

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

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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

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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 Beyşehir-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 diversité de grands blocs sédimentaires et d'écaillles 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), Far East Russia (Bragin 1991), China (Yang & Mizutani 1991; Zhiabrev *et al.* 2004; Yeh & Yang 2006), British Columbia, Canada (Carter 1993; Carter & Hori 2005; Longridge *et al.* 2007), Philippines (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; Kashigawa 1998; Kashigawa *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 Far East (Bragin 1991); China (Yang & Mizutani 1991; Yeh & Yang 2006; Xu *et al.* 2019); Montenegro (Goričan 1994; Crne *et al.* 2011); Argentina (Pujana 1996); Philippines (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).

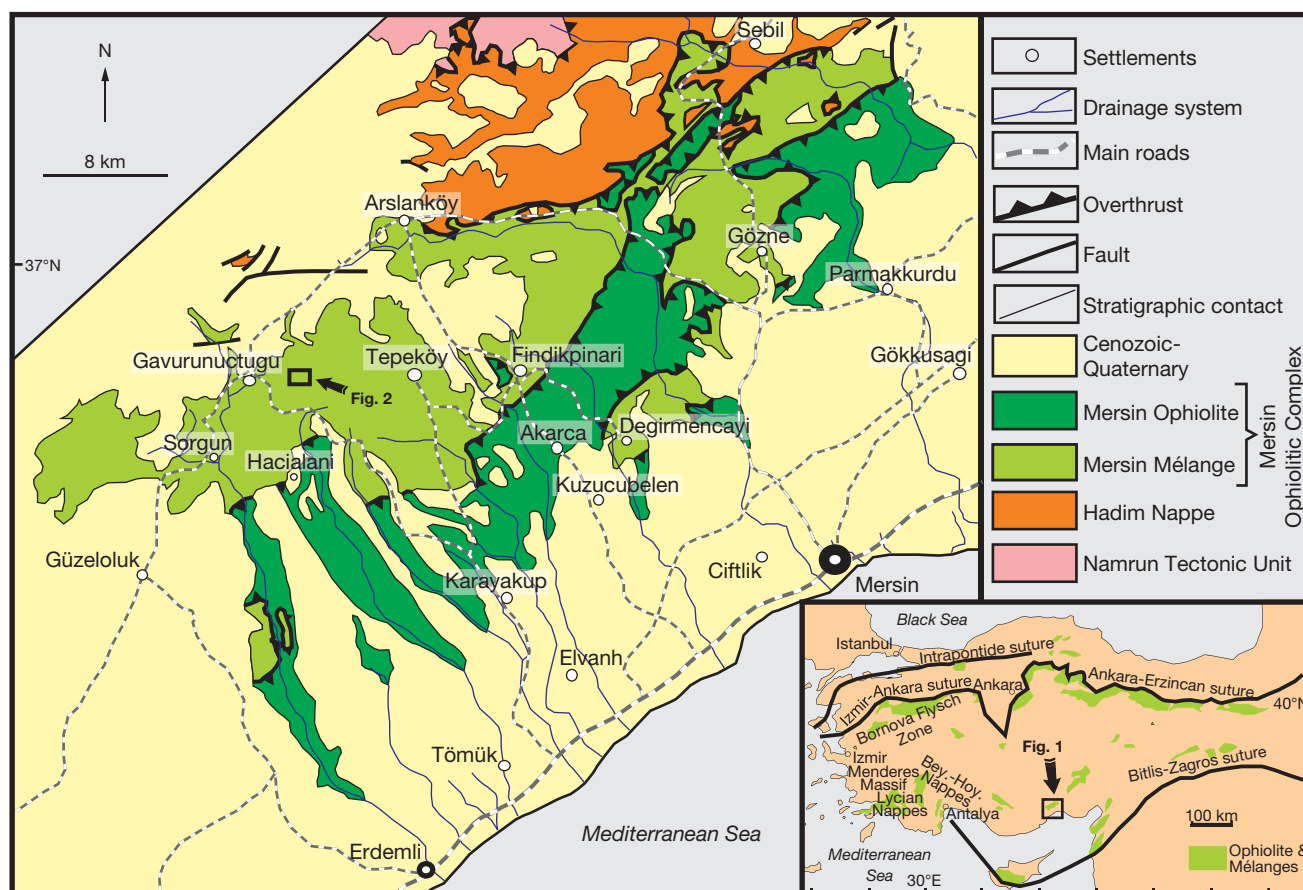


FIG. 1. — Geological base map showing the distribution of the Mersin Ophiolitic Complex and surrounding tectonic units in the northwest of Mersin city, southern Turkey (revised after Senel 2002 and Alan *et al.* 2007). For a detailed geological sketch of the Orbuklukeli section, see Fig. 2. Inset: Distribution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

