIES. — *Orbiculiforma railensis* Pessagno, 1977 by original desgination.

***Orbiculiformella callosa*** (Yeh, 1987)
(Fig. 8W-Y)

*Orbiculiforma callosa* Yeh, 1987a: 41, pl. 2, fig. 25; pl. 5, fig. 19; pl. 11, fig. 11; pl. 22, figs 10, 12. — Cordey 1998: 93, pl. 21, figs 2, 4, 10. — Goričan *et al.* 2003: 295, pl. 3, figs 1-4.

*Orbiculiforma kwunaensis* Carter *in* Carter, Cameron & Smith 1988: 44, pl. 1, figs 8, 11. — O'Dogherty & Gawlick 2008: 76, pl. 1, fig. 19.

*Orbiculiforma* sp. A – Pujana 1996: 135, pl. 1, fig. 12.

*Orbiculiformella kwunaensis* – Whalen & Carter 2002: 109, pl. 1, fig. 3.

*Orbiculiforma* sp. – Matsuoka 2004: fig. 53.

*Orbiculiformella callosa* – Goričan *et al.* 2006, 260-261, pl. ORB05, figs 1-11.

OCCURRENCE. — Lower Jurassic, lower Pliensbachian-Middle Jurassic, Aalenian of East-central Oregon, United States; Queen Charlotte Islands, British Columbia, Canada; Baja California Sur, Mexico; Argentina; Slovenia; Austria; Oman; Mino Terrane, Japan; Mersin Mélange, NW of Mersin city, southern Turkey.

***Orbiculiformella pulchra*** Tekin, n. sp.
(Fig. 9A-E)

urn:lsid:zoobank.org:act:E8E435F4-3248-48C1-9600-0874A2E181F7

HOLOTYPE. — Sample Orbuk-32, HU.JMB.0134 (Fig. 9A).

PARATYPES. — HU.JMB.0135 (Fig. 9B), HU.JMB.0136 (Fig. 9C), HU.JMB.0137 (Fig. 9D), HU.JMB.0138 (Fig. 9E).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — From the Latin *pulchra*, beautiful, fine, due its beutiful test.

OCCURRENCE. — Lower Jurassic, lower Sinemurian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on five specimens, in µm). — Diameter of cortical shell: 200-250 (holotype: 225, average: 226.2); Width of central area: 100-125 (holotype: 125, average: 110); Length of longest spine: 100-125 (holotype: 100, average: 112.5).

DESCRIPTION

Test thick, circular with relatively shallow central cavity. Test with large, polygonal (mainly tiangular) pore frames and small circular nodes at pore frame vertices. Margin of test with numerous (upto eight) peripheral spines. Peripheral spines needle-like, subcircular in transversal section, tapering distally gradually to the distal end. Usually one of them slightly longer than others.

REMARKS

This species differs from *Praeorbiculiformella* sp. A *sensu* Carter *et al.* (1998: 59, pl. 9, fig. 22) by possessing conical peripheral spines instead of bladed ones.

### ***Orbiculiformella ? trispina*** (Yeh, 1987)
### ***Orbiculiformella ? trispina trispina*** (Yeh, 1987)
(Fig. 9F-G)

*Orbiculiforma ? trispina* Yeh, 1987a: 42, pl. 9, figs 2, 10.

*Orbiculiforma silicatilis* Cordey, 1998: 93, pl. 21, figs 5, ? 8, *non* fig. 7.

*Orbiculiformella ? trispina trispina* – Goričan *et al.* 2006: 268-269, pl. ORB09, figs 1-2.

OCCURRENCE. — Lower Jurassic, Hettangian-lower Toarcian of East-central Oregon, United States; Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

### *Orbiculiformella* sp. A
(Fig. 9H)

OCCURRENCE. — Lower Jurassic, lower Sinemurian of Mersin Mélange, NW of Mersin city, southern Turkey.

DESCRIPTION

Test large, flat, subcircular with small pore frames without central cavity. Periphery of the rim contains upto ten spines. Peripheral spines short and conical.

REMARKS

This specimen differs from *Orbiculiformella pulchra* Tekin, n. sp. (in this study) by having a flat shell without central depression and more peripheral spines (10 instead of 8).

## Suborder SPUMELLARIINA *Incertae sedis*

### Genus *Danubea*
Whalen & Carter *in* Carter, Whalen & Guex, 1998

TYPE SPECIES. — *Danubea howardi* Whalen & Carter, 1998 by original designation.

### *Danubea* sp. A
(Fig. 9I)

OCCURRENCE. — Lower Jurassic, lower Sinemurian of the Mersin Mélange, NW of Mersin city, southern Turkey.

DESCRIPTION

Test large with inflated cortical shell and two polar spines. Cortical shell sphaerical with triangular and tetragonal pore frames. Small nodes present at pore frame vertices. Spines unequal in length, needle-like, circular in transversal section and tapering gradually to the distal end.

REMARKS

This specimen differs from *Danubea howardi* Whalen & Carter *in* Carter *et al.* (1998: 40-41, pl. 5, figs 2-4, 14, 18) by having an ellipsoidal test in the direction of polar spines and needle-like spines instead of tricarinate ones.

## Suborder ENTACTINARIA Kozur & Mostler, 1982
## Superfamily EPTINGIACEA Dumitrica,1978
revised Dumitrica *et al.* (2010)
## Family EPTINGIIDAE Dumitrica, 1978
## Subfamily CHARLOTTEINAE Whalen & Carter, 1998

### Genus *Charlottea*
Whalen & Carter in Carter, Whalen & Guex, 1998

TYPE SPECIES. — *Charlottea amurensis* Whalen & Carter, 1998 by original designation.

### ***Charlottea elegantissima*** Tekin, n. sp.
(Fig. 9J-L)

urn:lsid:zoobank.org:act:55CA8859-77C0-445D-81BF-D961D20F6D64

HOLOTYPE. — Sample Orbuk-32, HU.JMB.0139 (Fig. 9J).

PARATYPES. — HU.JMB.0140 (Fig. 9K), HU.JMB.0141 (Fig. 9L).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — From the Latin *elegantissima*, most elegant, due its elegant test.

OCCURRENCE. — Lower Jurassic, upper Hettangian-lower Sinemurian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on three specimens, in µm). — Maximum diameter of cortical shell: 80-100 (holotype: 80, average: 90); Maximum length of spine: 80-100 (holotype: 90, average: 90).

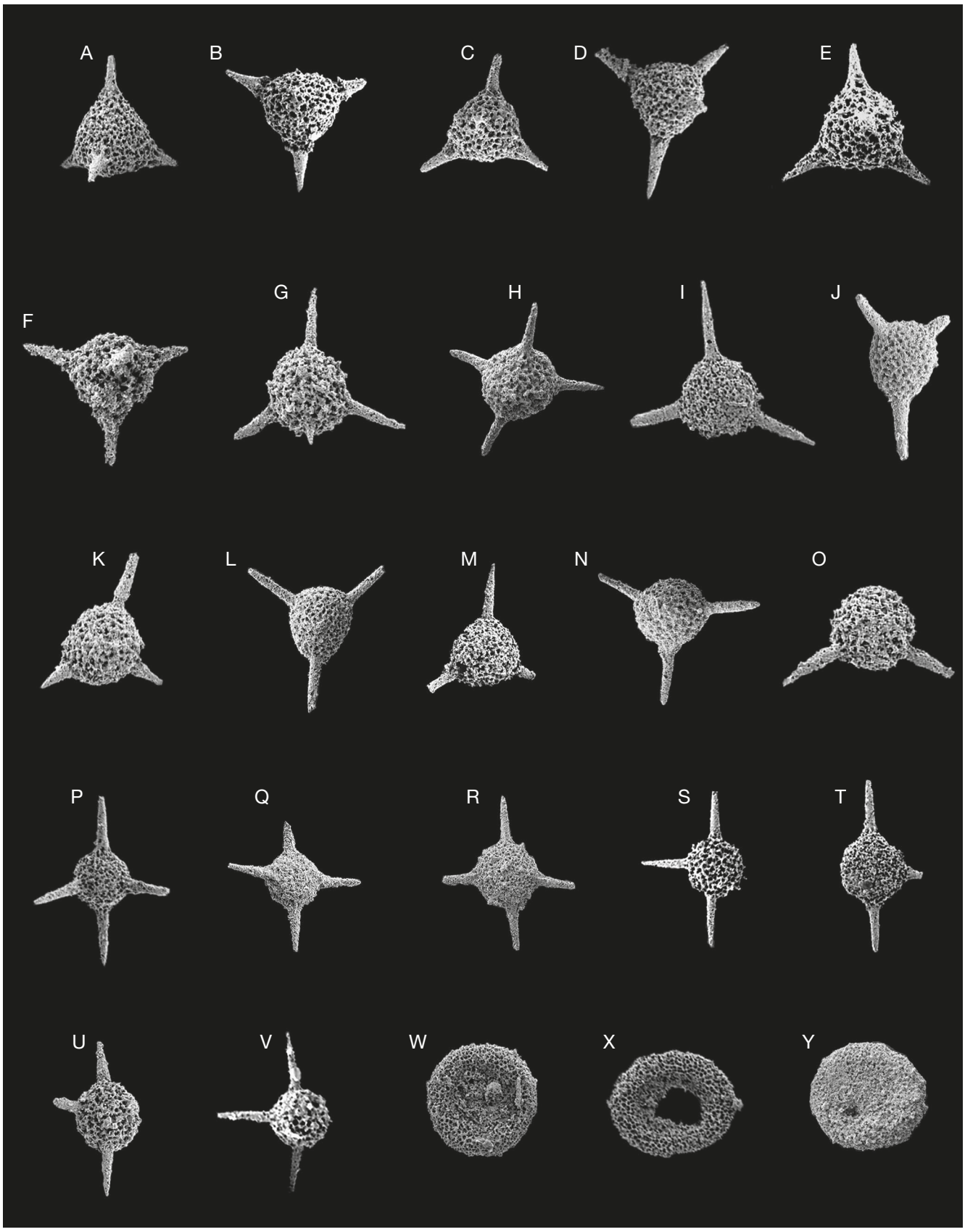



FIG. 8. — Photomicrographs of the radiolarians from the Orbuklukeli section; **A**-**H**, *Acanthotetrapaurinella kennecottensis* (Carter *in* Longridge, Carter, Smith & Tipper, 2007); **A**-**E**, **G**, Orbuk-26, **F**, **H**, Orbuk-27; **I**-**O**, *Paurinella liassica* Tekin, n. sp.; **I**, Holotype, Orbuk-27; **J**-**O**, Paratypes; **J**, **N**, Orbuk-27; **K**-**M**, Orbuk-32; **O**, Orbuk-26; **P**-**V**, *Tetrapaurinella sphaerica* Tekin, n. sp.; **P**, Holotype, Orbuk-32; **Q**-**V**, Paratypes; **Q**, Orbuk-32; **R**-**T**, Orbuk-27, **U**, Orbuk-26; **V**, Orbuk-31; **W**-**Y**, *Orbiculiformella callosa* (Yeh, 1987); **W**, **X**, Orbuk-36; **Y**, Orbuk-41. Scale bar: G-H, 100 µm; A-F, I-V, 150 µm; W-Y, 200 µm.

Description
Test small, slightly inflated globular with three primary spines. Cortical shell with small to medium sized, trigonal to tetragonal pore frames with subcircular nodes at pore frame vertices. Primary spines thin, needle-like throughout their length, subcircular in transversal section, tapering gradually to the distal end. Length of primary spines approximately equal to the diameter of the cortical shell.

Remarks
This species differs from *Charlottea johnsoni* (Carter *et al.* 1998: 38-39, pl. 3, figs 5, 10, 13, 14) by having a smaller test with needle-like primary spines throughout their length.

***Charlottea johnsoni***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 9M-N)

*Charlottea johnsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 38-39, pl. 3, figs 5, 10, 13, 14. — Suzuki *et al.* 2002: 168, fig. 4G. — Tekin 2002a: 188, pl. 3, fig. 16. — Bertinelli & Marcucci 2011: 411, pl. 2, figs 12-13.

Occurrence. — Lower Jurassic, uppermost Hettangian-lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; North Peru; Gran Sasso, central Apennines, Italy; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

*Charlottea* sp. A
*sensu* Whalen & Carter (2002)
(Fig. 9O)

*Charlottea* sp. A – Whalen & Carter 2002: 122, pl. 7, figs 4, 5. — Goričan *et al.* 2006: 108-109, pl. CHA07, figs 1-2.

Occurrence. — Lower Jurassic, lower Lower Pliensbachian of Baja California Sur, Mexico and Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Tozerium*
Whalen & Carter *in* Carter, Whalen & Guex, 1998

Type species. — *Tozerium nascens* Whalen & Carter, 1998 by original designation.

***Tozerium orbuklukeliense*** Tekin, n. sp.
(Fig. 9P-R)

urn:lsid:zoobank.org:act:D0FD13C2-4B21-4640-9815-2297D5FFBEB3

Holotype. — Sample Orbuk-32, HU.JMB.0142 (Fig. 9P).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — Named after its type locality.

Occurrence. — Lower Jurassic, lower Sinemurian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Paratypes. — HU.JMB.0143 (Fig. 9Q), HU.JMB.0144 (Fig. 9R).

Dimensions (based on three specimens, in µm). — Maximum diameter of cortical shell: 110-128 (holotype: 110, average: 116); Maximum length of spine: 85-114 (holotype: 100, average: 99.6).

Description
Cortical shell small to medium-sized with four strong spines. Cortical shell sphaerical to subsphaerical composed of small to medium-sized polygonal (mainly trigonal to tetragonal) pore frames and large, subcircular pores at pore frame vertices. Spines prominent, robust, needle-like, subcircular in transversal section, decreasing in width gradually to its end. Length of spines approximately equal to diameter of cortical shell.

Remarks
This species differs from *Tozerium nascens* (Carter *et al.* 1998: 44, pl. 1, figs 1, 7, 8, 13, 14, 18, 23, 24) by having a sphaerical, smaller cortical shell with smaller pore frames, large nodes at pore frame vertices and prominent, robust and longer primary spines.

*Tozerium* sp. A
(Fig. 9S, T)

Occurrence. — Lower Jurassic, lower Lower Pliensbachian of Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Description
Cortical shell small, subsphaerical with four strong spines. It composed of small, polygonal pore frames (mainly triangular) with small, circular nodes at pore frame vertices. Primary spines tetrahedrally disposed, strong, tricarinate with prominent ridges and shallow grooves. They are slightly decreasing in width distally and very slightly dextrally twisted.

Remarks
This taxon differs from *Tozerium orbuklukeliense* Tekin, n. sp. by having tricarinate and slightly dextrally twisted spines instead of needle-like spines.

Subfamily Ferresiinae Carter, 1993

Genus *Ferresium* Blome, 1984 emend. Carter (1993)

Type species. — *Ferresium laseekense* Blome, 1984 by original designation.

***Ferresium*** sp. cf. ***F. teekwoonense*** Carter, 1993
(Fig. 9U)

cf. *Ferresium teekwoonense* Carter, 1993: 69-70, pl. 8, figs 7-9, 12, 13.

Occurrence. — Upper Triassic, Rhaetian of Mersin Mélange, NW of Mersin city, southern Turkey.

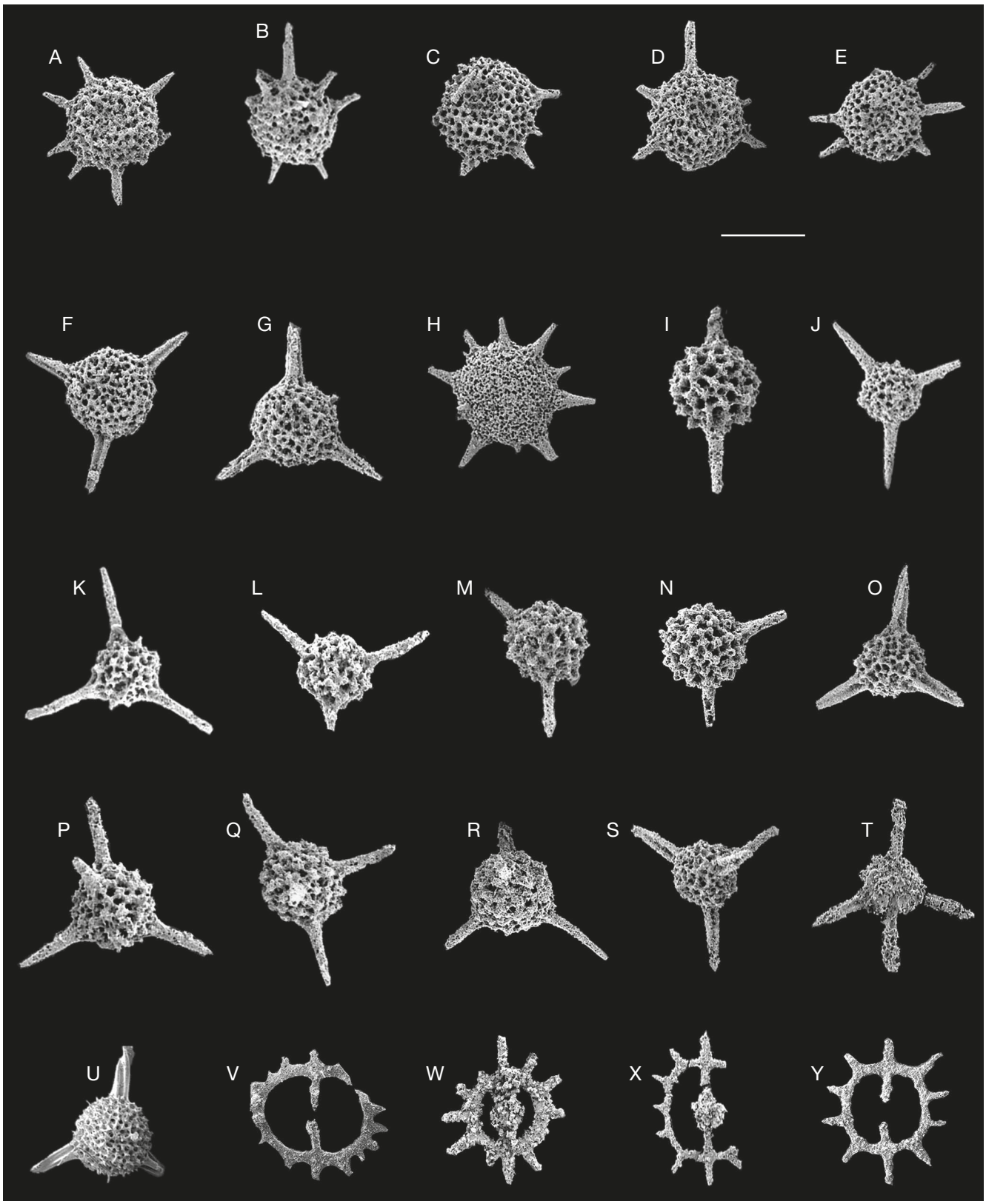



Fig. 9. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A**-**E**, *Orbiculiformella pulchra* Tekin, n. sp.; **A**, Holotype, Orbuk-32; **B**-**E**, Paratypes; **B**, Orbuk-31; **C**-**E**, Orbuk-32; **F**-**G**, *Orbiculiformella* ? *trispina trispina* (Yeh, 1987), Orbuk-32; **H**, *Orbiculiformella* sp. A, Orbuk-27; **I**, *Danubea* sp. A, Orbuk-27; **J**-**L**, *Charlottea elegantissima* Tekin, n. sp.; **J**, Orbuk-32, Holotype; **K**-**L**, Paratypes; **K**, Orbuk-27; **L**, Orbuk-32; **M**, **N**, *Charlottea johnsoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32; **O**, *Charlottea* sp. A *sensu* Whalen & Carter (2002), Orbuk-41; **P**-**R**, *Tozerium orbuklukeliense* Tekin, n. sp.; **P**, Holotype, Orbuk-32; **Q**-**R**. Paratypes; **Q**, Orbuk-32; **R**, Orbuk-31; **S**-**T**, *Tozerium* sp. A; **S**, Orbuk-41; **T**, Orbuk-44; **U**, *Ferresium* sp. cf. *F. teekwoonense* Carter, 1993, Orbuk-15; **V**, *Palaeosaturnalis blomei* Kozur & Mostler, 1990, Orbuk-32; **W**, *Palaeosaturnalis liassicus* Kozur & Mostler, 1990, Orbuk-38; **X**, *Palaeosaturnalis schaafi* Kozur & Mostler, 1990, Orbuk-38; **Y**, *Palaeosaturnalis subovalis* Kozur & Mostler, 1990, Orbuk-38. Scale bar: A-E, 200 µm; F-H, 170 µm; I, 80 µm; J-L, P-R, 120 µm; M-O, S-U, 150 µm; W, X, 220 µm.