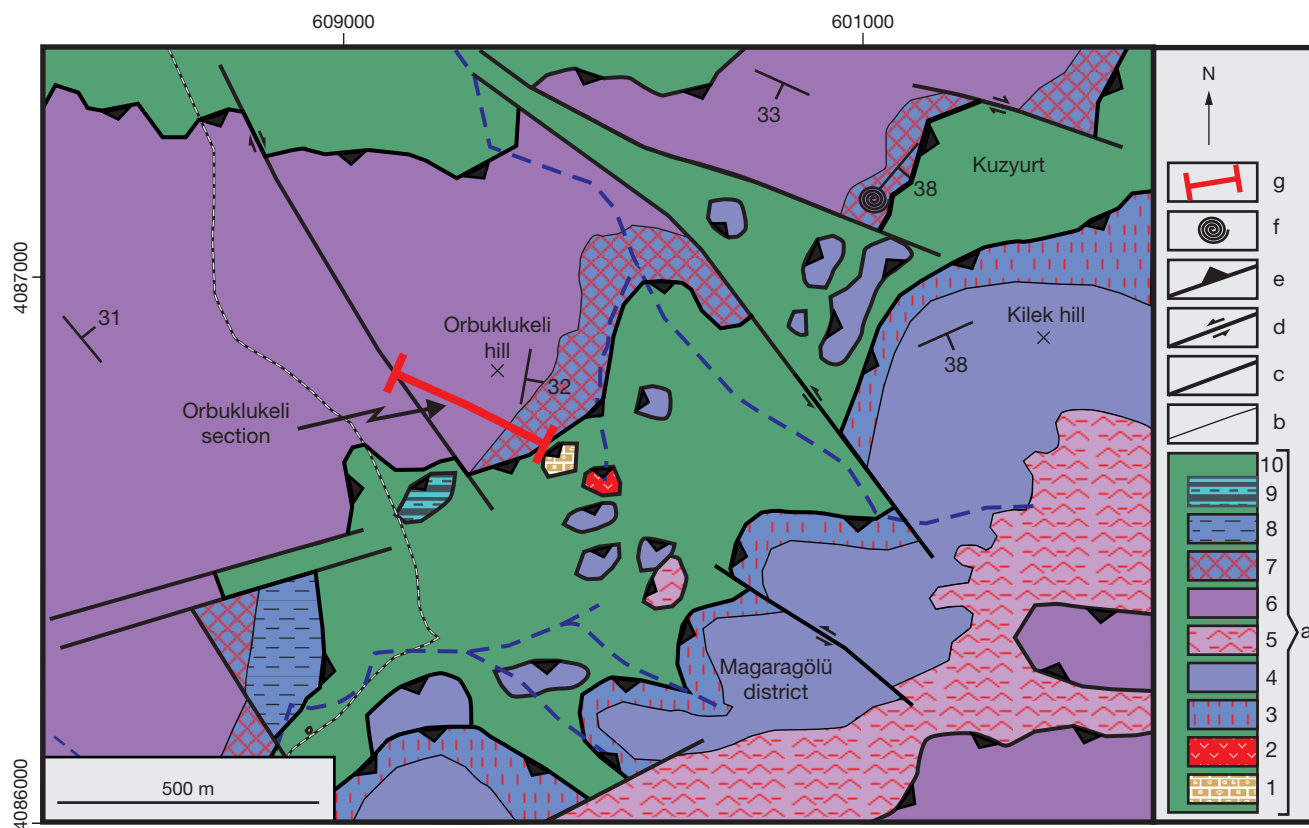


FIG. 2. — Detailed geological map of the Orbuklukeli hill surroundings, northwest of Mersin city (after Tekin *et al.* 2016a). Key: **a**, Mersin Mélange; 1, Middle Permian brecciated limestone; 2, Middle Triassic basic volcanic rocks; 3, Upper Triassic conglomerate, sandstone, and silt-claystone; 4, 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 Beyşehir-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 NW 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

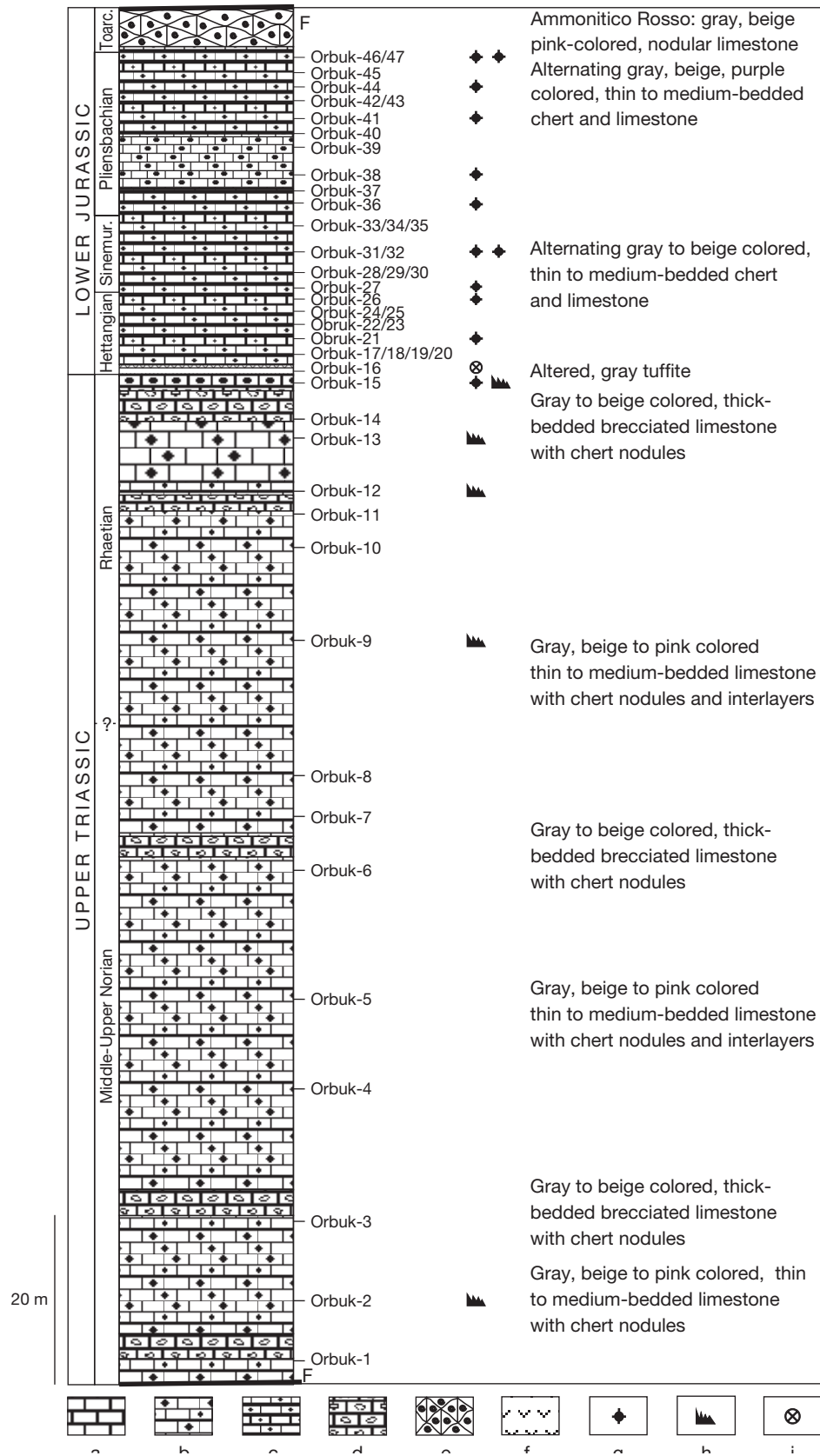


FIG. 3. — Columnar section of the Orbuklukeli section and sampling points. Key: **a**, Limestone; **b**, Limestone with chert nodules; **c**, Alternating chert and limestone with chert nodules; **d**, Brecciated limestone; **e**, Nodular limestone with ammonites; **f**, Tuffite; **g**, Radiolarian occurrence;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