Remarks

This specimen differs from the *Ferresium teekwoonense* by having a sphaerical test instead of a triangular one.

Superfamily Saturnaliacea Deflandre, 1953
Family Heliosaturnalidae Kozur & Mostler, 1972
emend. Dumitrica *et al.* (2010)

Genus *Palaeosaturnalis* Donofrio & Mostler, 1978
emend. Kozur & Mostler (1981)

Type species. — *Spongosaturnalis triassicus* Kozur & Mostler, 1972 by original designation.

***Palaeosaturnalis blomei*** Kozur & Mostler, 1990
(Fig. 9V)

*Palaeosaturnalis blomei* Kozur & Mostler, 1990: 191, pl. 9, fig. 9.

Occurrence. — Lower Jurassic, Hettangian-lower Sinemurian of Bavaria, Germany; Mersin Mélange, NW of Mersin city, southern Turkey.

***Palaeosaturnalis liassicus*** Kozur & Mostler, 1990
(Fig. 9W)

*Palaeosaturnalis liassicus* Kozur & Mostler, 1990: 192, pl. 1, figs 2, 3; pl. 12, figs 1, 3, 4, 6, 8-10; pl. 13, figs 1-2, 6-7. — Yang & Mizutani 1991: 65, pl. 2, figs 5, ?10. — Carter *et al.* 1998: 53-54, pl. 14, figs 11-12, 15-17. — Yeh & Cheng 1998: 16, pl. 2, fig. 7; pl. 11, fig. 7. —Tekin 2002a: 182, pl. 2, fig. 3. — ? Palfy *et al.* 2007: fig. 5.25.

*Paleosaturnalis* sp. D – Yao 1982: pl. 4, fig. 2.

Occurrence. — Lower Jurassic, middle Hettangian-lower Lower Pliensbachian of Japan; Alps and Varhegy Formation, northern Hungary; northeast China; Queen Charlotte Islands, British Columbia, Canada; Busuanga Island, Philippines; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Palaeosaturnalis schaafi*** Kozur & Mostler, 1990
(Fig. 9X)

*Palaeosaturnalis schaafi* Kozur & Mostler, 1990: 193, pl. 11, figs 9, 11-12; pl. 12, figs 2, 7. — Yeh & Cheng 1998: 16, pl. 2, figs 6, 10. —Tekin 2002a: 182, pl. 2, fig. 4.

*Palaeosaturnalis* cf. *schaafi* – Kozur & Mostler 1990: pl. 11, figs 10, 13; pl. 12, fig. 1.

Occurrence. — Lower Jurassic, middle Hettangian-lower Lower Pliensbachian of Alps and Varhegy Formation, northern Hungary; Busuanga Island, Philippines; Antalya nappes, Antalya and Mersin Mélange, NW of Mersin city, southern Turkey.

***Palaeosaturnalis subovalis*** Kozur & Mostler, 1990
(Figs 9Y; 10A)

*Palaeosaturnalis subovalis* Kozur & Mostler, 1990: 193-194, pl. 1, fig. 7; pl. 13, figs 4, *non* 9 (pathologic specimen). —Tekin 2002a: 182, pl. 2, fig. 5. — Goričan *et al.* 2006: 270-271, pl. SAT12, fig. 1, ?2, ?3, *non* 4 (= *Pseudoheliodiscus finchi* Pessagno *in* Pessagno, Finch & Abbott, 1979).

*Spongostaurnalis* ? sp. C – Yao 1972: pl. 8, fig. 3.

*Acanthocircus* sp. B – Yeh 1987a: 49, pl. 5, fig. 13.

Occurrence. — Lower Jurassic, uppermost Hettangian - Aalenian of Alps and northern Hungary; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Mesosaturnalis* Kozur & Mostler,1990

Type species. — *Palaeosaturnalis levis* Donofrio & Mostler, 1978 by original designation.

***Mesosaturnalis artus*** (Donofrio & Mostler, 1978)
(Fig. 10B, C)

*Palaeosaturnalis artus* Donofrio & Mostler, 1978: 34, pl. 7, fig. 11.

*Acanthocircus* sp. A – Yeh 1987a: 49, pl. 5, fig. 9; pl. 23, fig. 9.

*Mesosaturnalis artus* – Yang & Mizutani 1991: 64, pl. 3, fig. 10.

? *Mesosaturnalis* sp. aff. *M. artus* – Sugiyama 1997: 160, fig. 45.3.

?*Mesosaturnalis* sp. aff. *M. artus* – Carter *et al.* 1998: 55, pl. 14, figs 18, 22.

Occurrence. — Upper Triassic, upper Norian-Lower Jurassic, upper Pliensbachian of Pötschen, Austria; East-central Oregon, United States; northeast China; ? Japan; ? Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

***Mesosaturnalis octospinus*** Sugiyama, 1997
(Fig. 10D-E)

*Mesosaturnalis octospinus* Sugiyama, 1997: 160, fig. 45.1.

Occurrence. — Upper Triassic, Norian-Lower Jurassic, Hettangian of Mino Terrane, central Japan; Mersin Mélange, NW of Mersin city, southern Turkey.

Family Saturnalidae Deflandre, 1953
Subfamily Saturnalinae Deflandre, 1953

Genus *Praehexasaturnalis* Kozur & Mostler, 1983
emend. Kozur & Mostler (1990)

Type species. — *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler, 1978) by original designation.

***Praehexasaturnalis merici*** Tekin, 2002
(Fig. 10F, G)

*Praehexasaturnalis merici* Tekin, 2002a: 185, pl. 2, fig. 7-9.

Occurrence. — Lower Jurassic, uppermost Hettangian-upper Pliensbachian of Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Praehexasaturnalis poultoni***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 10H-I)

*Praehexasaturnalis poultoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 54, pl. 4, figs 3, 4, 7, 8, 13. — Palfy *et al.* 2007: fig. 5.24. — Dumitrica & Hüngerbühler 2017: 124, pl. 6, figs 6, 6a.

OCCURRENCE. — Lower Jurassic, lower Hettangian-lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; Hungary; Mersin Mélange, NW of Mersin city, southern Turkey.

***Praehexasaturnalis tenuispinosus***
(Donofrio & Mostler, 1978)
(Fig. 10J, K)

*Palaeosaturnalis tenuispinosus* Donofrio & Mostler, 1978: 37-38, pl. 7, figs 1-3, 8.

*Spongosaturnalis* sp. cf. *S. elegans* – De Wever *et al.* 1979: 81, pl. 2, figs 3-4.

*Palaeosaturnalis* aff. *tenuispinosus* – Yao 1982: pl. 3, fig. 17.

*Acanthocircus tenuispinosus* – De Wever 1982a: 206-207, pl. 13, figs 3-5.

*Praehexasaturnalis tenuispinosus* – Kozur & Mostler 1983: 30. — Sugiyama 1997: 185, figs 51.9-10. — Tekin 1999: 112, pl. 18, fig. 2. — Tekin & Yurtsever 2003: 154, pl. 2, fig. 1. — Bragin 2007: 994, pl. 9, fig. 8. — Uzuncimen *et al.* 2011 figs 10.1-2. — Carter & Orchard 2013: fig. 10.1.

*Acanthocircus vigrassi* Blome, 1984: 26, pl. 2, figs 9-10.

*Acanthocircus* cf. *A. elegance* – Yoshida 1986: pl. 15, figs 8, 9.

*Acanthocircus tenuispinosus* – Yeh 1990: 17, pl. 13, fig. 3.

OCCURRENCE. — Upper Triassic, upper Lower Norian-Lower Jurassic, lower Sinemurian of Pötschen, Austria; East-central Oregon, United States, Inuyama area and Mino Terrane, central Japan; Busuanga Island, Philippines; Antalya Nappes, Isparta city, NE and West of Antalya city, Kocali Complex, Adiyaman city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Praehexasaturnalis tetraradiatus*** Kozur & Mostler, 1990
(Fig. 10L-M)

*Praehexasaturnalis tetraradiatus* Kozur & Mostler, 1990: 195-196, pl. 6, figs 8, 9, 11, 12. — Carter 1994, pl. 1, fig. 19. — Carter *et al.* 1998: 54, pl. 14, figs 1, 2, 5, 6, 9, 10. — Whalen & Carter 2002: 108, pl. 5, figs 7, 11, 12. — Tekin 2002a: 184, pl. 2, fig. 10. — Goričan *et al.* 2006: 332-333, pl. SAT01, figs 1-3.

*Pseudoheliodiscus* (?) spp. – Whalen & Pessagno 1984: pl. 3, figs 12-13.

*Stauroacanthocircus quadratus* – Yang & Mizutani 1991: 73, pl. 3, fig. 1, 6.

*Palaeosaturnalis tetraradiatus* – Carter *et al.* 2010: pl. 1, fig. 1.

OCCURRENCE. — Lower Jurassic, middle Hettangian – lower Lower Pliensbachian of Baja California Sur, Mexico; Bavaria, Germany and northern Hungary; northeast China; Queen Charlotte Islands, British Columbia, Canada; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Genus *Stauroacanthocircus* Kozur & Mostler, 1983
emend. Kozur & Mostler (1990)

TYPE SPECIES. — *Pseudoheliodiscus concordis* De Wever, 1981 by original designation.

***Stauroacanthocircus dickinsoni*** (Yeh, 1989)
(Fig. 10N, O)

*Quadrisaturnalis dickinsoni* Yeh, 1989: 50, pl. 13, fig. 18.

? *Quadrisaturnalis* sp. cf. *Q. dickinsoni* – Yeh 1989: 50, pl. 13, fig. 14.

*Stauroacanthocircus dickinsoni* – Tekin & Yurtsever 2003: 156, pl. 2, fig. 2.

OCCURRENCE. — Upper Triassic, upper Lower Norian-Lower Jurassic, upper Pliensbachian of East-Central Oregon; Antalya Nappes, west of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Stauroacanthocircus*** ? ***poetschensis*** Kozur & Mostler, 1990
(Fig. 10P, Q)

*Stauroacanthocircus* ? *poetschensis* Kozur & Mostler, 1990: 199-200, pl. 7, fig. 8; pl. 8, figs 1, 4. — Tekin 1999: 116, pl. 19, figs 7-8. — Tekin & Yurtsever 2003: 156, pl. 2, fig. 3.

OCCURRENCE. — Upper Triassic, upper Lower Norian-lower Lower Jurassic, Pliensbachian of Pötschen, Austria; Antalya Nappes, west of Antalya city of Mersin Mélange, NW of Mersin city, southern Turkey.

*Stauroacanthocircus* sp. A
(Fig. 10R)

OCCURRENCE. — Lower Jurassic, lower Sinemurian of Mersin Mélange, NW of Mersin city, southern Turkey.

DESCRIPTION
Shell not preserved, ring broad and elliptical. Thin ring contains eight, thin, needle-like spines. Inner cavity broad, elliptical with four thin polar spines.

REMARKS
This specimen differs from *Stauroacanthocircus dickinsoni* (Yeh 1989: 50, pl. 13, fig. 18) by having a broad elliptical ring and inner cavity, and thin, short peripheral and polar spines.

Family PSEUDOACANTHOCIRCIDAE Kozur & Mostler, 1990

Genus *Pseudoacanthocircus* Kozur & Mostler, 1990

TYPE SPECIES. — *Pseudoacanthocircus mediospinosus* Kozur & Mostler, 1990 by original designation.

***Pseudoacanthocircus mediospinosus***
Kozur & Mostler, 1990
(Fig. 10S, T)

*Pseudoacanthocircus mediospinosus* Kozur & Mostler, 1990: 208, pl. 10, figs 6, 8.

OCCURRENCE. — Lower Jurassic, Hettangian-lower Lower Pliensbachian of Bavaria, Germany; Mersin Mélange, NW of Mersin city, southern Turkey.

### ***Pseudoacanthocircus mocki*** Kozur & Mostler, 1990 (Fig. 10U)

*Pseudoacanthocircus mocki* Kozur & Mostler, 1990: 209, pl. 1, fig. 1; pl. 10, fig. 9. — Dumitrica & Hüngerbühler 2017: pl. 8, figs 5, 8.

OCCURRENCE. — Lower Jurassic, Hettangian-upper Pliensbachian of Bavaria, Germany; Mersin Mélange, NW of Mersin city, southern Turkey.

### ***Pseudoacanthocircus troegeri*** Kozur & Mostler, 1990 (Fig. 10V)

*Pseudoacanthocircus troegeri* Kozur & Mostler,1990: 210, pl. 11, fig. 7. — Carter 1993: 56-57, pl. 5, figs 4, 7.

*Mesosaturnalis* sp. 1 – Carter 1990: pl. 2, fig. 3.

OCCURRENCE. — Upper Triassic, Rhaetian-Lower Jurassic, upper Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; Bavaria, Germany; Mersin Mélange, NW of Mersin city, southern Turkey.

### *Pseudoacanthocircus* sp. B *sensu* Sugiyama (1997) (Fig. 10W)

*Pseudoacanthocircus* sp. B – Sugiyama 1997: 168, fig. 45.13.

*Pseudoacanthocircus* sp. A – Tekin 1999: 116-117, pl. 19, fig. 9.

OCCURRENCE. — Upper Triassic, Norian-Lower Jurassic, lower Sinemurian of Mino Terrane, central Japan; Antalya Nappes, West of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

## Suborder NASSELLARIINA Ehrenberg, 1875
## Superfamily ARCHAEODICTYOMITRACEAE Pessagno, 1976
## Family BAGOTIDAE Pessagno & Whalen, 1982

### Genus *Droltus* Pessagno & Whalen, 1982

TYPE SPECIES. — *Droltus lyellensis* Pessagno & Whalen, 1982 by original designation.

### ***Droltus eurasiaticus*** Kozur & Mostler, 1990 (Fig. 10X, Y)

*Droltus eurasiaticus* Kozur & Mostler, 1990: 223, pl. 17, figs 3-4. — Sugiyama 1997: 176, fig. 50.4. — Yeh & Cheng 1998: 20, pl. 12, fig. 1. — Whalen & Carter 2002: 116, pl. 16, figs 5-6. — Goričan *et al.* 2006: 136-137, pl. DRO07, figs 1-3.

*Parahsuum* sp. ? A – Yao 1982: pl. 3, fig. 6.

OCCURRENCE. — Lower Jurassic, upper Hettangian - Pliensbachian of Japan; Bavaria, Germany and northern Hungary; Busuanga Island, Philippines; Mersin Mélange, NW of Mersin city, southern Turkey.

### ***Droltus*** sp. aff. ***D. eurasiaticus*** Kozur & Mostler, 1990 (Fig. 11A, B)

aff. *Droltus eurasiaticus* – Kozur & Mostler 1990: 223, pl. 17, figs 3-4.

OCCURRENCE. — Lower Jurassic, lower Sinemurian of the Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

REMARKS
This taxon differs from *Droltus eurasiaticus* by possessing a shorter and wider test.

### ***Droltus hecatensis*** Pessagno & Whalen, 1982 (Fig. 11C)

*Droltus hecatensis* Pessagno & Whalen, 1982: 121, pl. 1, figs 12, 13, 18, 22; pl. 4, figs 1, 2, 6, 10; pl. 12, figs 18-19. — Hattori 1989: pl. 12, fig. D, F; pl. 30, fig. G; pl. 43, fig. D. — Pujana 1996: 138, pl. 1, figs 6, 10, 17. — Carter *et al.*1998: 63, pl. 15, fig. 14. — Gawlick *et al.* 2001: pl. 5, fig. 13. — Suzuki *et al.* 2002: 181, figs 8G, L, M, *non* fig. 8H. — Tekin 2002a: 186, pl. 3, fig. 9. — Goričan *et al.* 2006: 136-137, pl. DRO02, figs 1-7.

*Droltus* sp. – Sashida 1988: 24, pl. 3, figs 7, 16, 17.

Bagotidae gen. et sp. indet. – Pujana 1996: 138, pl. 1, fig. 10.

OCCURRENCE. — Lower Jurassic, Hettangian-lower Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; Japan; Austria; North Peru; central - west Argentina; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

### ***Droltus laseekensis*** Pessagno & Whalen, 1982 (Fig. 11D-F)

*Droltus laseekensis* Pessagno & Whalen, 1982: 122, pl. 2, figs 5, 6, 11, 16; pl. 12, figs 8, 15. — Carter *et al.* 1998: 63, pl. 15, fig. 8, pl. 26, fig. 4. — Matsuoka 2004: fig. 199. — Goričan *et al.* 2006: 138-139, pl. DRO03, figs 1-5.

OCCURRENCE. — Lower Jurassic, lower Sinemurian-Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; Mino Terrane, Japan; Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

### Genus *Trexus* Whalen & Carter *in* Carter, Whalen & Guex, 1998

TYPE SPECIES. — *Trexus dodgensis* Whalen & Carter, 1998 by original designation.

### ***Trexus dodgensis*** Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 11G-J)

*Trexus dodgensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 82, pl. 24, figs 11, 12, 16, 22, 23. — Gawlick *et al.* 2001: pl. 2, fig. 26; pl. 6, fig. 5. — Suzuki *et al.* 2002: 184, fig. 9D. — Tekin 2002a: 196, pl. 5, fig. 17. — Goričan *et al.* 2006: 382-383, pl. TRX01, figs 1-2.

*Canutus* sp. – Matsuoka 2004: fig. 213.

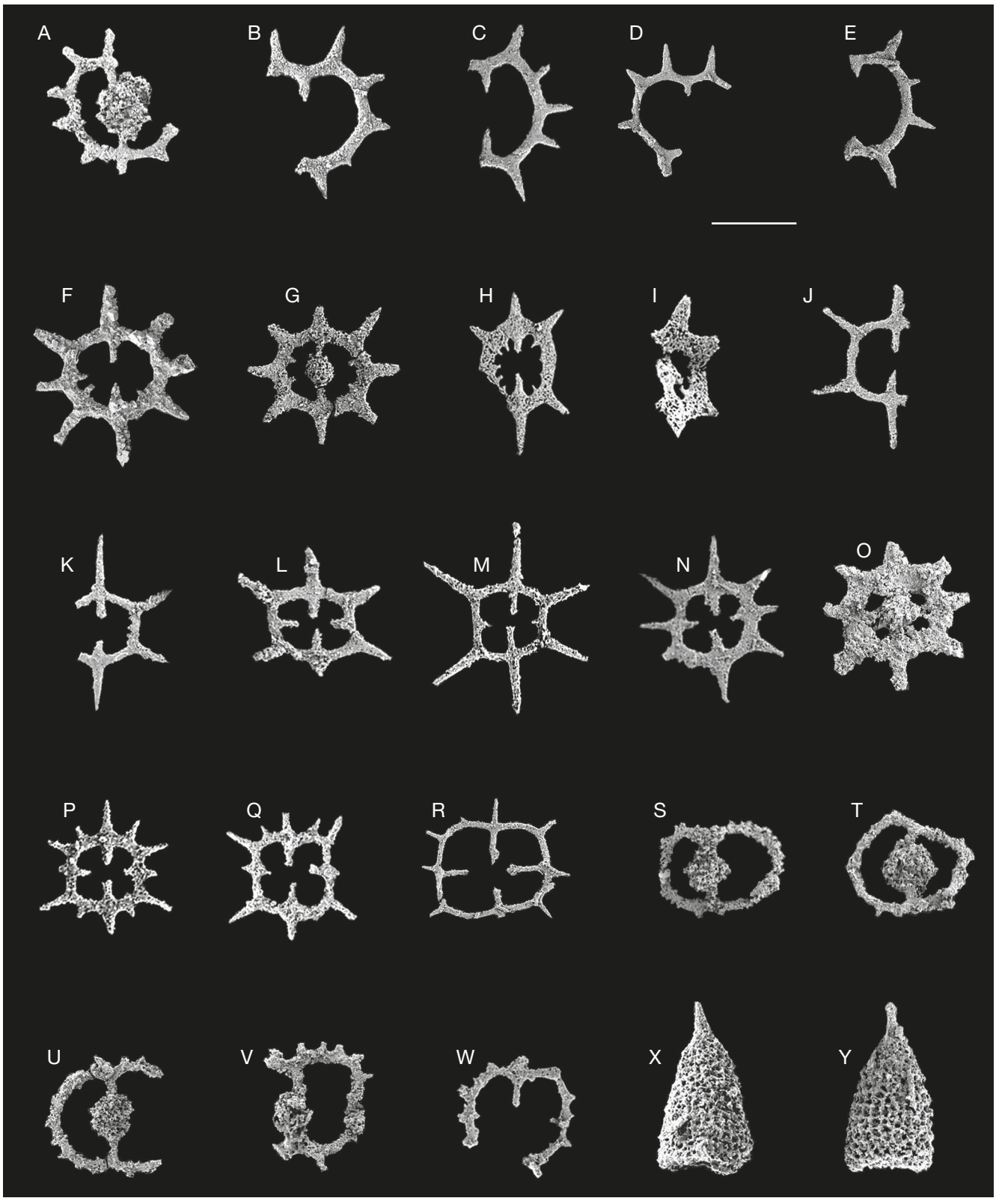



Fig. 10. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A**, *Palaeosaturnalis subovalis* Kozur & Mostler, 1990, Orbuk-44; **B**, **C**, *Mesosaturnalis artus* (Donofrio & Mostler, 1978), Orbuk-21; **D**, **E**, *Mesosaturnalis octospinus* Sugiyama, 1997, Orbuk-21; **F**, **G**, *Praehexasaturnalis merici* Tekin, 2002; **F**, Orbuk-46; **G**, Orbuk-47; **H**, **I**, *Praehexasaturnalis poultoni* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-31; **J**, **K**, *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler, 1978); **J**, Orbuk-26; **K**, Orbuk-31; **L**, **M**, *Praehexasaturnalis tetraradiatus* Kozur & Mostler, 1990; **L**, Orbuk-31; **M**, Orbuk-32; **N**-**O**, *Stauroacanthocircus dickinsoni* (Yeh, 1989); **N**, Orbuk-31; **O**, Orbuk-47; **P**, **Q**, *Stauroacanthocircus* ? *poetschensis* Kozur & Mostler, 1990, Orbuk-31; **R**, *Stauroacanthocircus* sp. A, Orbuk-32; **S**, **T**, *Pseudoacanthocircus mediospinosus* Kozur & Mostler, 1990; **S**, Orbuk-38; **T**, Orbuk-44; **U**, *Pseudoacanthocircus mocki* Kozur & Mostler, 1990, Orbuk-44; **V**, *Pseudoacanthocircus troegeri* Kozur & Mostler, 1990, Orbuk-44; **W**, *Pseudoacanthocircus* sp. B *sensu* Sugiyama (1997), Orbuk-31; **X**, **Y**, *Droltus eurasiaticus* Kozur & Mostler, 1990, Orbuk-32. Scale bar: A, 220 µm; B, C, 120 µm; D-G, L-P, R-V, 200 µm; H-K, W, 170 µm; Q, 240 µm; X, Y, 90 µm.

Occurrence. — Lower Jurassic, middle Hettangian-Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; Austria; North Peru; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

Superfamily Amphipyndacaceae Riedel, 1967
Family Parvicingulidae Pessagno, 1977
emend. Pessagno & Whalen (1982)
Subfamily Canoptinae Yeh, 1987

Genus *Canoptum* Pessagno *in* Pessagno, Finch & Abbott, 1979.

Type species. — *Canoptum poissoni* Pessagno, 1979 by original designation.

***Canoptum cephalobulbosum*** Tekin, n. sp.
(Fig. 11K-O)

urn:lsid:zoobank.org:act:E28BC50B-39C6-4959-B646-EB90ABB2B414

Holotype. — Sample Orbuk-15, HU.JMB.0145 (Fig. 11K).

Paratypes. — HU.JMB.0146 (Fig. 11L), HU.JMB.0147 (Fig. 11M), HU.JMB.0148 (Fig. 11N), HU.JMB.0149 (Fig. 11O).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — Due to its very bulbose cephalis.

Occurrence. — Upper Triassic, Rhaetian, Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on five specimens, in µm). — Maximum length of test: 144-160 (holotype: 144, average: 151.4); Maximum width of test: 80-96 (holotype: 96, average: 90.4).

Description
Test mainly conical with three to four post-abdominal segments, increasing in width until second post-abdominal segment, then last two post-abdominal segments decreasing in width. Cephalis knob-like, bulbous, poreless without horn. Collar stricture mainly poreless and marked by a shallow depression. Test increasing in width slowly until the second post-abdominal segment and subtrapezoidal to hoop-shaped in outline while last two segments decreasing in width, and inverse subtrapezoidal to hoop-shaped in outline. Thorax mainly covered by veneer of microgranular silica but sometimes including some subcircular scattered pores. In some specimens (Fig. 11K, O), small nodes are also visible at the surface of thorax. Abdomen and post-abdominal segments with small, numerous, circular to subcircular pores. In some specimens (Fig. 11K, M), where veneer of microgranular silica is not prominent, two rows of pores are visible just below and above the circumferential strictures.

Remarks
This species differs from *Canoptum rhaeticum* (Kozur & Mostler 1981: 103-104, pl. 20, figs 1-4) by having a very bulbous cephalis, shorter and slimmer test composed of less segments.

***Canoptum columbiaense***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 11P)

*Canoptum columbiaense* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 64, pl. 15, figs 6, 10, 11, 15, 19. — Suzuki *et al.* 2002: 181, figs 8C-E, J-K. — Tekin 2002a: 189, pl. 4, fig. 5. — Goričan *et al.* 2006: 86-87, pl. CAN08, fig. 1-9.

*Canoptum* sp. – Kashiwagi 1998: pl. 2, fig. 12.

Occurrence. — Lower Jurassic, lower Hettangian-lower Upper Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; North Peru; southwest Japan; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Canoptum merum*** Pessagno & Whalen, 1982
(Fig. 11Q)

*Canoptum merum* Pessagno & Whalen, 1982: 124, pl. 1, figs 1, 15, 16, 20; pl. 12, fig. 11. — Carter *et al.* 1998: 64-65, pl. 16, fig. 3. — Tekin 2002a: 189, pl. 4, fig. 8.

Occurrence. — Upper Triassic, Rhaetian-Lower Jurassic, lower Sinemurian of Queen Charlotte Islands, British Columbia, Canada; East-central Oregon, United States; Antalya Nappes, NE of Antalya City and Mersin Mélange, NW of Mersin city, southern Turkey.

***Canoptum productum*** Tekin, n. sp.
(Fig. 11R-U)

urn:lsid:zoobank.org:act:4E402E3A-79F5-405C-AB7F-EB5F656496A0

Holotype. — Sample Orbuk-15, HU.JMB.0150 (Fig. 11R).

Paratypes. — HU.JMB.0151 (Fig. 11S), HU.JMB52 (Fig. 11T), HU.JMB.0153 (Fig. 11U).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — From the Latin *productum*, lengthened, long, due its long test.

Occurrence. — Late Triassic, Rhaetian, Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on four specimens, in µm). — Maximum length of test: 170-220 (holotype: 220, average: 190); Maximum width of test: 80-100 (holotype: 100, average: 89.3).

Description
Test long, slender, very slowly incerasing in width and height distally with six post-abdominal segments. Cephalothorax dome-shaped, probably without horn, poreless, collar stricture indistinct. Lumbar stricture and other strictures prominent, marked by relatively deep depressions and mainly poreless. Abdomen to post-abdominal segments hoop-like, mainly covered by veneer of thick, microgranular silica with scattered, small, subcircular pores. Two rows of pores (15-16 pores at one row on half a circumference) can be seen just above and below septa located at strictures when silica accumulation is not prominent.

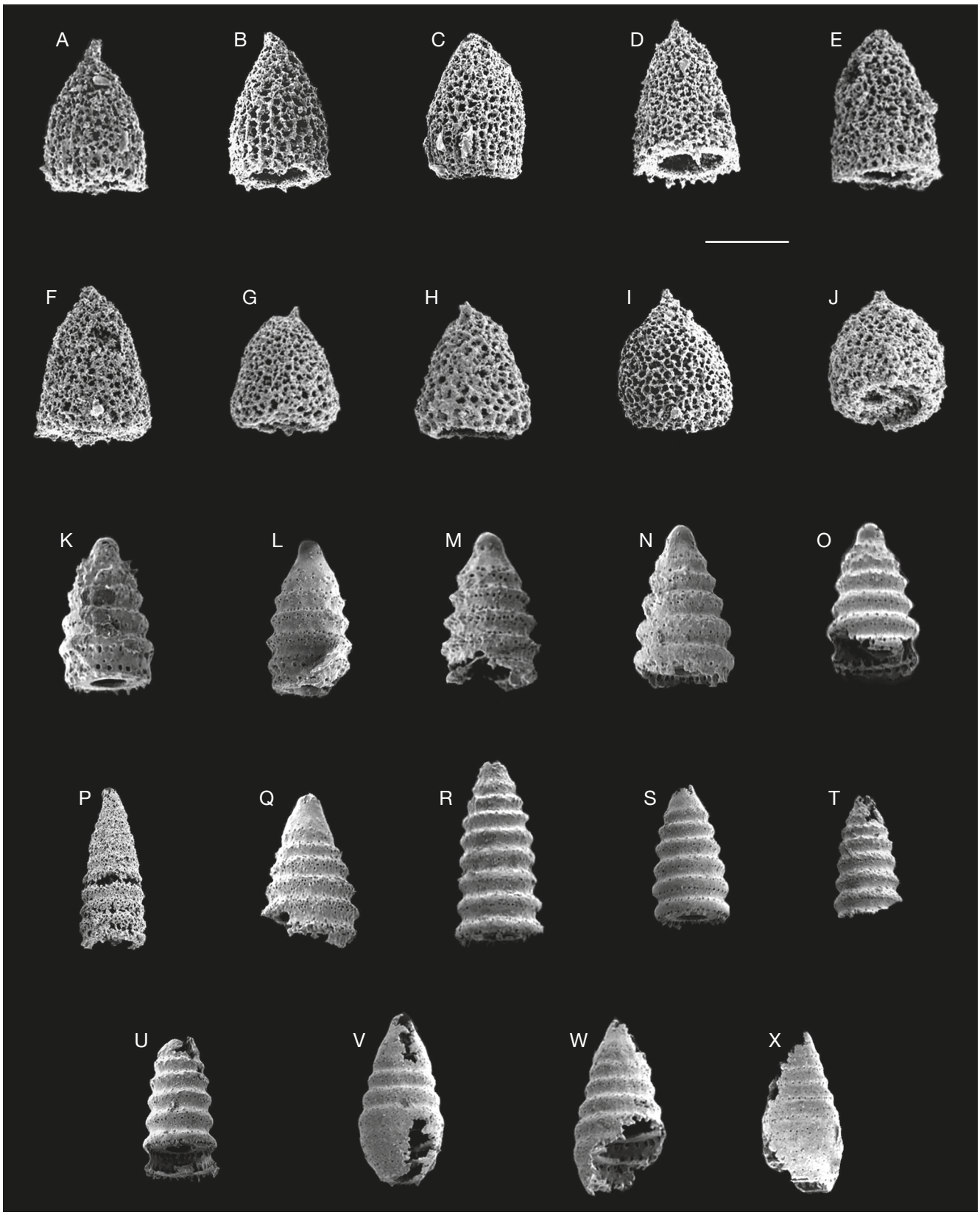



FIG. 11. — Photomicrographs of the radiolarians from the Orbuklukeli section; **A**, **B**, *Droltus* sp. aff. *D. eurasiaticus* Kozur & Mostler, 1990, Orbuk-32; **C**, *Droltus hecatensis* Pessagno & Whalen, 1982, Orbuk-32; **D**-**F**, *Droltus laseekensis* Pessagno & Whalen, 1982, Orbuk-27; **G**-**J**, *Trexus dodgensis* Whalen & Carter *in* Carter, Whalen & Guex, 1998; **G**-**H**, Orbuk-27; **I**, **J**, Orbuk-32; **K**-**O**, *Canoptum cephalobulbosum* Tekin, n. sp.; **K**, Holotype, Orbuk-15; **L**-**O**, Paratypes, Orbuk-15; **P**, *Canoptum columbiaense* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-27; **Q**, *Canoptum merum* Pessagno & Whalen, 1982, Orbuk-15; **R**-**U**, *Canoptum productum* Tekin, n. sp.; **R**, Holotype, Orbuk-15; **S**-**U**, Paratypes, Orbuk-15; **V**-**X**, *Canoptum rarum* Tekin, n. sp.; **V**, Holotype, Orbuk-15; **W**-**X**, Paratypes, Orbuk-15. Scale bar: A, B, 200 µm; C, P, 120 µm; D-J, 100 µm; K-O, R-X, 80 µm.

Remarks

This species differs from *Canoptum merum* (Pessagno & Whalen 1982: 124, pl. 1, figs 1, 15, 16, 20; pl. 12, fig. 11) by a having a more slender test covered by prominent silica accumulation, fewer scattered pores and abdomen to last post-abdominal segments hoop-like instead of trapezoidal in outline.

### *Canoptum rarum* Tekin, n. sp.
(Fig. 11V-X)

urn:lsid:zoobank.org:act:D8026B8E-0D55-4575-9022-E9AB66091477

Holotype. — Sample Orbuk-15, HU.JMB.0154 (Fig. 11V).

Paratypes. — HU.JMB.0155 (Fig. 11W), HU.JMB156 (Fig. 11X).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — From the Latin *rarum*, rare, due to its rare occurrence.

Occurrence. — Upper Triassic, Rhaetian, Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on three specimens, in µm). — Maximum length of test: 200-220 (holotype: 208, average: 209.3); Maximum width of test: 104-120 (holotype: 104, average: 111.3).