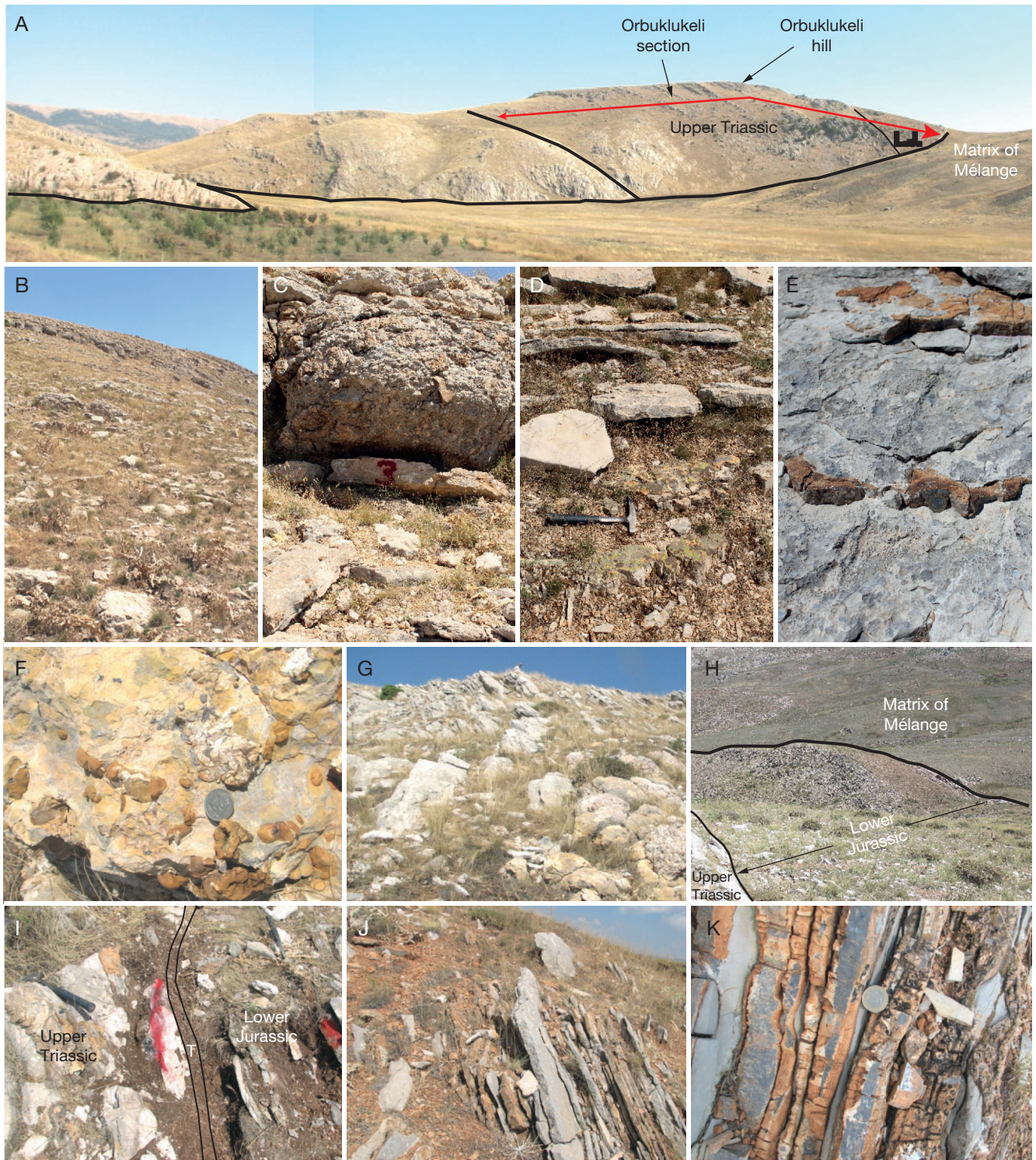


FIG. 4. — Field photographs of the Orbuklukeli section: **A–G**, Upper Triassic part of the section; **A**, General view of the Orbuklukeli section around Orbuklukeli hill, view from southwest to northeast; **B**, Basal part of the section represented by medium to thick-bedded, gray-colored limestones 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					
		16-27				21-3	4-7	11	14-15	3-4-25		10-22				
Radiolarian zones (Ua)																
	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
Samples																
Conodonta																
<i>Epigondolella</i> sp. cf. <i>E. postera</i> Kozur & Mostler, 1971	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Misikella hernsteini</i> (Mostler, 1967)	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Misikella rhaetica</i> Mostler, 1978	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Hindeodella</i> sp.	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Misikella posthernsteini</i> Kozur & Mock, 1974	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—
<i>Misikella ultima</i> Kozur & Mock, 1991	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Radiolaria																
<i>Betraccium kennecottense</i> Carter, 1993	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Betraccium perillense</i> Carter, 1993	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Pantanellium fosteri</i> Pessagno & Blome, 1980	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Praeudalia rhaetica</i> Tekin, n. gen., n. sp.	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Serilla tledoensis</i> (Carter, 1993)	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Ferresium</i> sp. cf. <i>F. teekwoonense</i> Carter, 1993	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Canoptum cephalobulbosum</i> Tekin, n. sp.	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Canoptum productum</i> Tekin, n. sp.	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Canoptum rarum</i> Tekin, n. sp.	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Canoptum rhaeticum</i> Kozur & Mostler, 1981	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
<i>Canoptum merum</i> Pessagno & Whalen, 1982	—	—	—	—	×	?	?	×	×	—	—	—	—	—	—	—
<i>Mesosaturnalis artus</i> (Donofrio & Mostler, 1978)	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—
<i>Mesosaturnalis octospinus</i> Sugiyama, 1997	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—
<i>Thurstonia gibsoni</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—
<i>Pantanellium kluense</i> Pessagno & Blome, 1980	—	—	—	—	—	—	×	×	—	—	—	—	—	—	—	—
<i>Farcus</i> sp. A	—	—	—	—	—	—	×	×	—	—	—	—	—	—	—	—
<i>Pantanellium tanuense</i> Pessagno & Blome, 1980	—	—	—	—	—	—	×	×	×	—	—	—	—	—	—	—
<i>Pantanellium freboldi</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	×	×	×	—	—	—	—	—	—	—
<i>Novamuria impensa</i> (Whalen & Carter in Carter, Whalen & Guex, 1998)	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—	—
<i>Praehexasaturnalis poultoni</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—	—
<i>Acanthotetrapaurinella kennecottensis</i> (Carter in Longridge, Carter, Smith & Tipper, 2007)	—	—	—	—	—	—	×	×	?	×	—	—	—	—	—	—
<i>Tetrapaurinella sphaerica</i> Tekin, n. sp.	—	—	—	—	—	—	×	×	×	×	—	—	—	—	—	—
<i>Charlottea elegantissima</i> Tekin, n. sp.	—	—	—	—	—	—	×	×	?	×	—	—	—	—	—	—
<i>Praehexasaturnalis tenuispinosus</i> (Donofrio & Mostler, 1978)	—	—	—	—	—	—	×	×	×	×	—	—	—	—	—	—
<i>Trexus dodgensis</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	×	×	?	×	—	—	—	—	—	—
<i>Paurinella liassica</i> Tekin, n. sp.	—	—	—	—	—	—	×	×	?	×	—	—	—	—	—	—
<i>Pantanellium giganteum</i> Tekin, n. sp.	—	—	—	—	—	—	×	×	×	?	×	—	—	—	—	—
<i>Praehexasaturnalis tetradactylus</i> Kozur & Mostler, 1990	—	—	—	—	—	—	×	×	×	×	?	?	×	×	—	—
<i>Udalia primaeva</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Orbiculiformella</i> sp. A	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Danubea</i> sp. A	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Laxtorum obscurum</i> Tekin, n. sp.	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Atalantica</i> sp. A	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Farcus</i> sp. B	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Bipedis helenae</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
<i>Droplitis laseekensis</i> Pessagno & Whalen, 1982	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—	—
<i>Thurstonia minutaglobus</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—
<i>Udalia dennisoni</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—
<i>Droplitis hecatensis</i> Pessagno & Whalen, 1982	—	—	—	—	—	—	—	×	×	×	—	—	—	—	—	—
<i>Canoptum striatum</i> (Kozur & Mostler, 1990)	—	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—