Description

Test spindle-shaped, multicyrtid with six post-abdominal segments. Test increasing in width gradually up to the third post-abdominal segment, then the last three segments are decreasing in width. Cephalothorax hemisphaerical, mainly poreless. Abdomen to third post-abdominal segment hoop-like and strictures between these segments less-prominent, marked only by very shallow depressions. Strictures between third to sixth post-abdominal segments not visible. Because of dense silica accumulation, only small scattered pores are visible on the surface of test. When accumulation of silica is not prominent, two rows of pores can be seen around strictures. On wider part of test, corresponding to the third post-abdominal segment, 16 pores are visible in one row.

Remarks

This taxon can be differentiated from other species of the genus *Canoptum* Pessagno by having the spindle-shaped last three segments without superficial strictures.

### *Canoptum rhaeticum* Kozur & Mostler, 1981
(Fig. 12A, B)

*Canoptum rhaeticum* Kozur & Mostler, 1981: 103-104, pl. 20, figs 1-4; 1990: 219-220. — Sugiyama 1997: 175, fig. 50.5. — Tekin 1999: 138, pl. 29, fig. 1; 2002b: 432, pl. 4, fig. 2. — Uzuncimen *et al.* 2011: fig. 11.20-22.

*Canoptum triassicum* Yao, 1982: 60, pl. 3, figs 3-4. — Yao *et al.* 1982: pl. 2, fig. 1. — ? Bragin 1986: pl. 3, fig. 5; ? 1991: 102, pl. 7, figs 1, 5. — Yeh & Cheng 1996: 11, pl. 3, fig. 5. — *non* Palfy *et al.* 2007: fig. 5.4. — *non* Baumgartner *et al.* 2008: pl. 3, fig. 18.

Occurrence. — Late Triassic; upper Norian-Rhaetian of Zlambachgraben, Austria; Inuyama Area and Mino Terrane, central Japan; Sakhalin, Fareast Russia; Busuanga Island, Philippines; Ankara regian, central Turkey; Kocali Complex, eastern Turkey and Antalya Nappes, NE of and West of Antalya City and Mersin Mélange, NW of Mersin city, southern Turkey.

### *Canoptum striatum* (Kozur & Mostler, 1990)
(Fig. 12C)

*Relanus striatus* Kozur & Mostler, 1990: pl. 16, figs 8-9; pl. 17, figs 17-18.

Occurrence. — Lower Jurassic, Hettangian-lower Sinemurian of Bavaria, Germany; Mersin Mélange, NW of Mersin city, southern Turkey.

## Genus *Laxtorum* Blome, 1984 emend. Carter (1993)

Type species. — *Laxtorum hindei* Blome, 1984 by original designation.

### *Laxtorum breve* Tekin, n. sp.
(Fig. 12D-J)

urn:lsid:zoobank.org:act:AAC22989-AF44-439E-8E99-6493848E6229

*Laxtorum* sp. – Aita & Spörli 1992: pl. 5, fig. 12.

Holotype. — Sample Orbuk-32, HU.JMB.0157 (Fig. 12D).

Paratypes. — HU.JMB.0158 (Fig. 12G), HU.JMB159 (Fig. 12H), JMB.0160 (Fig. 12I), HU.JMB161 (Fig. 12J).

Type locality. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Etymology. — From the Latin *brevis-e* – short, brief, due its short shell.

Occurrence. — Lower Jurassic, lower Sinemurian of Auckland, New Zealand and Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Dimensions (based on seven specimens, in µm). — Length of horn: 84-120 (holotype: 100, average: 105.7); Maximum length of test: 132-158 (holotype: 158, average: 141.1); Maximum width of test: 120-168 (holotype: 125, average: 136.1).

Description

Test short with three post-abdominal segments. Cephalis hemisphaerical with a long horn. Horn needle-like, subcircular in transversal section, slightly decreasing in width distally and terminated in a sharp end. Rest of the test increasing in width very slowly, and decreasing in width at last segment. Collar, lumbar and following strictures not prominent, not visible at the surface of test. Surface of test covered with thick layer of silica with irregular surface. Test bears circular to subcircular pores of different sizes.

Remarks

This species differs from *Laxtorum hemingense* Whalen & Carter *in* Carter *et al.* (1998: 80, pl. 25, figs 6-8, 13, 14,

24, 25; pl. 27, figs 5, 6, 16, 20) by having a shorter test with very long horn and indistinct circumferential ridges. It can be differentiated from *Laxtorum obscurum* Tekin, n. sp. by possessing a thin, long horn and longer test with more segments.

***Laxtorum obscurum*** Tekin, n. sp.
(Fig. 12K, L)

urn:lsid:zoobank.org:act:C977E9D3-0777-4F5E-9E55-1DB51E89B925

*Laxtorum* sp. A – Tekin 2002a: 194, 196, pl. 5, fig. 15.

HOLOTYPE. — Sample Orbuk-27, HU.JMB.0162 (Fig. 12K).

PARATYPE. — HU.JMB.0163 (Fig. 12L).

TYPE LOCALITY. — Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

ETYMOLOGY. — From the Latin *obscurum*, obscure, indistinct, due to its obscure inner structure of test.

OCCURRENCE. — Lower Jurassic, lower Sinemurian of Antalya Nappes, NE of Antalya City and Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

DIMENSIONS (based on two specimens, in µm). — Length of horn: 65-70 (holotype: 70, average: 67.5); Maximum length of test: 150-160 (holotype: 150, average: 155); Maximum width of test: 90-100 (holotype: 90, average: 95).

DESCRIPTION
Test long, increasing in width gradually to the distal end, conical with four to five post-abdominal segments. Cephalis hemisphaerical with stout, needle-like and pointed apical horn. Thorax and rest of segments subtrapezoidal in outline. Strictures invisible at the surface of test. Surface of the test covered with thick silica layers. Cephalis and thorax with very rare pores, abdomen and the rest of test with large, subcircular to ellipsoidal pores and very rough surface.

REMARKS
This species has been compared to *Laxtorum breve* Tekin, n. sp. under the latter taxon. It can be differentiated from *Laxtorum hemingense* Whalen & Carter *in* Carter *et al.* (1998: 80, pl. 25, figs 6-8, 13, 14, 24, 25; pl. 27, figs 5, 6, 16, 20) by having a test with a stout horn and indistinct circumferential ridges.

Subfamily PARVICINGULINAE Pessagno, 1977a

Genus *Atalantria* Cordey & Carter, 2007

TYPE SPECIES. — *Atalanta emmela* Cordey & Carter, 1996 by original designation.

***Atalantria emmela*** (Cordey & Carter, 1996)
(Fig. 12M, N)

*Atalanta emmela* Cordey & Carter, 1996: 67, pl. 24, fig. 13. — Cordey 1998: 126, pl. 25, fig. 1. — Carter *et al.* 1998: 447, pl. 1, figs 1-3. — Gawlick *et al.* 2001: pl. 2, fig. 22. — Whalen & Carter 2002: 128, pl. 16, figs 1, 8. — Tekin 2002a: 190, pl. 4, figs 10-11. — Goričan *et al.* 2006: 48-49, pl. ATA02, figs 1-2. — O'Dogherty & Gawlick 2008: 73, pl. 1, fig. 7. — Shibutani & Hori 2008: pl. 2, figs 16-17.

Gen. indet Z sp. A – Cordey 1988: 291, pl. 24, fig. 9. — Tipper *et al.* 1991: pl. 8, fig. 8.

*Atalantria emmela* – Cordey & Carter 2007: 430.

OCCURRENCE. — Lower Jurassic, lower Sinemurian-lower Pliensbachian of Queen Charlotte Islands, British Columbia and central British Columbia, Canada; Baja California Sur, Mexico; North Calcerous Alps, Austria; Tamba Terrane, southwest Japan; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

*Atalantria* sp. A
(Fig. 12O)

OCCURRENCE. — Lower Jurassic, lower Sinemurian of Mersin Mélange, NW of Mersin city, southern Turkey.

DESCRIPTION
Test multicyrtid, increasing in width distally except the last segment. Last segment decreasing in width. Cephalis hemisphaerical, poreless with small, rudimentary, needle-like horn. Thorax to rest of segments, except the last one, subtrapezoidal. Last segment inverse subtrapezoidal in outline. Segments have two transverse rows of pores with hexagonal pore frames.

REMARKS
This specimen differs from *Atalantria emmela* (Cordey & Carter 1996: 67, pl. 24, fig. 13) by having a distally constricted test. It can be differentiated also from *Atalantria epaphrodita* (Cordey & Carter 1996: 446, pl. 1, figs 6, 7, 10, 11) by having a shorter test and cephalis with unbranched, needle-like horn.

Superfamily EUCYRTIDIACEA Ehrenberg, 1847
Family EUCYRTIDIIAE Takemura, 1986

Genus *Pseudoeucyrtis* Pessagno, 1977

TYPE SPECIES. — *Eucyrtis* ? *zhamoidai* Foreman, 1973 by original designation.

***Pseudoeucyrtis aquila***
(Whalen & Carter *in* Carter, Whalen & Guex, 1998)
(Fig. 12P, Q)

*Protokatroma aquila* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 71-72, pl. 18, figs 6-8, 15. — Tekin 2002a: 191, pl. 5, fig. 4.

*Eucyrtis* ? sp. – Spörli & Aita 1988: pl. 4, fig. 13.

Eucyrtid gen. and sp. indet. – Carter 1993: 114-115, pl. 20, figs 15, ?16.

*Pseudoeucyrtis aquila* – O'Dogherty *et al.* 2009: 328.

OCCURRENCE. — Upper Triassic, Rhaetian-Lower Jurassic, lower Sinemurian of New Zealand; Queen Charlotte Islands, British Columbia, Canada; Mersin Mélange, NW of Mersin city, southern Turkey.

***Pseudoeucyrtis busuangaensis*** (Yeh & Cheng, 1998)
(Fig. 12R)

*Protokatroma busuangaensis* Yeh & Cheng, 1998: 30-31, pl. 7, fig. 2, 3; pl. 9, figs 4, 5, 24.

*Protokatroma* sp. cf. *P. aquila* – Yeh & Cheng 1998: 30, pl. 7, fig. 1; pl. 9, figs 6, 7.

*Protokatroma* sp. – Yeh & Cheng 1998: 31, pl. 7, figs 2-3.

*Pseudoeucyrtis* sp. – Hori 2004: 31, pl. 2, figs 49-51.

*Pseudoeucyrtis busuangaensis* – Goričan *et al.* 2006: 350, 352, pl. PSE04, figs 1-7.

Occurrence. — Lower Jurassic, lower Sinemurian-lower Pliensbachian of Busuanga Island, Philippines; Oman; Japan; Mersin Mélange, NW of Mersin city, southern Turkey.

Superfamily Foremanellinacea Dumitrica, 1982
Family Foremanellinidae Dumitrica, 1982

Genus *Farcus* Pessagno, Whalen & Yeh, 1986

Type species. — *Farcus graylockensis* Pessagno, Whalen & Yeh, 1986 by original designation.

***Farcus graylockensis*** Pessagno, Whalen & Yeh, 1986
(Fig. 12S)

*Farcus graylockensis* Pessagno, Whalen & Yeh, 1986: 24, pl. 2, figs 4, 6-8, 12, 15. — Yeh 1987a: 76, pl. 1, fig. 7. — Pujana 1996: 139, pl. 1, fig. 7. — Yao 1997: pl. 8, fig. 395. — Tekin 2002a: 189, pl. 4, fig. 2. — Goričan *et al.* 2006: 162-163, pl. FAR04, figs 1-2.

? *Farcus* sp. cf. *F. graylockensis* – Yeh 1987a: 76, pl. 25, fig. 4.

*Farcus* aff. *kozuri* – Yao 1997: pl. 8, fig. 396.

Occurrence. — Lower Jurassic, lower Sinemurian-lower Toarcian of East-central Oregon, United States; Argentina; Oman; Japan; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

*Farcus* sp. A
(Fig. 12T, U)

Occurrence. — Lower Jurassic, upper Hettangian-lower Sinemurian of Orbuklukeli section, Mersin Mélange, NW of Mersin city, southern Turkey.

Description
Test dicyrtid with short feet. Cephalis hemisphaerical with very rare, scatted pores and a tricarinate distally contracting horn. Horn with prominent ridges, deep furrows and a sharp end. Collar stricture not marked externally. Thorax large, distally expanding and with a smooth surface with scattered, subcircular pores of different sizes. Base of the thorax with four short and tricarinate feet.

Remarks
This taxon differs from *Farcus graylockensis* (Pessagno *et al.* 1986: 24, pl. 2, figs 4, 6-8, 12, 15) by possessing a smaller test, indistinct collar stricture, thorax with smooth surface, scattered pores and very short feet.

*Farcus* sp. B
(Fig. 12V)

Occurrence. — Lower Jurassic, lower Sinemurian of the Mersin Mélange, NW of Mersin city, southern Turkey.

Description
Tets long, dicyrtid with hemisphaerical cephalis. Cephalis mainly poreless/with rare pores and a long, needle-like, distally tapering horn. Collar stricture marked by a slight depression. Thorax truncated pyramidal in outline with scattered, subcircular pores, in some cases pores aligned in vertical rows. Thorax terminated in a short tube with scattered and subcircular pores. Four feet long, needle-like and decreasing in width distally.

Remarks
This specimen differs from *Farcus priscus* Yeh & Cheng (1998: 24, pl. 5, figs 1, 6, 12) by possessing a long, pyramidal test, few pores at the surface of thorax, longer, prominent tube at the end of thorax and longer feet.

Family Ultranaporidae Pessagno, 1977
emend. Pessagno *et al.* (1986)

Genus *Anaticapitula* Dumitrica & Zügel, 2003

Type species. — *Anaticapitula clauda* Dumitrica & Zügel, 2003 by original designation.

***Anaticapitula anatiformis*** (De Wever, 1982)
(Fig. 12W, X)

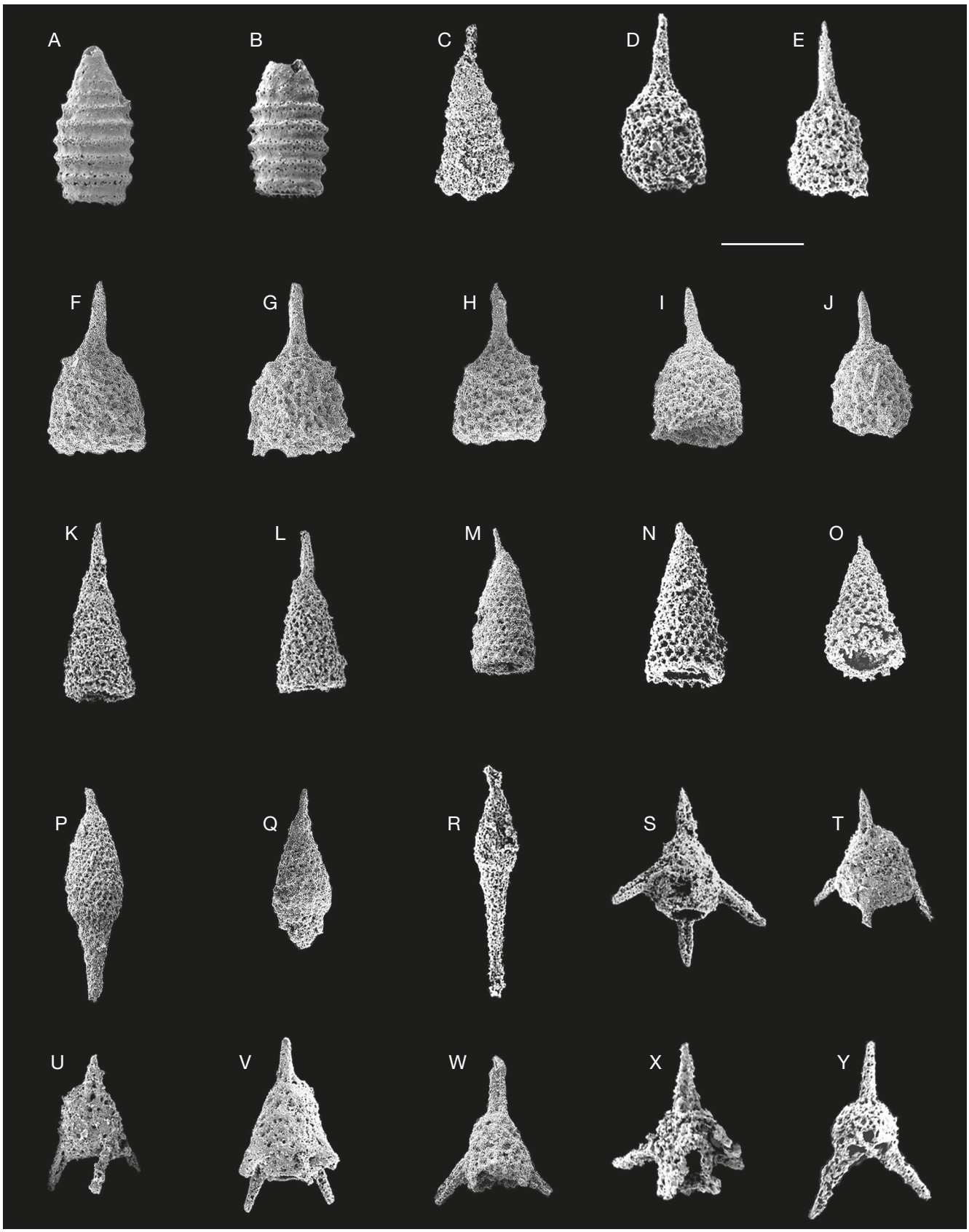
*Jacus* ? *anatiformis* De Wever, 1982a: 205, pl. 11, figs 10-15; 1982b: 343, pl. 54, figs 1-5; pl. 58, figs 1, 2, 6. — Carter *et al.* 1998: 74, pl. 18, figs 13-14, 17-19, 27. — Yeh & Cheng 1998: 32, pl. 6, fig. 10. — Hori & Wakita 2002: pl. 3, fig. 7. — Whalen & Carter 2002: 138, pl. 8, fig. 8.

*Bisphaerocephalina* (?) sp. – Imoto *et al.* 1982: pl. 1, fig. 10.

*Jacus* sp. A – Murchey 1984: pl. 2, fig. 29. — Hattori 1987: pl. 11, fig. 7; 1989: pl. 5, fig. I.

*Jacus* sp. B – Murchey 1984: pl. 2, fig. 28.

Fig. 12. — Photomicrographs of the radiolarians from the Orbuklukeli section; **A**, **B**, *Canoptum rhaeticum* Kozur & Mostler, 1981, Orbuk-15; **C**, *Canoptum striatum* (Kozur & Mostler, 1990), Orbuk-27; **D**-**J**, *Laxtorum breve* Tekin, n. sp.; **D**, Holotype, Orbuk-32; **E**-**J**, Paratypes, Orbuk-32; **K**-**L**, *Laxtorum obscurum* Tekin, n. sp., **K**, Holotype, Orbuk-27; **L**, Paratype, Orbuk-27; **M**-**N**, *Atalantria emmela* (Cordey & Carter, 1996), Orbuk-32; **O**, *Atalantria* sp. A, Orbuk-27; **P**-**Q**, *Pseudoeucyrtis*




*aquila* (Whalen & Carter *in* Carter, Whalen & Guex, 1998), Orbuk-32; **R**, *Pseudoeucyrtis busuangaensis* (Yeh & Cheng, 1998), Orbuk-32; **S**, *Farcus graylockensis* Pessagno, Whalen & Yeh, 1986, Orbuk-32; **T**-**U**, *Farcus* sp. A, Orbuk-26; **V**, *Farcus* sp. B, Orbuk-27; **W**-**X**, *Anaticapitula anatiformis* (De Wever, 1982); **W**, Orbuk-32; **X**, Orbuk-38; **Y**, *Saitoum* sp. aff. *S. triumphense* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32. Scale bar: A-C, K-L, T-U, W-Y, 100 µm; D-J, M-O, 120 µm; P-S, V, 150 µm.

*Jacus* sp. D – Hattori 1987: pl. 11, fig. 8.

*Jacus*? sp. B – Hattori 1989: pl. 5, fig. J.

*Jacus anatiformis* – De Wever *et al.* 1990: pl. 3, fig. 10. — Gawlick *et al.* 2001: pl. 2, fig. 16.

*Thetis* sp. B – Yao 1997: pl. 10, fig. 467.

*Jacus* cf. *anatiformis* – Gawlick *et al.* 2001: pl. 2, fig. 16.

*Anaticapitula anatiformis* – Tekin 2002a: 191, pl. 5, fig. 8. — Goričan *et al.* 2006: 18-20, pl. JAC02, figs 1-11.

*Jacus* ? aff. *anatiformis* – Goričan *et al.* 2003: 296, pl. 4, figs 5-6.

*Jacus* ? sp. – Goričan *et al.* 2003: 296, pl. 4, fig. 7.

*Anaticapitula* (?) sp. – Matsuoka 2004: fig. 144.

*Anaticapitula* ? *anatiformis* – Matsuoka 2004: fig. 145.

Occurrence. — Lower Jurassic, middle Hettangian-middle Toarcian of Gümüslü village, Lycien Nappes, Burdur, Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey; Queen Charlotte Islands, British Columbia, Canada; Baja California Sur, Mexico; Austria; Slovenia; Oman; Busuanga Island, Philippines; Japan.

Superfamily Pylentonemiaceae Deflandre, 1963
Family Poulpidae De Wever, 1981

Genus *Saitoum* Pessagno, 1977

Type species. — *Saitoum pagei* Pessagno, 1977 by original designation.

***Saitoum*** sp. aff. ***S. triumphense***
Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Figs 12Y; 13A)

aff. *Saitoum triumphense* – Whalen & Carter *in* Carter, Whalen & Guex, 1998: 68-69, pl. 17, figs 10-11, 14-15.

Occurrence. — Lower Jurassic, lower Sinemurian of Mersin Mélange, NW of Mersin city, southern Turkey.

Remarks
It differs from the holotype by having less-developed, rare and scattered pores on the surface of the test.

*Saitoum* sp. A
(Fig. 13B)

Occurrence. — Lower Jurassic, lower Sinemurian of the Mersin Mélange, NW of Mersin city, southern Turkey.

## Description

Test small with subsphaerical cephalis and a short horn. Surface of cephalis with irregularly arranged, scattered, large, subcircular pores. Horn short, needle-like, uniform in width till to the end of its preserved length. Horn not aligned to the apex of cephalis. Three feet circular in transversal section.

Remarks
This specimen differs from *Saitoum triumphense* (Carter *et al.* 1998: 68-69, pl. 17, figs 10-11, 14-15) by possessing a very short apical horn, rare, scattered, large pores on the surface of test and short foot. It differs also from *Saitoum keki* (De Wever 1982a: 192, pl. 4, figs 4-6) by having both needle-like horn and feet instead of tricarinate ones.

Superfamily Syringocapsaceae Foreman, 1973
Family Syringocapsidae Foreman, 1973
emend. Pessagno (1977a)

Genus *Katroma* Pessagno & Poisson, 1981
emend. De Wever (1982a)
emend. Whalen & Carter *in* Carter *et al.* (1998)

Type species. — *Katroma neagui* Pessagno & Poisson, 1981 by original designation.

***Katroma ninstintsi*** Carter *in* Carter, Cameron & Smith, 1988
(Fig. 13C-E)

*Katroma ninstintsi* Carter *in* Carter, Cameron & Smith 1988: 60, pl. 2, figs 4, 9. — Goričan *et al.* 2006: 228-229, pl. KAT14, figs 1-10.

*Katroma* sp. – Igo *et al.* 1985: pl. 15, fig. 4. — Pessagno & Mizutani 1992: 99, pl. 99, figs 6, 10, 11, 15.

*Katroma* sp. A – Yeh 1987a: 81, pl. 3, fig. 1; pl. 6, figs 4, 14. — Tumanda *et al.* 1996: 181, fig. 4.15. — Yeh & Cheng 1998: 30, pl. 7, figs 7, 10.

*Syringocapsa inflata* – Gawlick *et al.* 2001: pl. 5, fig. 9.

Occurrence. — Lower Jurassic, lower Pliensbachian-upper Pliensbachian of Queen Charlotte Islands, British Columbia and northeastern British Columbia, Canada; Oregon, UnitedStates; Austria; Philippines; Japan and Mersin Mélange, NW of Mersin city, southern Turkey.

Superfamily uncertain
Family Theoperidae Haeckel, 1881
emend. Takemura (1986)

Genus *Ares* De Wever, 1982

Type species. — Ares armatus De Wever, 1982 by original designation.

***Ares sutherlandi*** Whalen & Carter *in* Carter, Whalen & Guex, 1998 (Fig. 13F, G)

*Ares sutherlandi* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 76, pl. 21, figs 3, 16, pl. 27, figs 1, 7.- Goričan *et al.* 2006: 44-45, pl. ARS02, figs 1-2.

*Ares* sp. – Whalen & Pessagno 1984: pl. 1, fig. 12.

*Ares* sp. A – Whalen & Pessagno 1984: 142, pl. 15, figs 6, 13.

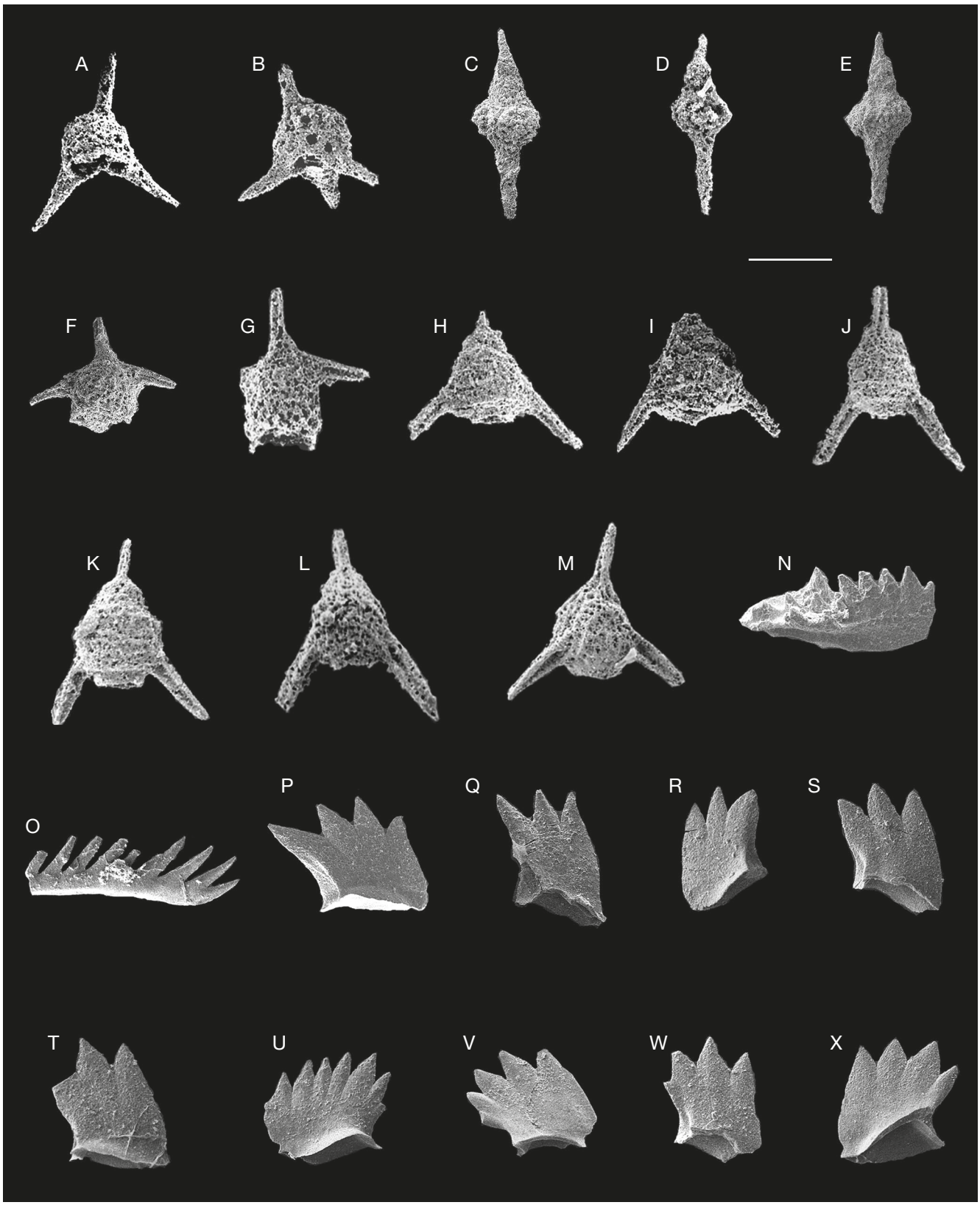



FIG. 13. — Photomicrographs of the radiolarians and conodonts from the Orbuklukeli section: **A**, *Saitoum* sp. aff. *S. triumphense* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32; **B**, *Saitoum* sp. A, Orbuk-32; **C**-**E**, *Katroma ninstintsi* Carter *in* Carter, Cameron & Smith, 1988, Orbuk-46; **F**-**G**, *Ares sutherlandi* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32; **H**-**I**, *Bipedis douglasi* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-32; **J**-**L**, *Bipedis hannai* Whalen & Carter *in* Carter, Whalen & Guex, 1998; **J**, Orbuk-27; **K**, **L**, Orbuk-32; **M**, *Bipedis helenae* Whalen & Carter *in* Carter, Whalen & Guex, 1998, Orbuk-27; **N**, *Epigondolella* sp. cf. *E. postera* Kozur & Mostler, 1971, Orbuk-2; **O**, *Hindeodella* sp., Orbuk-12; **P**, *Misikella hernsteini* (Mostler, 1967), Orbuk-9; **Q**-**T**, *Misikella posthernsteini* Kozur & Mock, 1974; **Q**-**R**, Orbuk-13, **S**, **T**, Orbuk-15; **U**, *Misikella rhaetica* Mostler, 1978, Orbuk-9; **V**-**X**, *Misikella ultima* Kozur & Mock, 1991, Orbuk-15. Scale bar: A-B, F-M, 100 µm; N-X, 150 µm; C-E, 180 µm.

OCCURRENCE. — Lower Jurassic, lower Sinemurian-lower Lower Pliensbachian of Queen Charlotte Islands, British Columbia, Canada; Baja California Sur; Mexico; Mersin Mélange, NW of Mersin city, southern Turkey.

Suborder NASSELLARIA *Incertae sedis*

Genus *Bipedis* De Wever, 1982

TYPE SPECIES. — Bipedis calvabovis De Wever, 1982 by original designation.

***Bipedis douglasi*** Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 13H, I)

*Bipedis douglasi* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 76-77, pl. 23, figs 1, 5, 9-12; pl. 27, figs 15, 19. —Tekin 2002a: 192, pl. 5, fig. 11.

OCCURRENCE. — Lower Jurassic, lower Sinemurian-upper Sinemurian of Queen Charlotte Islands, British Columbia; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Bipedis hannai*** Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 13J-L)

*Bipedis hannai* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 77-78, pl. 21, figs 5, 6, 12, 14, 15; pl. 22, figs 2, 3, 5, 6, 9-11, 14, 15. — Yeh & Cheng 1998: 33, pl. 8, fig. 2. —Tekin 2002a: 194, pl. 5, figs 13-14.

OCCURRENCE. — Lower Jurassic, ? lower Hettangian-lower Sinemurian-upper Sinemurian of Queen Charlotte Islands, British Columbia; Busuanga Island, Philippines; Antalya Nappes, NE of Antalya city and Mersin Mélange, NW of Mersin city, southern Turkey.

***Bipedis helenae*** Whalen & Carter *in* Carter, Whalen & Guex, 1998
(Fig. 13M)

*Bipedis helenae* Whalen & Carter *in* Carter, Whalen & Guex, 1998: 78, pl. 23, figs 2-3, 14-15. — Yeh & Cheng 1998: pl. 4, fig. 2.

OCCURRENCE. — Lower Jurassic, uppermost Hettangian-upper Sinemurian of Queen Charlotte Islands, British Columbia; Busuanga Island, Philippines; Mersin Mélange, NW of Mersin city, southern Turkey.

## RESULTS AND CONCLUSIONS

Diverse pelagic fossil assemblages (conodonts, radiolarians and ammonites) have been obtained and described from the Tavuscayiri Block along the Orbuklukeli section from the Mersin Mélange including the remnants of the Beysehir-Hoyran Nappes originated from the Northern Neotethys. Results are as follows;

1. The basal part of the section is characterized by thin to medium-bedded, rarely thick-bedded, gray-colored limestones with gray-colored chert nodules. Thin-bedded, gray-colored chert interlayers are also present within the limestones. Based on the conodont assemblages, middle Norian to Rhaetian age is assigned to this part. From the uppermost part of this section, diverse radiolarians of late Rhaetian age with many taxa were described.

2. The Upper Triassic part of the section is overlain by green tuffite layer corresponding to the Triassic-Jurassic boundary.

3. Due to the shallow water sea conditions, the lower levels of the Jurassic part of the section is characterized by alternation of thin-bedded, gray-colored limestones and gray cherts with some sponge remains. These cherts do not have any radiolarians. After that, due to the gradually deepening upward sequence, the first radiolarians were retrieved from the middle Hettangian strata.

4. The middle Hettangian to upper Pliensbachian part of the section dated by radiolarians is represented by alternation of thin-bedded, gray-colored limestone and thin-bedded, gray-colored chert at the basal part. Thin to medium-bedded, gray, red to purple-colored limestones with red-colored chert interlayers are the dominant lithologies in the upper part of the section.

5. Determination of the diverse radiolarians revealed eighty-five taxa from the Rhaetian to late Pliensbachian time interval. These radiolarian assemblages include one new genus (*Praeudalia* Tekin, n. gen.) and fourteen new species. The radiolarian assemblages from this section are well-correlative to the circum-Pacific and Tethyan radiolarian assemblages. The radiolarian zonations by Carter (1993) and Carter *et al.* (1998, 2010) were applied to this study for the Rhaetian to Pliensbachian time interval.

6. From the uppermost part of the section, diverse ammonite assemblages of early to early Late Toarcian age were obtained from the nodular limestones showing typical features of the Ammonitico rosso facies.

7. Lithological features characterized by pelagic/hemi-pelagic sequences of middle Norian (Late Triassic)-Toarcian (late Early Jurassic) age in the Orbuklukeli section is very rare in the Mersin Mélange. The lithogical characteristics of the Tavuscayiri Block is correlative to the Gümüslü Unit described by Poisson (1968), Brunn *et al.* (1970, 1971)/the Gülbahar unit by Poisson (1977) in the Lycian Nappes, western Turkey, and the Kayabasi Group by Özgül (1976, 1984)/the Kayabasi Formation of Korualan Group in the Bozkir Unit by Özgül (1997) from the central Taurides.

**Acknowledgements**
Authors are grateful to Turkish Scientific Council (Project No: 112Y370) for providing financial support to this research. The reviewers (Paulian Dumitrica and Spela Goričan) are acknowledged for their constructive remarks.