TABLE 1. — Continuation.

Age	Upper Triassic						Lower Jurassic									
	MN	Rhaetian				Hettangian		Sinemurian			Pliensbachian					
		16-27				21-3	4-7	11	14-15	3-4-25			10-22			
Radiolarian zones (Ua)																
	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
Samples																
Radiolaria (continuation)																
<i>Bipedis hannai</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	?	×	—	—	—	—	—	—
<i>Canoptum columbiaense</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	×	?	×	×	×	—	—	—	—
<i>Præhexasaturnalis merici</i> Tekin, 2002	—	—	—	—	—	—	—	×	?	?	?	?	?	?	×	×
<i>Pseudoacanthocircus</i> sp. B	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—
<i>Orbiculiformella pulchra</i> Tekin, n. sp.	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—
<i>Tozerium orbuklukeliense</i> Tekin, n. sp.	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—
<i>Stauroacanthocircus</i> ? <i>poetschensis</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	×	?	?	×	—	—	—	—
<i>Stauroacanthocircus dickinsoni</i> (Yeh, 1989)	—	—	—	—	—	—	—	—	×	?	?	?	?	?	?	×
<i>Gorgansium alpinum</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Orbiculiformella</i> ? <i>trispina trispina</i> (Yeh, 1987)	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Charlottea johnsoni</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Palaeosaturnalis blomei</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Stauroacanthocircus</i> sp. A	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Droltus eurasiaticus</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Droltus</i> sp. aff. <i>D. eurasiaticus</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Lactorum breve</i> Tekin, n. sp.	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Atalantria emmela</i> (Cordey & Carter, 1996)	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Pseudoecyrtis aquila</i> (Whalen & Carter in Carter, Whalen & Guex, 1998)	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Pseudoecyrtis busuangaensis</i> (Yeh & Cheng, 1998)	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Farcus graylockensis</i> Pessagno, Whalen & Yeh, 1986	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Saitoum</i> sp. aff. <i>S. triumphense</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Saitoum</i> sp. A	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Ares sutherlandi</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Bipedis douglasi</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
<i>Beatricea sanpabloensis</i> (Whalen & Carter, 2002)	—	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—
<i>Anaticapitula anatifomis</i> (De Wever, 1982)	—	—	—	—	—	—	—	—	—	×	?	×	—	—	—	—
<i>Thurstonia timberensis</i> Whalen & Carter in Carter, Whalen & Guex, 1998	—	—	—	—	—	—	—	—	—	×	?	?	?	?	×	×
<i>Udalia infrequens</i> Tekin, n. sp.	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
<i>Orbiculiformella callosa</i> (Yeh, 1987)	—	—	—	—	—	—	—	—	—	—	×	?	×	—	—	—
<i>Cyclastrum scammonense</i> Whalen & Carter, 2002	—	—	—	—	—	—	—	—	—	—	×	?	?	×	—	—
<i>Paronaella grahamensis</i> Carter in Carter, Cameron & Smith, 1988	—	—	—	—	—	—	—	—	—	—	×	×	×	×	?	×
<i>Palaeosaturnalis liassicus</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—
<i>Palaeosaturnalis schaafl</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—
<i>Pseudoacanthocircus mediospinosus</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	×	?	×	—	—
<i>Palaeosaturnalis subovalis</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	×	?	×	—	—
<i>Paronaella tripla</i> De Wever, 1981	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
<i>Charlottea</i> sp. A	—	—	—	—	—	—	—	—	—	—	—	—	×	×	—	—
<i>Gorgansium gongyloideum</i> Kishida & Hisada, 1985	—	—	—	—	—	—	—	—	—	—	—	—	×	×	—	—
<i>Tozerium</i> sp. A	—	—	—	—	—	—	—	—	—	—	—	—	×	×	—	—
<i>Crucella mirabunda</i> Whalen & Carter, 2002	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—
<i>Pseudoacanthocircus mocki</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—
<i>Pseudoacanthocircus troegeri</i> Kozur & Mostler, 1990	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—
<i>Emiluvia prisca</i> Tekin, n. sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×
<i>Katroma ninstintsi</i> Carter in Carter, Cameron & Smith, 1988	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×
<i>Crucella mijo</i> 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 perileense*, *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 saturniids – 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 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*, *Pseudoecyrtis 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. tetra radiatus* Kozur & Mostler, 1990 (Fig. 10L, M), *Trexus dodgensii* 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 columbiense* 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), *Pseudoecyrtis aquila* (Whalen & Carter in Carter, Whalen & Guex, 1998) (Fig. 12P, Q), *Pseudoecyrtis 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*,