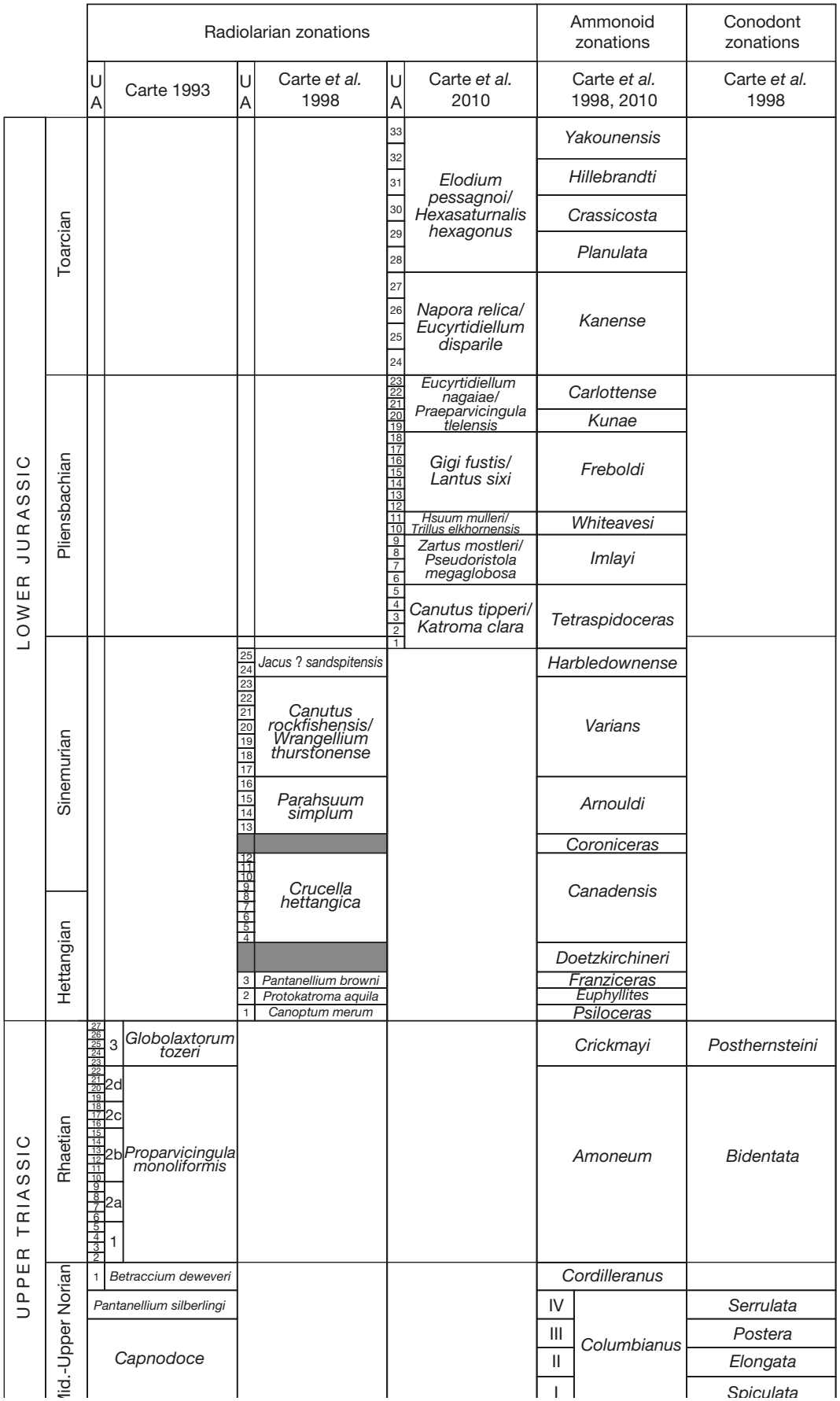



FIG. 14. — Upper Triassic-Lower Jurassic radiolarian, Conodont and Ammonoid zonations from North America (after Carter 1993; Carter *et al.* 1998, 2010). Abbreviations: **Hettan.**, Hettangian; **M.U. Norian**, Middle-Upper Norian; **UA**, Unitary Association.

## REFERENCES


AITA Y. & SPÖRLI K. B. 1992. — Tectonic and palaeogeographic significance of radiolarian microfauna in the Permian and Mesozoic basement rocks of the North Island, New Zealand. *Palaeogeography, Palaeoclimatology, Palaeoecology* 96: 103-125. https://doi.org/10.1016/0031-0182(92)90062-A

ALAN I., SAHIN S., KESKIN H., ALTUN I., BAKIRHAN B., BALCI V., BÖKE N., SACLI L., PEHLIVAN S., KOP A., HANILCI N. & CELIK, Ö. F. 2007. — *Geodynamic Evolution of Central Tauride-Eregli (Konya)-Ulukisla (Nigde)-Karsanti (Adana)-Namrun (Icel) region*. General Directorate of Mineral Research and Exploration, Department of Geological Investigation, Report No: 245 (unpublished, in Turkish).

BAUMGARTNER P. O. 1980. — Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peloponnesus, Greece). *Micropaleontology* 26 (3): 274-322. https://doi.org/10.2307/1485315

BAUMGARTNER P. O., FLORES K., BANDINI A. N., GIRAULT F. & CRUZ D. 2008. — Upper Triassic to Cretaceous Radiolaria from Nicaragua and northern Costa Rica – The Mesquito Composite Oceanic Terrane. *Ofioliti* 33 (1): 1-19.

BAZZUCCHI P., BERTINELLI A., CIARIPICA G., MARCUCCI M., PASSERI L., RIGO M. & ROGHI G. 2005. — The Triassic-Jurassic stratigraphic succession of Pignola (Lagonegro-Molise Basin, southern Apennines, Italy). *Bolletino della Societa Geologica Italiana* 124: 143-153.

BERTINELLI A. & MARCUCCI M. 2011. — Middle and late Hettangian radiolarians from the Mt. Camicia (Gran Sasso, Central Apennines-Italy). *Rivista Italiana di Paleontologia e Stratigrafia* 117 (3): 399-421. https://doi.org/10.13130/2039-4942/5983

BERTINELLI A., NANNARONE C., PASSERI L. & VENTURI F. 2004. — Hettangian Ammonites and radiolarians in the Mt. Camicia (Gran Sasso, central Apennines). *Bolletino della Societa Geologica Italiana* 110 (1): 87-95.

BLOME C. D. 1984. — Upper Triassic Radiolaria and radiolarian zonation from western North America. *Bulletins of American Paleontology* 85 (318): 1-88. https://www.biodiversitylibrary.org/page/28866200

BRAGIN N. YU. 1986. — Triassic biostratigraphy of deposits in South Sakhalin. *New proceedings, Academy of Science of the USSR. Moscow, Geological Series* 4: 61-75 (in Russian).

BRAGIN N. YU. 1991. — Radiolaria of Lower Mesozoic units of the USSR, east regions. *Transaction of the Academy of Sciences of the USSR* 469: 1-125 (in Russian with English summary).

BRAGIN N. YU. 2007. — Late Triassic radiolarians of southern Cyprus. *Paleontological Journal* 41 (10): 951-1029. https://doi.org/10.1134/S0031030107100012

BRAGIN N. YU. & BRAGINA L. G. 2017. — Early and Middle Jurassic (Pliensbachian to Bajocian) radiolaria from cherts of Kiselevka-Manoma accretionary complex (Amur River, eastern Russia). *Ofioliti* 42 (1): 1-19.

BRONNIMANN P., POISSON A. & ZANINETTI L. 1970. — L'unité du Domaz Dag (Turus Lycien-Turquie). Microfaciès et foraminifères du Trias et du Lias. *Rivista Italiana di Paleontologia e Stratigrafia* 76 (1): 1-36.

BRUNN J. H., DE GRACIANSKY P. C., GUTNIC M., JUTEAU T., LEFÉVRE R., MARCOUX J., MONOD O. & POISSON A. 1970. — Structures majeures et corrélations stratigraphiques dans les Taurides occidentales. *Bulletin de la Société géologique de France* 12 (3): 515-556. https://doi.org/10.2113/gssgfbull.S7-XII.3.515

BRUNN J. H., DUMONT J. F., GRACIANSKY P. C., GUTNIC M., JUTEAU T., MARCOUX J., MONOD O. & POISSON A. 1971. — Outline of the geology of the western Taurids, *in* CAMPBELL A. S. (ed.), *Geology and History of Turkey*. Petroleum Exploration Society of Libya, Tripoli: 225-255.

CARTER E. S. 1990. — New biostratigraphic elements for dating Upper Norian strata from the Sandilands Formation, Queen Charlotte Islands, British Columbia, Canada. *Marine Micropaleontology* 15: 313-328. https://doi.org/10.1016/0377-8398(90)90017-G

CARTER E. S. 1993. — *Biochronology and Paleontology of Uppermost Triassic (Rhaetian) Radiolarians, Queen Charlotte Islands, British Columbia, Canada*. Thèse de Doctorat, Université de Lausanne Faculté des Sciences, Mémoires de Géologie (Lausanne) 11, 177 p.

CARTER E. S. 1994. — Evolutionary trends in latest Norian through Hettangian radiolarians from the Queen Charlotte Islands, British Columbia. *Geobios* 17: 111-119. https://doi.org/10.1016/S0016-6995(94)80130-4

CARTER E. S. 2007. — New names for two Triassic radiolarian genera from the Queen Charlotte Islands: *Ellisus* replaces *Harsa* Carter 1991 non Marcus 1951; *Serilla* replaces *Risella* Carter 1993 non Gray 1840 (1847). *Micropaleontology* 53 (2): 104.

CARTER E. S. & GUEX J. 1999. — Phyletic trends in uppermost Triassic (Rhaetian) Radiolaria: Two examples from Queen Charlotte Islands, British Columbia, Canada. *Micropaleontology* 45 (2): 183-200. https://doi.org/10.2307/1486112

CARTER E. S. & ORCHARD M. J. 2013. — Intercalibration of conodont and radiolarian faunas from the Carnian-Norian boundary interval in Haida Gwaii, British Columbia, Canada, *in* TANNER L. H., SPIELMANN J. A. & LUCAS S. G. (eds), The Triassic System. *Bulletin of the New Mexico Museum of Natural History and Science* 61: 67-92.

CARTER E. S. & HORI R. S. 2005. — Global correlation of the radiolarian faunal change across the Triassic-Jurassic boundary. *Canadian Journal of Earth Sciences* 42: 777-790. https://doi.org/10.1139/e05-020

CARTER E. S., CAMERON B. & SMITH P. L. 1988. — Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada Bulletin* 386: 1-110. https://doi.org/10.4095/126315

CARTER E. S., WHALEN P. A. & GUEX J. 1998. — Biochronology and paleontology of Lower Jurassic (Hettangian and Sinemurian) radiolarians, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada Bulletin* 496: 1-162. https://doi.org/10.4095/209778

CARTER E. S., GORIČAN S., GUEX J., O'DOGHERTY L., DE WEVER P., DUMITRICA P., HORI R. S., MATSUOKA A. & WHALEN P. A. 2010. — Global radiolarian zonation for the Pliensbachian, Toarcian and Aalenian. *Palaeogeography, Palaeoclimatology, Palaeoecology* 297: 401-419. https://doi.org/10.1016/j.palaeo.2010.08.024

CELIK S. 2010. — *Taxonomy and Biostratigraphy of Jurassic-Early Cretaceous Radiolarian Fauna of the Pelagic Deposits in Izmir-Ankara-Erzincan Suture Complex, NE and SW Cankiri, Northern Turkey.* Master Thesis of the Hacettepe University, 133 p. (unpublished, in Turkish with English abstract).

CHENG Y. 1989. — Upper Paleozoic and Lower Mesozoic radiolarian assemblages from the Busuanga Islands, North Palawan Block, Philippines. *Bulletin of the National Museum of Natural Science* 1: 129-175.

CHIARI M., BAUMGARTNER P. O., BERNOULLI D., BORTOLOTTI V., MARCUCCI M., PHOTIADES A. & PIRINCIPI G. 2013. — Late Triassic, Early and Middle Jurassic Radiolaria from ferromanganese-chert 'nodules' (Angelokastron, Argolis, Greece): evidence for prolonged radiolarite sedimentation in the Maliac-Vardar Ocean. *Facies* 59: 391-424. https://doi.org/10.1007/s10347-012-0314-4

CORDEY F. 1988. — *Étude des Radiolaires permiens, triasiques et jurassiques des complexes ophiolitiques de Cache Creek, Bridge River et Hozameen (Colombie-britanique, Canada) : implications paléogéographiques et structurales*. Mémoires des Sciences de la Terre, Académie de Paris, Université Pierre et Marie Curie, Paris 88-17, 398 p.

CORDEY F. 1998. — Radiolaires des complexes d'accrétion de la Cordillere Canadienne (Colombie-Britannique). *Bulletin de la Commission géologique du Canada* 509: 1-209.

CORDEY F. & CARTER E. S. 1996. — New Nassellaria (Radiolaria) from the Lower Jurassic of the Canadian Cordillera. *Canadian Journal of Earth Science* 3: 444-451. https://doi.org/10.1139/e96-034

CORDEY F. & CARTER E. S. 2007. — *Atalantria*, new name for *Atalanta* Cordey and Carter 1996 (Nassellaria, Radiolaria). *Micropaleontology* 53 (5): 430. https://doi.org/10.2113/gsmicropal.53.5.430

CRNE A. E., WEISSERT H., GORIČAN S. & BERNASCONI S.M. 2011. — A biocalcification crisis at the Triassic-Jurassic boundary recorded in the Budva Basin (Dinarides, Montenegro). *Geological Society of America Bulletin* 123: 40-50. https://doi.org/10.1130/B30157.1

DEENEN M. H. L., RUHL M., BONIS R. N., KRIJGSMAN W., KUERSCHNER W. M. REITSMA M. & VAN BERGEN M. J. 2010. — A new chronology for end-Triassic mass-extinction. *Earth and Planatery Science Letters* 291: 113-125. https://doi.org/10.1016/j.epsl.2010.01.003

DEFLANDRE G. G. 1953. — Radiolaires fossiles, *in* GRASSE P. P. (ed.), *Traité de Zoologie-Anatomie, Systématique, Biologie*. Tome I, fascicule II. Masson et Companie, Paris: 389-436.

DEFLANDRE G. 1963. — *Pylentonema* nouveau genre de Radiolaire du Viséen: Sphaerellaire ou Nassellaire? *Comptes rendus hebdomadaires des Séances de l'Académie des sciences* 257 (3): 3981-3984. https://gallica.bnf.fr/ark:/12148/bpt6k4009k/f1253

DE WEVER P. 1981a. — Hagiastridae, Patulibracchiidae et Spongodiscidae (Radiolaires Polycystines) du Lias de Turquie. *Revue de Micropaléontologie* 24 (1): 27-50.

DE WEVER P. 1981b. — Une nouvelle sous-famille, les Poulpinae, et quatre nouvelles espèces de *Saitoum* radiolaires mésozoïques téthysiens. *Geobios* 14 (1): 5-15. https://doi.org/10.1016/S0016-6995(81)80163-5

DE WEVER P. 1981c. — Parasaturnalidae, Pantanellidae et Sponguridae (radiolaires polycystines) du Lias de Turquie. *Revue de Micropaléontologie* 24 (3): 138-156.

DE WEVER P. 1982a. — Nassellaria (Radiolaires Polycystines) du Lias de Turquie. *Revue de Micropaléontologie* 24 (4): 189-232.

DE WEVER P. 1982b. — Radiolaires du Trias et du Lias de la Téthys (Systématique, Stratigraphie). *Société géologique du Nord* 7 (1-2): 1-599.

DE WEVER P., SANFILIPPO A., RIEDEL W. R. & GRUBER B. 1979. — Triassic Radiolaria from Greece, Sicily and Turkey. *Micropaleontology* 25 (1): 75-110. https://doi.org/10.2307/1485211

DE WEVER P., GRISSAC C. & BECHENEC F. 1990. — Permian to Cretaceous radiolarian biostratigraphic data from the Hawasina Complex, Oman Mountains, *in* ROBERTSON A. H. F, SEARLE M. P. & RIES A. C. (eds), The Geology and Tectonics of the Oman Region. *Geological Society Special Publication* 49: 225-238. https://doi.org/10.1144/GSL.SP.1992.049.01.15

DE WEVER P., DUMITRICA P., CAULET J. P., NIGRINI C. & CARIDROIT M. 2001. — *Radiolarians in the Sedimentary Record*. Gordon and Breach Science Publishers, London, 524 p.

DONOFRIO D. A. & MOSTLER H. 1978. — Zur Verbreitung der Saturnalidae (Radiolaria) im Mesozoikum der Nördlischen Kalkalpen and Südalpen. *Geologisch-Paläontologische Mitteilungen Innsbruck* 7 (5): 1-55.

DUMITRICA P. 1970. — Cryptocephalic and Cryptothoracic Nasseleria in some Mesozoic deposits of Romania. *Revue roumaine de Géologie, Géophysique et Géographie (série Géologie)* 14 (1): 45-124.

DUMITRICA P. 1978. — Family Eptingiidae n. fam., extinct Nasselleria (Radiolaria) with sagital ring. *Dări de Seamă ale Sedintelor , Institutul de Geologie si Geofizică, Bucureşti* 64: 27-38.

DUMITRICA P. 1982. — Foremanellinidae, a new family of Triassic Radiolaria. *Dări de Seamă ale Sedintelor , Institutul de Geologie si Geofizică, Bucureşti* 67 (3): 75-82.

DUMITRICA P. 1989. — Internal skeletal structures of the Superfamily Pyloniacea (Radiolaria), a basis of a new systematic. *Revista Espanola Micropaleontologia* 21 (2): 207-264.

DUMITRICA P. 1995. — Systematic framework of Jurassic and Cretaceous Radiolaria, *in* BAUMGARTNER P. O., O'DOGHERTY L., GORIČAN S., URQUHART E., PILLEVUIT A. & DE WEVER P. (eds), *Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology*. Université de Lausanne, Lausanne: 19-35 (Mémoires de Géologie; 23).

DUMITRICA P. & HÜNGERBÜHLER A. 2017. — Asymmetry of the ring of the Saturnalidae (entactinarian Radiolaria): Causes and morphological and evolutionary consequences. *Revue de Micropaléontologie* 60: 87-135. https://doi.org/10.1016/j.revmic.2016.12.001

DUMITRICA P. & ZÜGEL P. 2003. — Lower Tithonian mono- and dicyrtid Nassellaria (Radiolaria) from the Solnhofen area (southern Germany). *Geodiversitas* 25 (1): 5-72.

DUMITRICA P., TEKIN U. K. & BEDI Y. 2010. — Eptingiacea and Saturnaliacea (Radiolaria) from the middle Carnian of Turkey and some late Ladinian to early Norian samples from Oman and Alaska. *Paläontologische Zeitschrift* 84: 259-292 https://doi.org/10.1007/s12542-009-0043-3

DUMITRICA P., TEKIN U. K. & BEDI Y. 2013. — Taxonomic study of the tetrahedral, pentagonal and hexagonal spongy spumellarian Radiolaria from the middle Carnian (Late Triassic) of the Köseyahya nappe (Elbistan, Se Turkey) and other Triassic localities. *Paläontologische Zeitschrift* 87 (3): 311-343. https://doi.org/10.1007/s12542-012-0160-2

EHRENBERG C. G. 1838. — Über die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. Königliche *Preussischen Akademie der Wissenschaften zu Berlin, Abhandlungen, Jahre 1838*: 59-147.