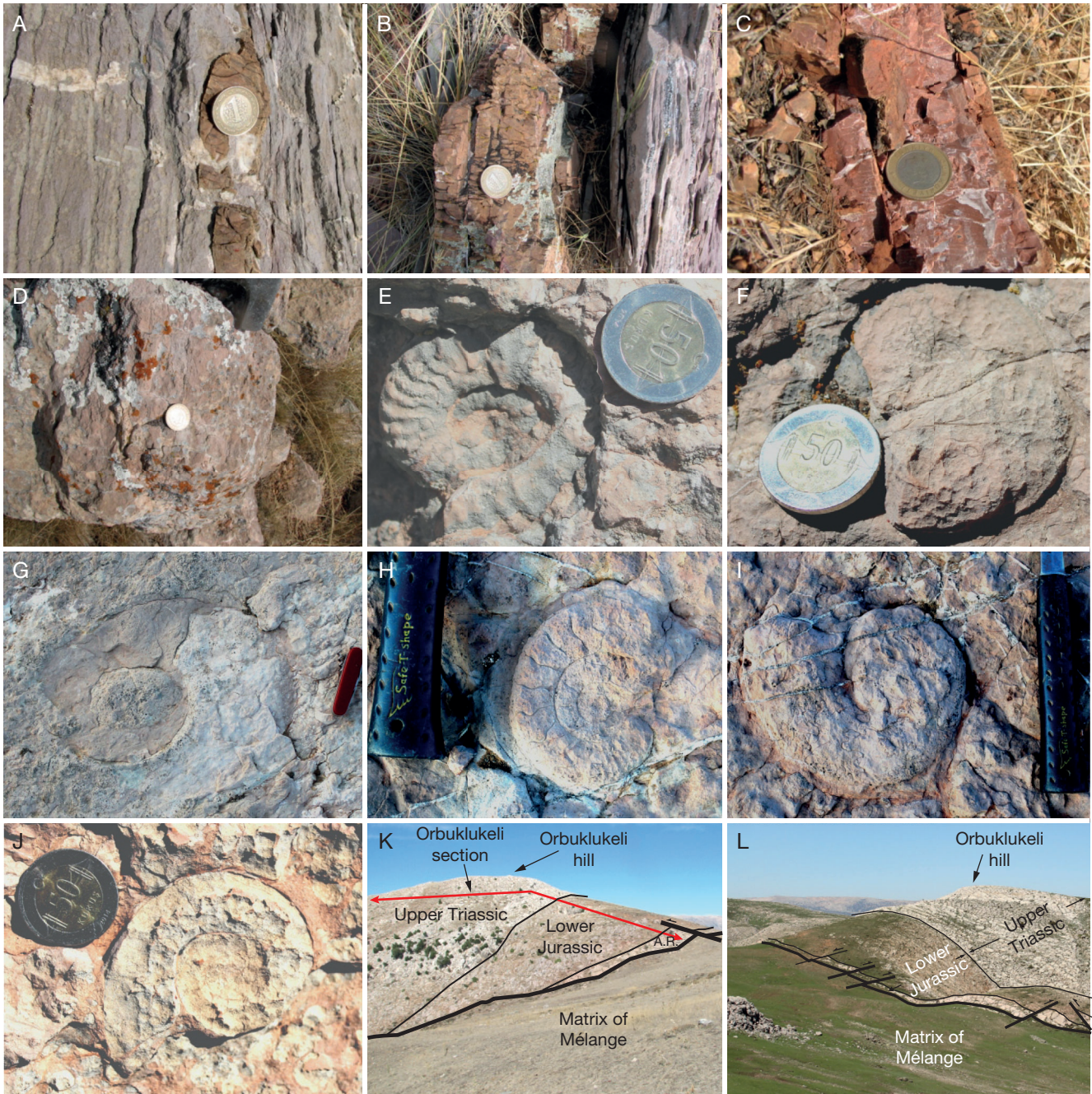


FIG. 5. — Field photographs from the Lower Jurassic part of the section: **A**, Thin to medium-bedded, gray, red to purple-colored limestones with red-colored chert interlayers from where the sample Orbuk-39 was collected; **B**, Alternating thin-bedded, purple-colored limestone, and thin-bedded, red-colored 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.

Pseudoencyrtis aquila and *Bipedis hannaï*) 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 *Cyclasturum 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 tettradiatus* (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 tipperli*/*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 *Platyleuroceras* 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 Phyllocerataceae (c. 50%) highlights the Mediterranean character of the fauna consisting of *Phylloceras nilssoni* (Hebert, 1866), *Meneghiniceras lariense* (Meneghini, 1875), *Lytoceras* sp., *Nodicoeloceras* 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 Gümüşlü 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 Beyşehir-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 Beyşehir-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 Boyalıtepe 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 Boyalıtepe Unit (Kuztepe Limestone of Özgül 1997) in the Beyşehir-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 hemipelagic 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. 4.

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.

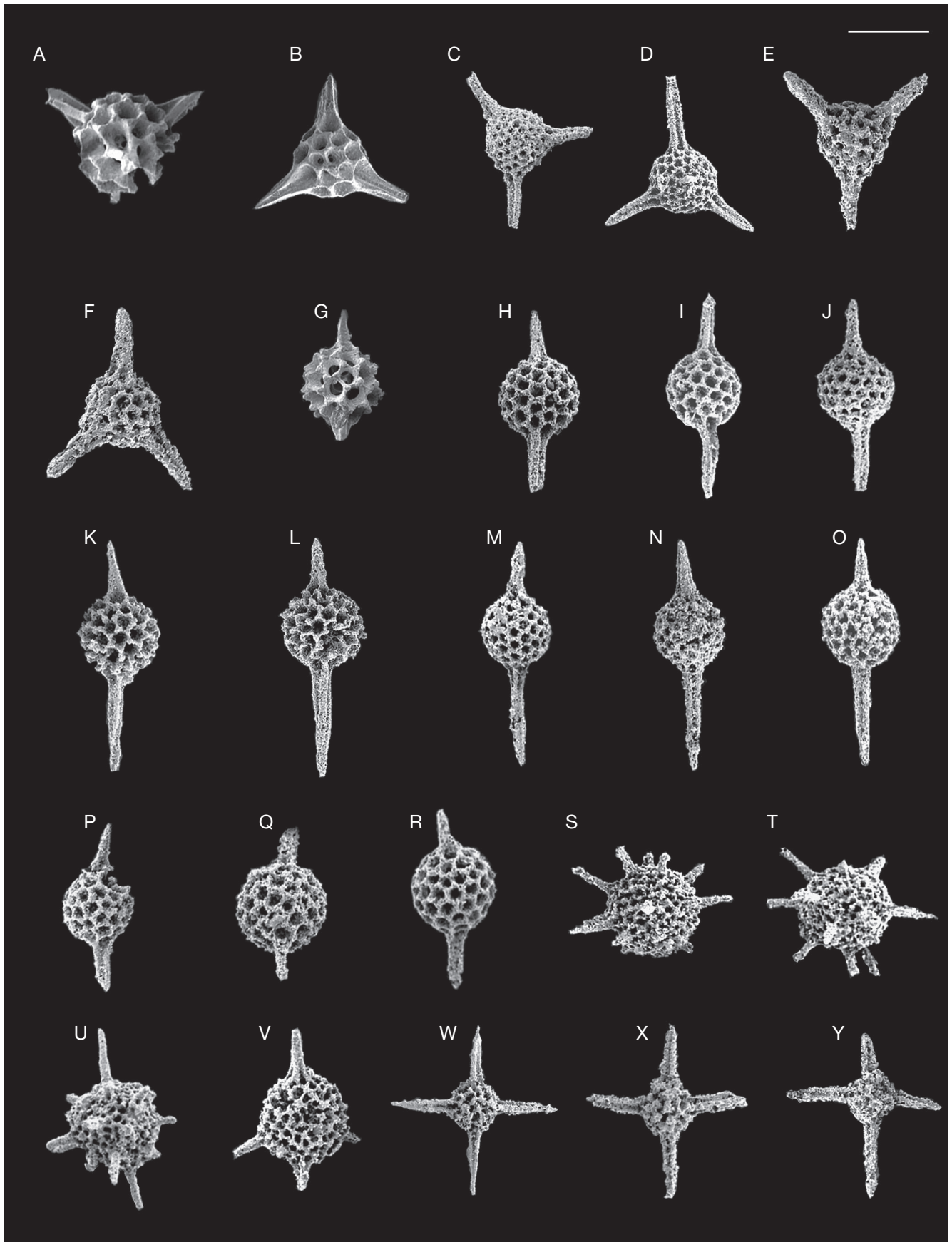
Pantanellium kluense Pessagno & Blome, 1980
(Fig. 6P)