EHRENBERG C. G. 1847. — Über die mikroskopischen kieselschaligen Polycystinen als machtige Gebirgsmasse von Barbados und über das Verhaltniss der aus mehr als 300 neuen Arten bestehenden ganz eigentumlichen Formengruppe fener Felsmasse zu den jetz lebenden Thieren und zur Kreidebildung. Eine neue Anregung zur Erforschung des Erdlebens. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Konigl. Preufs. Akademie der Wissenschaften zu Berlin* 1875: 40-60. https://www.biodiversitylibrary.org/page/11226274

EHRENBERG C. G. 1875. — Fortsetzung der mikrogeologischen Studien als Gesammt-Übersicht der mikroskopischen Paläontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rücksicht auf den Polycystinen-Mergel von Barbados. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin*: 1-226. https://www.biodiversitylibrary.org/page/30148696

FOREL M. B., TEKIN U. K., OKUYUCU C., BEDI Y., TUNCER A. & CRASQUIN S. 2019. — Discovery of a long-term refuge for ostracods (Crustacea) after the end-Permian extinction: a unique Carnian (Late Triassic) fauna from the Mersin Mélange, southern Turkey. *Journal of Systematic Palaeontology* 17 (1): 9-58. https://doi.org/10.1080/14772019.2017.1391342

FOREMAN H. P. 1973. — Radiolaria of Leg 10 with systematic and ranges for the families Amphyndacidae, Artostrobidae, Theoperidae. *Deep Sea Drilling Project Initial Reports* 10: 407-474. https://doi.org/10.2973/dsdp.proc.10.118.1973

GAWLICK H., SUZUKI H. & MISSONI S. 2001. — Nachweis von unterliassischen Beckensedimenten in Hallstätter Fazies (Dürrnberg-Formation) im Bereich der Hallein – Berchtesgadener Hallstätter Zone und des Lammer Beckens (Hettangium – Sinemurium). *Mitteilungen der Gesselschaft der Geologie und Bergbaustudenten in Österreich* 45: 39-55.

GÖNCÜOGLU M. C., DIRIK K. & KOZLU H. 1997. — General characteristics of pre-Alpine and Alpine Terranes in Turkey: explanatory notes to the terrane map of Turkey. *Annales géologiques des Pays helléniques* 37: 515-536.

GORIČAN S. 1994. — *Jurassic and Cretaceous Radiolarian Biostratigraphy and Sedimentary Evolution of the Budva Zone (Dinarides, Montenegro)*. Université de Lausanne, Lausanne, 120 p. (Mémoires de Géologie, Special Publication; 18).

GORIČAN S., SMUC A. & BAUMGARTNER P. O. 2003. — Toarcian Radiolaria from Mt. Mangart (Slovenian-Italian border) and their paleoecological implications. *Marine Micropaleontology* 49: 275-301. https://doi.org/10.1016/S0377-8398(03)00034-3

GORIČAN S., CARTER E. S., DUMITRICA P., WHALEN P. A., HORI R. S., DE WEVER P., O'DOGHERTY L., MATSUOKA A. & GUEX

J. 2006. — *Catalogue and Systematics of Pliensbachian, Toarcian and Aalenian Radiolarian Genera and Species*. Založba ZRC/ZRC Publishing, ZRC SAZU, Ljubljana, 446 p.

Gutnic M. & Monod O. 1968. — Une série mésozoïque condensée dans les nappes du Taurus occidental : la série du Boyalitepe. *Comptes rendus sommaires de la Société géologique de France* 5: 166, 167.

Gutnic M., Kelter D. & Monod O. 1968. — Découverte de nappes de charriages dans le Nord du Taurus occidental (Turquie). *Comptes rendus hebdomadaires des séances de l'Académie des sciences. Série D, Sciences naturelles* 266: 988-991. https://gallica.bnf.fr/ark:/12148/bpt6k6362246w/f26

Haeckel E. 1862. — *Die radiolarien (Rhizopoda radiolaria): Eine Monographie*. Riemer, Berlin, 572 p. https://doi.org/10.5962/bhl.title.10155

Haeckel E. 1881. — Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien. *Janische Zeitschrift für Naturwissenschaft* 15: 418-472.

Hallam A. 1990. — The end-Triassic mass extinction event, *in* Sharpton V. L. & Ward P. D. (eds), Global Catastrophes in Earth History; an Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality. *Geological Society of America, Special Paper* 247: 577-583. https://doi.org/10.1130/SPE247-p577

Hallam A. 1997. — Estimates of the amount and rate of sea-level change across the Rhaetian-Hettangian and Pliensbachian-Toarcian boundaries (latest Triassic to early Jurassic). *Journal Geological Society of London* 154: 733-779. https://doi.org/10.1144/gsjgs.154.5.0773

Hallam A. & Wignall P. B. 1997. — *Mass Extinctions and their Aftermath*. Oxford University Press, Oxford, 320 p.

Hattori I. 1987. — Jurassic radiolarian fossils from the Nanjo Massif, Fukui Prefacture, central Japan. *Bulletin of Fukui Municipial Museum of Natural History* 34: 29-101.

Hattori I. 1989. — Jurassic radiolarians from manganese nodules at three sites in the western Nanjo Massif, Fukui Prefecture, central Japan (Data). *Journal of Faculty Education, Fukui University Part II (Natural Sciences)* 3: 47-134.

Hori R. S. 1990. — Lower Jurassic Radiolarian zones of SW Japan. Transactions and Proceedings *Paleontological Society of Japan* 159: 562-586.

Hori N. 2004. — Jurassic radiolarians from chert and clastic rocks of the Chichibu Belt in the Toyohashi district, Aichi Prefecture, southwest Japan. *Bulletin of the Geological Survey of Japan* 55 (9/10): 335-388. https://doi.org/10.9795/bullgsj.55.335

Hori N. & Wakita J. 2002. — Jurassic radiolarians from manganese carbonate nodules from Chichibu Belt in the Ino district, Kochi Prefecture, Shikoku. *Journal of the Geological Society of Japan* 108 (7): 478-481. https://doi.org/10.5575/geosoc.108.478

Hori N. & Wakita J. 2004. — Reconstructed oceanic plate stratigraphy of the Ino Formation in the Ino district, Kochi prefecture, central Shikoku, Japan. *Journal of Asian Earth Science* 24: 185-197. https://doi.org/10.1016/j.jseaes.2003.10.003

Hori R. S., Kurimoto C. & Goto H. 2004. — Radiolarian fossils from the Ikuno district, Hyogo Prefecture, Tamba Terrane, southwest Japan. *News of Osaka Micropaleontologists, Special Volume* 13: 59-69.

Igo H. & Nishimura H. 1984. — The Late Triassic and Early Jurassic radiolarian biostratigraphy in the Karasawa, Kuzu Town, Tochigi Prefecture. *Bulletin of the Tokyo Gakugei University, Section* 4 (3): 173-193.

Igo H., Koike T., Sashida K., Hisada K., Isozaki Y. & Danner W. R. 1985. — Biostratigraphic studies of conodonts and radiolarians in chert formation of the Cordilleran Geosyncline, *in* Igo H. (ed.), *Report of Research Fund of the Ministry of Education, Science and Culture*. Japanase Government Publications, 58041013 and 59043013: 1-78.

Imoto N., Tamaki A., Tanabe T. & Ishiga H. 1982. — An age determination on the basis of radiolarian biostratigraphy of bedded manganese deposit at the Yumiyama mine in the Tamba District, southwest Japan. *News of Osaka Micropaleontologists, Special Volume* 5: 227-236.

Kashiwagi K. 1998. — Early Jurassic radiolarians from the Oura Complex of the northern Chichibu Terrane in the western Kii Peninsula, southwest Japan. *News of Osaka Micropaleontologists, Special Volume* 11: 123-135.

Kashiwagi K., Niwa M. & Tokiwa T. 2005. — Early Jurassic radiolarians from the Chichibu Composite Belt in the Sannokou area, central Kii Peninsula, southwest Japan. *Journal of Geological Society of Japan* 111 (3): 170-181. https://doi.org/10.5575/geosoc.111.170

Kishida Y. & Hisada K. 1985. — Late Triassic to Early Jurassic radiolarian assemblages from the Ueno-mura Area, Kanto Mountains, Central Japan. *Memoir of the Osaka Kyoi University* 3 (34): 103-120.

Kishida Y. & Hisada K. 1986. — Radiolarian assemblages of the Sambosan Belt in the western part of the Kanto Mountains, central Japan. *News of Osaka Micropalaeontologists, Special Volume* 7: 25-34 (in Japanese with English Abstract).

Kozur H. & Mostler H. 1971. — Probleme der Conodontenforschung in der Trias. *Geologisch-Paläontologische Mitteilungen Innsbruck* 1 (4): 1-19.

Kozur H. & Mostler H. 1972. — Beiträge zur Erforschung der mesozoischen Radiolarien. Teil. 1, Revision der Oberfamilie Coccodiscacea Haeckel, 1862 emend. und Beschreibung ihrer triassischen Vertreter. *Geologisch-Paläontologische Mitteilungen Innsbruck* 2 (8/9): 1-60.

Kozur H. & Mock R. 1974. — *Misikella posthernsteini* n. sp., die jüngste Conodontenart der tethyalen Trias. *Casopis pro Mineralogii a Geologii* 19 (2): 245-250.

Kozur H. & Mostler H. 1978. — Beiträge zur Erforschung der mesozoischen Radiolarien. Teil II. Oberfamilie Trematodiscacea Haeckel 1862 emend. und Beischreibung ihrer triassischen Vertreter. *Geologisch-Paläontologische Mitteilungen Innsbruck* 8: 123-182.

Kozur H. & Mostler H. 1981. — Beiträge zur Erforschung der mesozoischen Radiolarien. Teil IV. Thalassosphaeracea Haeckel, 1862, Hexastylacea Haeckel, 1862 emend Petrushevskaya 1979, Sponguracea Haeckel, 1862 emend. und weitere triassische Lithocycliacea, Trematodiscacea, Actinommacea und Nassellaria. *Geologisch-Paläontologische Mitteilungen Innsbruck* 1: 1-208.

Kozur H. & Mostler H. 1982. — Entactinaria subordo nov., a new radiolarian suborder. *Geologisch-Paläontologische Mitteilungen Innsbruck* 11-12: 399-414.

Kozur H. & Mostler H. 1983. — The polyphyletic origin and the classification of the Mesozoic saturnalids (Radiolaria). *Geologisch-Paläontologische Mitteilungen Innsbruck* 13: 1-47.

Kozur H. & Mostler H. 1990. — Saturnaliacea Deflandre and some others stratigraphically important Radiolaria from the Hettangian of Lenggries/Isar (Bavaria, Northern Calcareous Alps). *Geologisch-Paläontologische Mitteilungen Innsbruck* 17: 179-248.

Kozur H. & Mostler H. 1994. — Anisian to Middle Carnian radiolarian zonation and description of some stratigraphically important radiolarians. *Geologisch-Paläontologische Mitteilungen Innsbruck* 3: 39-255.

Kozur H. & Mostler H. 2006. — Radiolarien aus dem Longobard der Dinariden. *Hallesches Jahrbuch für Geowissenschaften* 2: 23-91.

Krystyn L. 2008. — The Hallstatt pelagies Norian and Rhaetian Fossillagerastaetten of Hallstatt. *Berichte der Geologischen Bundesanstalt A* 78: 81-98.

Lahm B. 1984. — Spumellarienfaunen (Radiolaria) aus den mitteltriassischen Buchensteiner-Schichten von Recoaro (Norditalien) und den obertriassischen Reiflingerkalken von Grossreifling (Österreich), Systematik, Stratigraphie. *Münchener Geowissenschaftliche Abhandlungen Reihe A* 1: 1-161.

LONGRIDGE L. M., CARTER E. S., SMITH P. L. & TIPPER H. W. 2007. — Early Hettangian ammonites and radiolarians from the Queen Charlotte Islands, British Columbia and their bearing on the definition of the Triassic-Jurassic boundary. *Palaeogeography, Palaeoclimatology, Palaeoecology* 244: 142–169. https://doi.org/10.1016/j.palaeo.2006.06.027

MATSUOKA A. 2004. — Toarcian (Early Jurassic) radiolarian fauna from the Nanjo Massif in the Mino Terrane, central Japan. *News of Osaka Micropaleontologists, Special Volume* 13: 69-87.

MASSET O. & MOIX P. 2004. — Les mélanges de l'ophiolite de Mersin (Turquie du Sud). Thèse de Master, Université de Lausanne Faculté des Sciences, Mémoires de Géologie (Lausanne), 143 p. (unpublished).

MOIX P., KOZUR H. W., STAMPFLI G. M. & MOSTLER H. 2007. — New paleontological, biostratigraphic and paleogeographic results from the Triassic of the Mersin Mélange, Se Turkey, *in* LUCAS S. G. & SPIELMANN J. A. (eds), The Global Triassic. *Bulletin of the New Mexico Museum of Natural History and Science* 41: 282-311.

MOIX P., BECCALETTO L., KOZUR H. W., HOCHARD, C. ROSSELET F. & STAMPFLI G. M. 2008. — A new classification of the Turkish terranes and sutures and its implication for the paleotectonic history of the region. *Tectonophysics* 451: 7-39. https://doi.org/10.1016/j.tecto.2007.11.044

MOIX P., BECCALETTO L., MASSET O., KOZUR H. W., DUMITRICA P., VACHARD D., MARTINI R. & STAMPFLI G. M. 2011. — Geology and correlation of the Mersin Mélanges, southern Turkey. *Turkish Journal of Earth Science* 20: 57-98.

MOIX P., VACHARD D., ALLIBON J., MARTINI R., WERNLI R., KOZUR H. W. & STAMPFLI G. M. 2013. — Palaeotethyan, Neotethyan and Huglu-Pindos series in the Lycian Nappes (Sw Turkey): Geodynamical implications, *in* TANNER L. H., SPIELMANN J. A. & LUCAS S. G. (eds), The Triassic System. *Bulletin of the New Mexico Museum of Natural History and Science* 61: 401-444.

MOSTLER H., SCHEURING B. & ULRICHS M. 1978. — Zur Mega- und Mikrofauna und Mikroflora der Kössener Schichten (alpine Obertrias) vom Weisloferbach in Tirol unter besonderer Berücksichtigung der in der Suessi- und Marshi-Zone auftretenden Conodonten. *Schriften der Erdwissenschaftlichen Kommission Österreichische Akademie der Wissenschaften* 4: 127-137.

MURCHEY B. 1984. — Biostratigraphy and litostratigraphy of chert in the Franciscan Complex, Marin headlands, California, *in* BLAKE M. C. (ed.), *Franciscan Geology of Northern California*. Society of Economic Paleontologists and Mineralogists 5: 51-70.

MÜLLER J. 1858. — Uber die Thalassicollen, Polycystinen und Acanthometren des Mittelmeeres. *Abhandlungen der Preussischen Akademie der Wissenschafteler zu Berlin, Jahrang, 1858*: 1-62.

NAGAI H. 1990. — Supersonic vibration effect on the surface texture of Jurassic *Eucyritidiellum* (Radiolaria). *Bulletin of the Nagoya University Museum* 5: 1-19.

O'DOGHERTY L. & GAWLICK H. J. 2008. — Pliensbachian radiolarians in Teltschengraben (Northern Calcareous Alps, Austria): A keystone in reconstructing the Early Jurassic evolution of the Tethys. *Stratigraphy* 5 (1): 63-81.

O'DOGHERTY L., CARTER E. S., DUMITRICA P., GORIČAN Š., DE WEVER P., BANDINI A. N., BAUMGARTNER P. O. & MATSUOKA A. 2009. — Catalogue of Mesozoic radiolarian genera. Part 2: Jurassic-Cretaceous. *Geodiversitas* 31 (2): 271-356. https://doi.org/10.5252/g2009n2a4

OKUYUCU C., TEKIN U. K., NOBLE P, J., BEDI Y., SAYDAM-DEMIRAY D. G. & SAYIT K. 2018. — Benthic Foraminifera, Radiolaria and Conodont assemblages from the Early Mississipian (late Tournaisian)/Early Pennsylvanian (early Bashkirian) blocks within the Mersin Mélange, southern Turkey: Biochronological and paleogeographical implications. *Palaeoworld* 27: 438-457. https://doi.org/10.1016/j.palwor.2018.08.002

OKUYUCU C., TEKIN U. K., BEDI Y. & SAYIT K. 2020. — Biostratigraphy of Lower Permian foraminiferal assemblages from platform-slope carbonate blocks within the Mersin Mélange, southern Turkey: Paleogeographical implications *Geobios* 59: 61-77. https://doi.org/10.1016/j.geobios.2020.02.001

ORCHARD M. J., CARTER E. S., LUCAS S. G. &TAYLOR D. G., 2007a. — Rhaetian (Upper Triassic) conodonts and radiolarians from New York Canyon, Nevada, United States. *Albertiana* 35: 59-65. https://doi.org/10.13140/2.1.3675.6163

ORCHARD M. J., WHALEN P. A., CARTER E. S. & TAYLOR H. J. 2007b. — Latest Triassic Conodonts and Radiolarian-Bearing successions in Baja California Sur, *in* LUCAS S. G. & SPIELMANN J. A. (eds), The Global Triassic. *Bulletin of the New Mexico Museum of Natural History and Science* 41: 355-365.

ÖZDIKMEN H. 2009. — Substitute names for some unicellular animal taxa (Protozoa). *Munis Entomology and Zoology* 4 (1): 233-256.

ÖZGÜL N. 1976. — Some geological aspects of the Taurus orogenic belt (Turkey). *Bulletin of the Geological Society of Turkey* 19: 65-78 (in Turkish with English abstract).