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; Gümsü 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 perileense* 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 PYLONACEA 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 slightly 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 Gümüşlü 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)

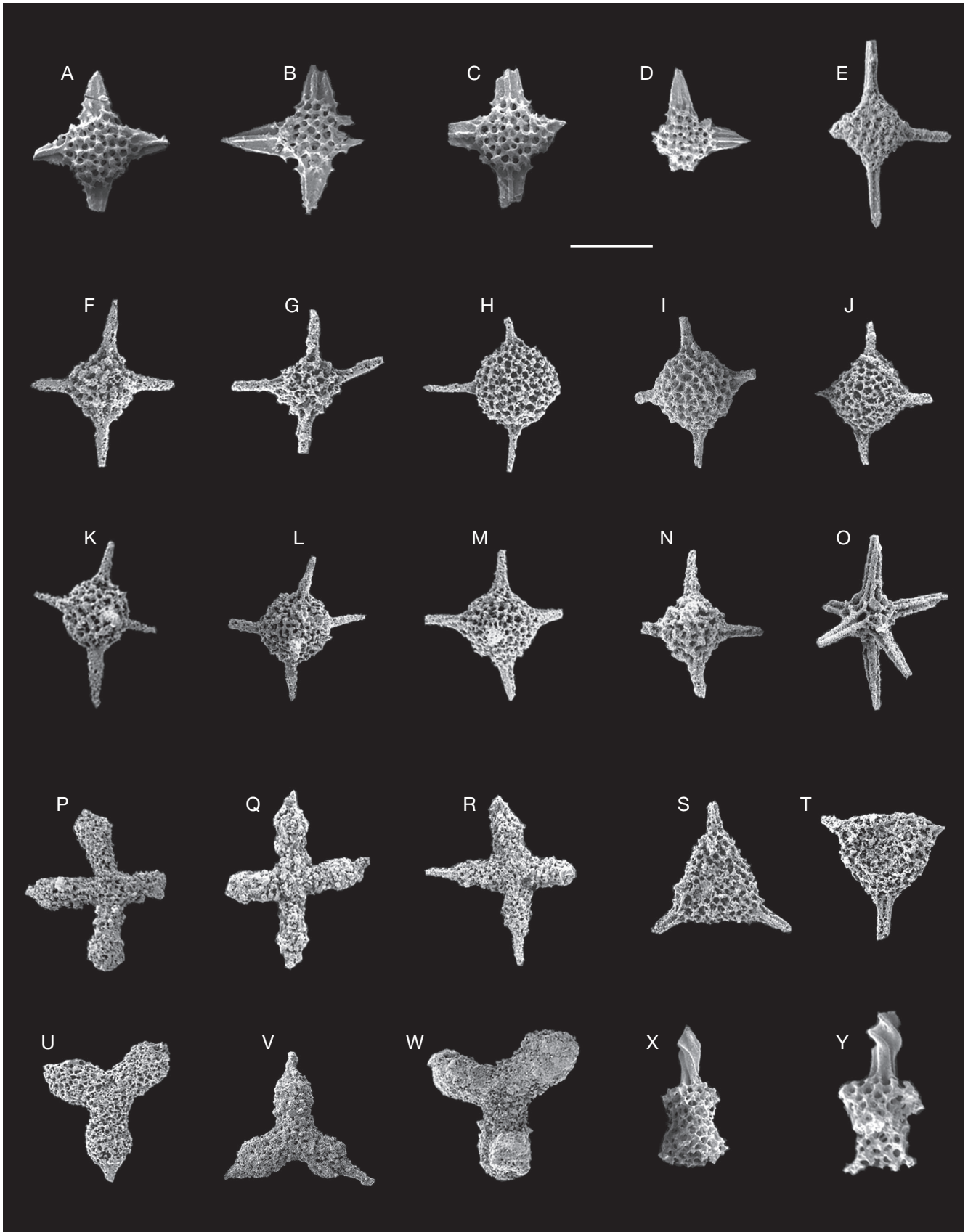
Subfamily PATULIBRACCHIINAE Pessagno, 1971

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; Far-east 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 spherical 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 designation.

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 beautiful 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 triangular) 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 *Praeorbuliformella* sp. A *sensu* Carter *et al.* (1998: 59, pl. 9, fig. 22) by possessing conical peripheral spines instead of bladed ones.

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

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

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

Orbuliformella ? *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.

Orbuliformella 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 *Orbuliformella 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).