ÖZGÜL N. 1984. — Stratigraphy and tectonic evolution of the central Taurides, *in* TEKELI O. & GÖNCÜOGLU C. (eds), *Geology of the Taurus Belt*. Proceedings of the International Symposium held by the Mineral Research and Exploration Institute, 26-29 September 1983, Ankara. Geological Society of Turkey and the Mineral Research and Exploration Institute, Ankara: 77-90.

ÖZGÜL N. 1997. — Stratigraphy of the tectono-stratigraphic units in the region Bozkir-Hadim-Taskent (northern central Taurides). *Bulletin of the Mineral Research and Exploration* 119: 113-174 (in Turkish).

PALFY J., DEMENY A., HAAS J., CARTER E. S., GÖRÖG A., HALASZ D., ORAVECZ-SCHEFFER A., HETENYI M., MÁRTON E., ORCHARD M. J., OZSVART P., VETÖ I. & ZAJZON N. 2007. — Triassic–Jurassic boundary events inferred from integrate stratigraphy of the Csővár section, Hungary. *Palaeogeography, Palaeoclimatology, Palaeoecology* 244: 11-33. https://doi.org/10.1016/j.palaeo.2006.06.021

PARLAK O. & ROBERTSON A. H. F. 2004. — The ophiolite-related Mersin Mélange, southern Turkey: Its role in the tectonic-sedimentary setting of Tethys in the eastern Mediterranean region. *Geological Magazine* 141: 257-286. https://doi.org/10.1017/S0016756804009094

PESSAGNO E. A. JR 1971. — Jurassic and Cretaceous Hagiastridae from the Blake Bahama Basin (Site 5A, Joides Leg 1) and the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology* 60 (264): 1-83. https://www.biodiversitylibrary.org/page/28721248

PESSAGNO E. A. JR 1976. — Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley Sequence, California Coast Ranges. *Special Publication in Micropaleontology* 2: 1-95.

PESSAGNO E. A. JR 1977a. — Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology* 23 (1): 56-113. https://doi.org/10.2307/1485310

PESSAGNO E. A. JR 1977b. — Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. *Cushman Foundation for Foraminiferal Research, Special Publication* 15: 1-87.

PESSAGNO E. A. JR & BLOME C. D. 1980. — Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology* 26 (3): 225-273. https://doi.org/10.2307/1485314

PESSAGNO E. A. JR & MIZUTANI S. 1992. — Radiolarian biozones of North America and Japan, *in* WESTERMANN G. E. G. (ed.), *The Jurassic of Circum Pacific*. Cambridge University Press, Cambridge: 293-295. https://doi.org/10.1017/CBO9780511529375.016

PESSAGNO E. A. JR & NEWPORT R. L. 1972. — A new technique for extracting Radiolaria from radiolarian cherts. *Micropaleontology* 18 (2): 231-234. https://doi.org/10.2307/1484997

PESSAGNO E. A. JR & POISSON A. 1981. — Lower Jurassic Radiolaria from the Gümüslü Allochthon of southwestern Turkey (Taurides Occidentales). *Bulletin of the Mineral Research and Exploration Institute of Turkey* 92: 47-69.

PESSAGNO E. A. JR & WHALEN P. A. 1982. — Lower-Middle Jurassic Radiolaria (multicrytid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology* 28 (2): 111-169. https://doi.org/10.2307/1485228

PESSAGNO E. A. JR, SIX W. M. & YANG Q. 1989. — The Xiphostylidae Haeckel and Parvivaccidae n. fam. (Radiolaria) from the North American Jurassic. *Micropaleontology* 35 (3): 193-255. https://doi.org/10.2307/1485682

PESSAGNO E. A. JR, FINCH W. & ABBOTT P. L. 1979. — Upper Triassic Radiolaria from San Hipolito Formation, Baja California. *Micropaleontology* 25 (2): 160-197. https://doi.org/10.2307/1485265

PESSAGNO E. A. JR, WHALEN P. A. & YEH K. Y. 1986. — Jurassic Nassellariina (Radiolaria) from the North American geologic terranes. *Bulletin of the American Paleontology* 91 (26): 1-75.

POISSON A. 1968. — L'unité inférieure du Domuz Dag (Taurus Lycien, Turquie), série sédimentaire avec intercalation de coulées sous-marines en coussins. *Bulletin of the Mineral Research and Exploration* 70: 100-105.

POISSON A. 1977. — *Recherches géologiques dans les Taurides occidentales (Turquie).* Thèse de l'Université de Paris-Sud Orsay, 795 p.

PUJANA I. 1996. — A new Lower Jurassic Radiolarian fauna from the Neuquén Basin, centralwest Argentina, *in* XIII Congreso Argentino de Geología, y Ii Congreso de Exploración de Hidrocarburos, Actas : Buenos Aires, 13 al 18 de octubre de 1996. Asociación Geológica Argentina : Instituto Argentino del Petroleo y del Gas: 133-142.

RAUP D. M. & SEPKOSKI JR J. J. 1982. — Mass extinctions in the marine fossil record. *Science* 215: 1501-1503. https://doi.org/10.1126/science.215.4539.1501

RAYMOND L. A. 1984. — Classification of Mélanges, *in* RAYMOND L. A. (ed.), Mélanges: Their Nature, Origin, and Significance. *Geological Society of America, Special Paper* 198: 7-20. https://doi.org/10.1130/SPE198-p7

RIEDEL W. R. 1967. — Subclass Radiolaria, *in* HARLAND W. B. (ed.), *The Fossil Record, A Symposium with Documentation*. Geological Society, London: 291-298.

ROBERTSON A. H. F., PARLAK O., YILDIRIM N., DUMITRICA P. & TASLI K. 2016. — Late Triassic rifting and Jurassic-Cretaceous passive margin development of the Southern Neotethys: evidence from the Adıyaman area, Se Turkey. *International Journal of Earth Sciences* 105 (1): 167-201. https://doi.org/10.1007/s00531-015-1176-0

ROBERTSON A. H. F., PARLAK O., RIZAOGLU T., ÜNLÜGENC U. C., INAN N., TASLI K. & USTAÖMER T. 2007. — Tectonic evolution of the South Tethyan Ocean: Evidence from the eastern Taurus Mountains (Elazig Region, Se Turkey), *in* RIES A.C., BUTLER R. W. H. & GRAHAM R. H. (eds), *Deformation of the Continental Crust: The Legacy of Mike Coward*. Geological Society, London 272: 231–270. https://doi.org/10.1144/GSL.SP.2007.272.01.14

RÜST D. 1898. — Neue Beiträge zur Kenntniss der Fossilen Radiolarien aus Gesteinen des Jura und der Kreide. *Palaeontolographica* 45: 1-67. https://www.biodiversitylibrary.org/page/33127890

SASHIDA K. 1988. — Lower Jurassic multisegmented Nasselleria from the Itsukaichi area, western part of Tokyo Prefecture, central Japan. *Scientific Reports of Institute Geoscience, University of Tsukuba, Section B* 9: 1-27.

SATO T., MURATA M. & YOSHIDA H. 1986. — Triassic to Jurassic radiolarian biostratigraphy in the southern part of Chichibu Terrane of Kyushu, Japan. *News of Osaka Micropaleontologists, Special Volume* 7: 9-23.

SAYIT K., BEDI Y., TEKIN U. K., GÖNCÜOGLU M. C. & OKUYUCU C. 2017. — Middle Triassic back-arc basalts from the blocks in the Mersin Mélange, southern Turkey: Implications for the geodynamic evolution of the Northern Neotethys. *Lithos* 268-271: 102-113. https://doi.org/10.1016/j.lithos.2016.10.032

SENEL M. 2002. — 1/500.000 scale Turkish geological maps, Adana Quadrangle. *Publication of General Directorate of Mineral Research and Exploration*.

SENGÖR A. M. C. & YILMAZ Y. 1981. — Tethyan evolution of Turkey: a plate tectonics approach. *Tectonophysics* 75: 181-241. https://doi.org/10.1016/0040-1951(81)90275-4

SEPKOSKI JR J. J. 1994. — Extinction and the fossil record. *Geotimes* 39 (3): 15-17.

SHIBUTANI S. & HORI R. S. 2008. — Lower Jurassic (Hettangian-Sinemurian) radiolarian assemblages from black cherts in the Wakai accretionary complex, Ikuno area, Tamba Terrane, southwest Japan. *Stratigraphy* 5 (1): 83-98.

SPÖRLI K. B. & AITA Y. 1988. — Field trip guide to Waipapa basement rocks, Kawakawa Bay, Auckland, Workshop of Radiolaria 1988. *Geological Society of New Zealand Miscellaneous Publications* 39: 1-27.

SPÖRLI K. B., AITA Y. & GIBSON G. W. 1989. — Juxtaposition of Tethyan and Nontethyan Mesozoic radiolarian faunas in mélanges, Waipapa Terranne, North Island, New Zealand. *Geology* 17: 753-756. https://doi.org/cqwz8z

SQUINABOL S. 1904. — Radiolarie Cretacee degli Euganei. *Atti e Memorie Della R. Accademia di Scienze Lettere ed arti in Padova* 20: 171-204.

SUGIYAMA K. 1997. — Triassic and Lower Jurassic Radiolarian biostratigraphy in the siliceous claystone and bedded chert units of the southeastern Mino Terrane, central Japan. *Bulletin of the Mizunami Fossil Museum* 24: 79-193.

SUZUKI H., PRINZ-GRIMM P. & SCHMIDT-EFFING R. 2002. — Radiolarien aus dem Grenzbereich Hettangium/Sinemurium von Nordperu. *Paläontologische Zeitschrift* 76: 163-187. https://doi.org/10.1007/BF02989855

TAKEMURA A. 1986. — Classification of Jurassic Nassellarians (Radiolaria). *Paleontographica Abt. A* 195 (1-3): 29-74.

TEKIN U. K. 1999. — Biostratigraphy and systematics of late Middle to Late Triassic radiolarians from the Taurus Mountains and Ankara Region, Turkey. *Geologisch-Paläontologische Mitteilungen Innsbruck,* special issue 5: 1-297.

TEKIN U. K. 2002a. — Lower Jurassic (Hettangian-Sinemurian) radiolarians from the Antalya Nappes, central Taurides, southern Turkey. *Micropaleontology* 48 (2): 177-205. https://doi.org/10.2113/48.2.177

TEKIN U. K. 2002b. — Late Triassic (Late Norian-Rhaetian) radiolarians from the Antalya Nappes, central Taurides, southern Turkey. *Rivista Italiana di Paleontologia e Stratigrafia* 108 (3): 1-26. https://doi.org/10.13130/2039-4942/5486

TEKIN U. K. & YURTSEVER T. S. 2003. — Upper Triassic (lower to middle Norian) radiolarians from Antalya Nappes, Antalya, Sw Turkey. *Journal of Micropalaeontology* 22 (2): 147-162. https://doi.org/10.1144/jm.22.2.147

TEKIN U. K., CELIK, S., UNER T. & ARAT I. 2012. — Radiolarian biochronology of Early Jurassic-Early Cretaceous pelagic deposits in Izmir-Ankara-Erzincan Suture Complex, Ne and Sw Cankiri, northern Turkey: Remarks on the evolution of Northern Branch of Neotethys. 13th Meeting of the International Association of Radiolarian Palaeontologists, Abstracts: 243-244.

TEKIN U. K., BEDI Y., OKUYUCU C., GÖNCÜOGLU M. C., SAYIT K., KRYSTYN L., NOBLE P., ERDOGAN K., LEIN R. & UZUNCIMEN-KECELI S. 2016a. — *Dating of Sedimentary Units of the Mersin Mélange(s) (central Taurides, southern Turkey) using Radiolarian and Other (Conodont, Ammonite and Foraminifera) Faunas and Geochemistry/Petrography of its Volcanic/Volcanosedimentary Units*. Tubitak Project No: Çaydag 112Y370, 645 p. (unpublished, in Turkish).

TEKIN U. K., BEDI Y., OKUYUCU C., GÖNCÜOGLU M. C. & SAYIT K. 2016b. — Radiolarian biochronology of upper Anisian to upper Ladinian (Middle Triassic) blocks and tectonic slices of volcano-sedimentary successions in the Mersin Mélange, southern Turkey: New insights for the evolution of Neotethys. *Journal of African Earth Sciences* 124: 409-426. https://doi.org/10.1016/j.jafrearsci.2016.09.039

TEKIN U. K., OKUYUCU C., SAYIT K., BEDI Y., NOBLE P, J., KRYSTYN L. & GÖNCÜOGLU M. C. 2019. — Integrated Radiolaria, benthic foraminifera and conodont biochronology of the pelagic Permian blocks/tectonic slices and geochemistry of associated volcanic rocks from the Mersin Mélange, southern Turkey: Implications for the Permian evolution of the Northern Neotethys. *Island Arc* 28 (2). https://doi.org/10.1111/iar.12286

TIPPER H. W., SMITH P. L., CAMERON B. E. B., CARTER E. S., JACOBS G. K. & JOHNS M. J. 1991. — Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia, *in* WOODSWORTH G. J. (ed.), *Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia*. Geological Survey of Canada, Paper 90-10: 203-236.

TUMANDA F., SASHIDA K. & IGO H. 1996. — Some Jurassic radiolarians from Busuanga Island, Calamian Island Group, Palawan, Philippines, *in* NODA H. & SASHIDA K. (eds), *Professor Hisayoshi Igo Commemorative Volume on Geology and Paleontology of Japan and Southeast Asia*. Gakujyutsu Tosho Insatsu:16-192.

UZUNCIMEN S., TEKIN U. K., BEDI Y., PERINCEK D., VAROL E. & SOYCAN H. 2011. — Discovery of the Late Triassic (middle Carnian – Rhaetian) radiolarians in the volcano-sedimentary sequences of the Kocali Complex, SE Turkey: Correlation with the other Tauride units. *Journal of Asian Earth Sciences* 40: 180-200. https://doi.org/10.1016/j.jseaes.2010.08.004

WHALEN P. A. & CARTER E. S. 2002. — Pliensbachian (Lower Jurassic) Radiolaria from Baja California Sur, Mexico. *Micropaleontology* 48 (2): 97-151. https://doi.org/10.2113/48.2.97

WHALEN P. A. & PESSAGNO E. A. JR 1984. — Lower Jurassic Radiolaria, San Hipolto Formation, Vizcaino Peninsula, Baja California Sur, *in* FRIZZELL V. A. JR (ed.), *Pacific Section.* Economic Palaeontologists and Minerologists 39: 53-65.

XU B., LUO H. & WANG X. 2019. — New discovery of Early Jurassic radiolarians from Luoqu, Xigaze, southern Tibet and its geological significance. *Journal of Asian Earth Sciences* 175: 49-67. https://doi.org/10.1016/j.jseaes.2018.07.031

YANG Q. & MIZUTANI A. 1991. — Radiolaria from the Nadanhada Terrane, northeast China. *The Journal of Earth Sciences, Nagoya University* 38: 49-78.

YAO A. 1972. — Radiolarian fauna from the Mino Belt in the northern part of the Inuyama area, central Japan. Part1, Spongosaturnalids. *Osaka City University, Journal of Geoscience* 15 (2): 21-64.

YAO A. 1982. — Middle Triassic to Early Jurassic radiolarians from the Inuyama Area, Central Japan. *Journal of Geoscience, Osaka City University* 25: 53-70.

YAO A. 1997. — Faunal change of early-middle Jurassic radiolarians. *News of Osaka Micropaleontologists, Special Volume* 10: 155-182.

YAO A., MATSUOKA A. & NAKATANI T. 1982. — Triassic and Jurassic radiolarian assemblage in the southmost the Mesozoic basin development in the southern Chichibu Terrane. *Journal of Geoscience, Osaka City University* 27 (2): 41-103.

YEH K. 1987a. — Taxonomic studies of Lower Jurassic Radiolaria from East-Central Oregon. *Bulletin of the National Museum of Natural Science, Taichung, Taiwan* 2: 169p.

YEH K. 1987b. — A revised classification for the family Canoptidae (Radiolaria). *Memoirs of the Geological Society of China* 8: 63-72.

YEH K. 1989. — Studies of Radiolaria from the Fields Creek Formation, East-Central Oregon, United States. *Bulletin of the National Museum of Natural Sciences, Taiwan* 1: 43-110.

YEH K. 1990. — Taxonomic studies of Triassic Radiolaria from Busuanga Island, Philippines. *Bulletin of the National Museum of Natural Sciences, Taiwan* 2: 1-63.

YEH K. 1992. — Triassic Radiolaria from Uson Island, Philippines. *Bulletin of the National Museum of Natural Sciences, Taiwan* 3: 51-91.

YEH K. 2009. — A Middle Jurassic radiolarian fauna from Southfork member of Snowshoe Formation, east-Central Oregon. *Collection and Research* 22: 15-125.

YEH K. & CHENG Y. 1996. — Jurassic radiolarians from the northwest coast of Busuanga Island, North Palawan Block, Philippines. *Micropaleontology* 42 (2): 93-124. https://doi.org/10.2307/1485865

YEH K. & CHENG Y. 1998. — Radiolarians from the Lower Jurassic of the Busuanga Island, Philippines. *Bulletin of the National Museum of Natural Sciences, Taiwan* 11: 1-65.

YEH K. & PESSAGNO E. A. 2013. — Upper Bathonian (Middle Jurassic) radiolarians from Snowshoe Formation, east-central Oregon, United States. *Collection and Research* 26: 51-175.

YEH K. & YANG Q. 2006. — Radiolarian assemblages from T-J boundary strata, Nadanhada Terrane, Ne China. *Acta Micropaleontologica Sinica* 23 (4): 317-360.

YOSHIDA H. 1986. — Upper Triassic to Lower Jurassic radiolarian biostratigraphy in Kagamigahara City, Gifu Prefecture, central Japan. *Journal of Earth Science, Nagoya University* 34: 1-21.

ZIABREV S. V., AITCHISON J. C., ABRAJEVITCH A V., ZHU B., DAVIS A. M. & LUO H. 2004. — Bainang Terrane, Yarlung-Tsangpo Suture, southern Tibet (Xizang, China): A record of Intra-Neotethyan subduction–accretion processes preserved on the roof of the world. *Journal of the Geological Society, London* 161: 523-538. https://doi.org/10.1144/0016-764903-099

*Submitted on 25 May 2019;*
*accepted on 23 October 2019;*
*published on 26 November 2020.*