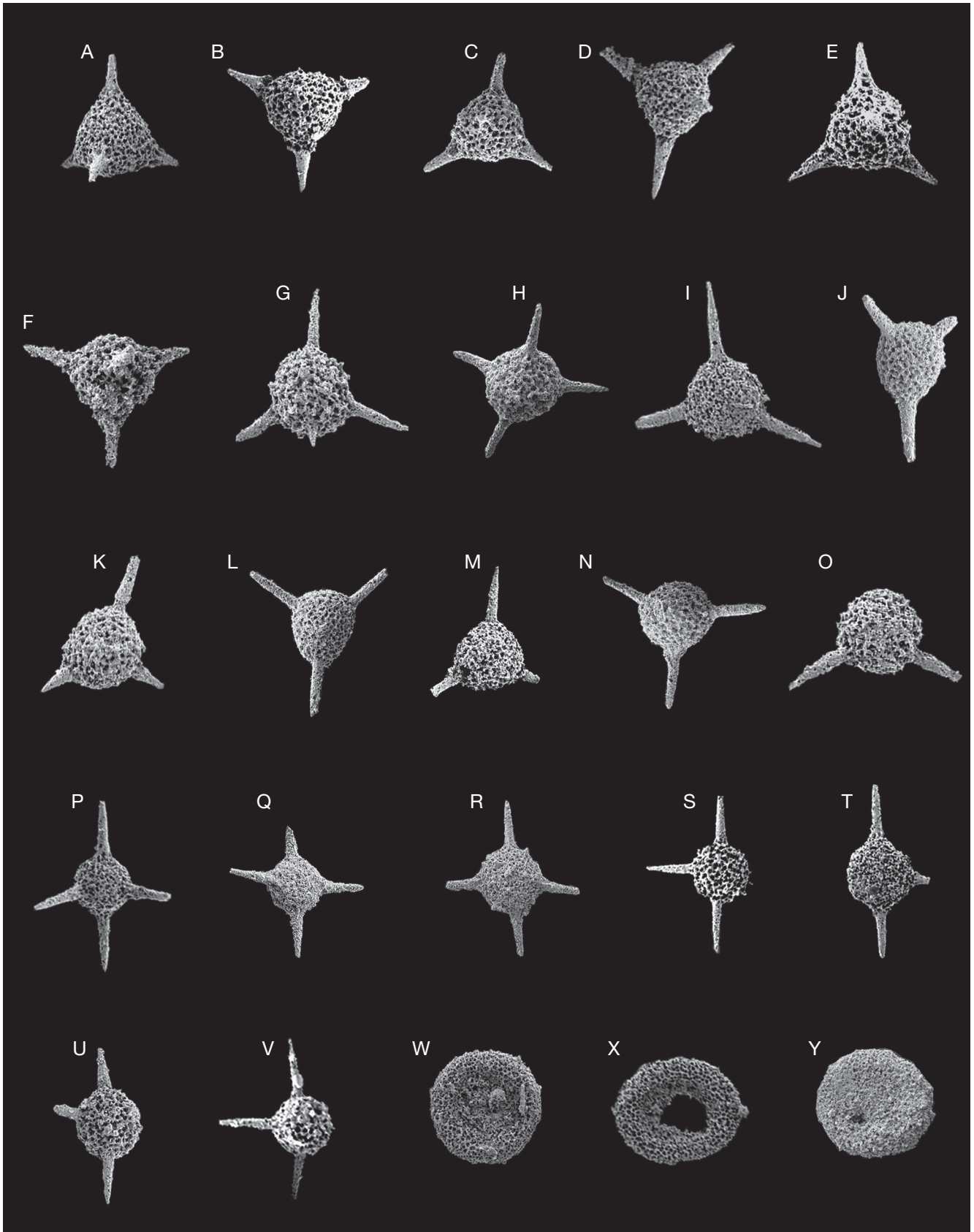


FIG. 8. — Photomicrographs of the radiolarians from the Orbuklukeli section; **A-H**, *Acanthotetrapaurinella kennecottensis* (Carter *in* Longridge, Carter, Smith & Tipper, 2007); **A-E, G**, Orbuk-26, **F, H**, Orbuk-27; **I-O**, *Paurinella liassica* Tekin, n. sp.; **I**, Holotype, Orbuk-27; **J-O**, 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 μ m; A-F, I-V, 150 μ m; W-Y, 200 μ m.

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 spherical, 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.

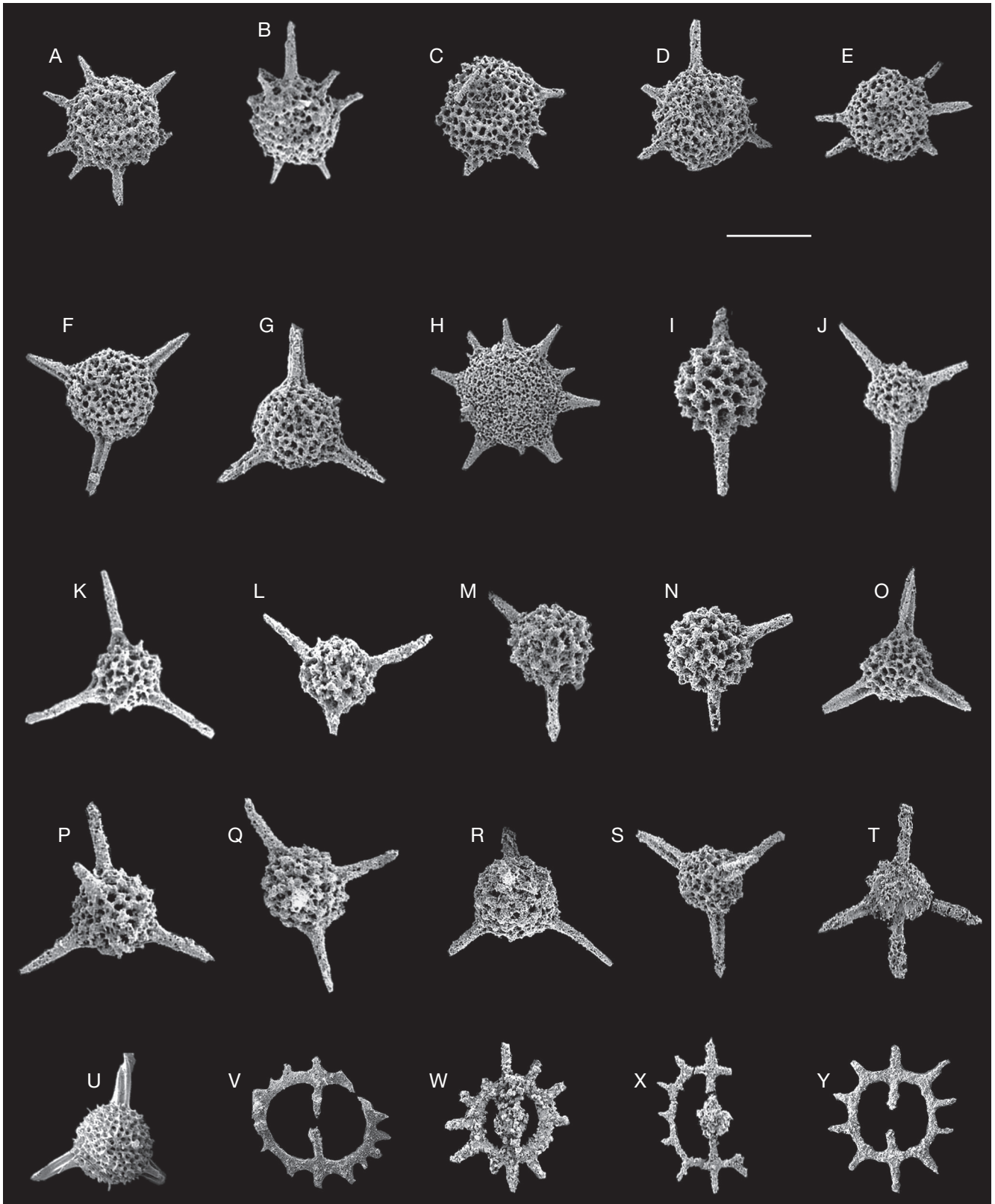


FIG. 9. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A-E**, *Orbiculiformella pulchra* Tekin, n. sp.; **A**, Holotype, Orbuk-32; **B-E**, Paratypes; **B**, Orbuk-31; **C-E**, Orbuk-32; **F-G**, *Orbiculiformella ? trispina trispina* (Yeh, 1987), Orbuk-32; **H**, *Orbiculiformella* 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 spherical test instead of a triangular one.

Superfamily SATURNALICEA 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.

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

Palaeosaturnalis schaafti 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. *schaafti* – 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).

Spongosaturnalis ? 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 & Hüngrerbühler 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 tetradialatus Kozur & Mostler, 1990
(Fig. 10L-M)

Praehexasaturnalis tetradialatus 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 tetradialatus – 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 & Hünigbühler 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 ARCHAEOICTYOMITRACEAE Pessagno, 1976
Family BAGOTIDAE Pessagno & Whalen, 1982

Genus *Droetus* Pessagno & Whalen, 1982

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

Droetus eurasiaticus Kozur & Mostler, 1990
(Fig. 10X, Y)

Droetus 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.

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

aff. *Droetus 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 *Droetus eurasiaticus* by possessing a shorter and wider test.

Droetus hecatensis Pessagno & Whalen, 1982
(Fig. 11C)

Droetus 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.

Droetus 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.

Droetus laseekensis Pessagno & Whalen, 1982
(Fig. 11D-F)

Droetus 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.

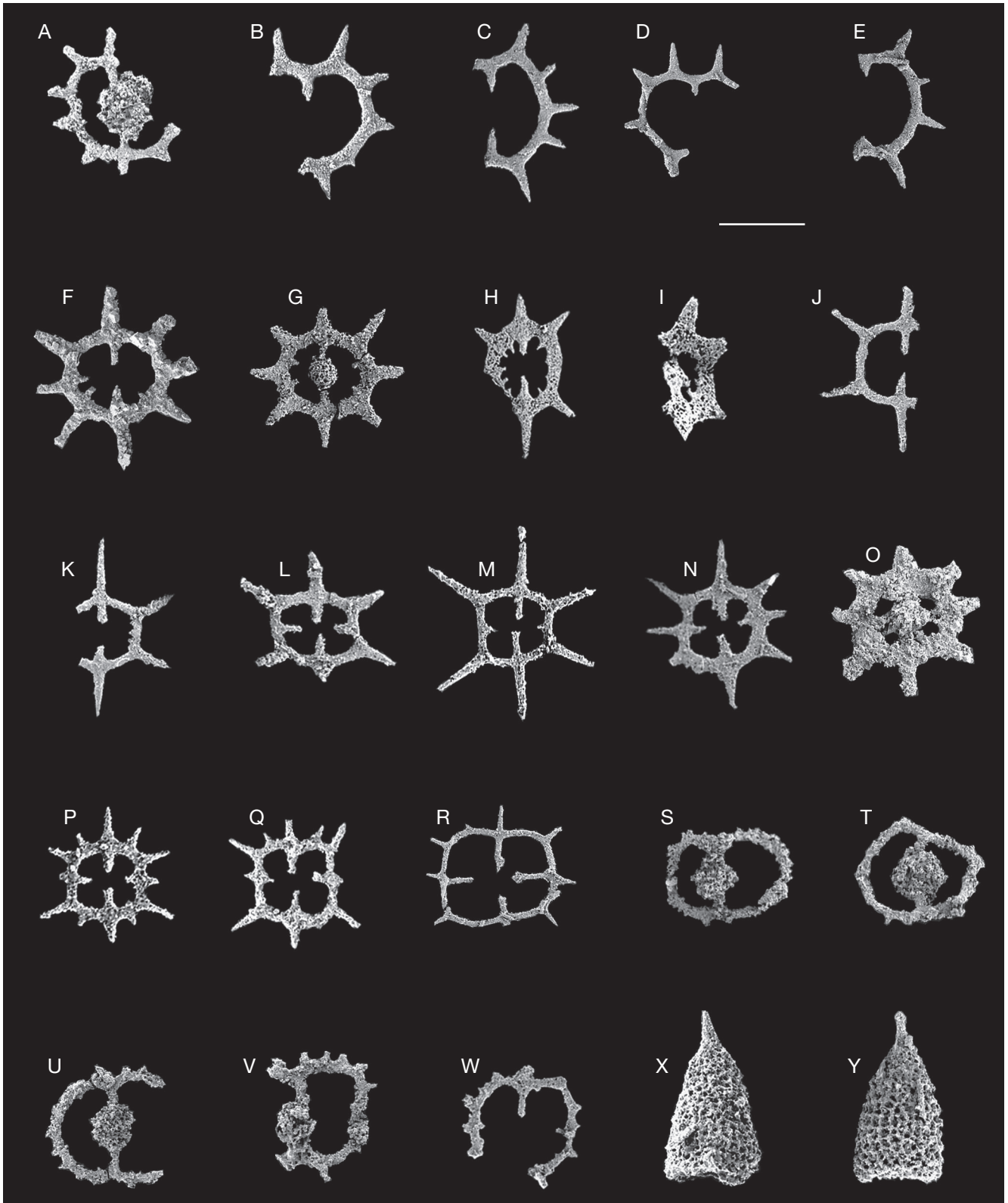


FIG. 10. — Photomicrographs of the radiolarians from the Orbuklukeli section: **A**, *Palaeosaturnalis subovalis* Kozur & Mostler, 1990, Orbuk-44; **B, C**, *Mesosaturnalis artus* (Donofrio & Mostler, 1978), Orbuk-21; **D, E**, *Mesosaturnalis octospinus* Sugiyama, 1997, Orbuk-21; **F, G**, *Praehexasaturnalis 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 tetradiradius* Kozur & Mostler, 1990; **L**, Orbuk-31; **M**, Orbuk-32; **N-O**, *Stauracanthocircus dickinsoni* (Yeh, 1989); **N**, Orbuk-31; **O**, Orbuk-47; **P, Q**, *Stauracanthocircus ? poetschensis* Kozur & Mostler, 1990, Orbuk-31; **R**, *Stauracanthocircus* 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 eurasiticus* 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 bulbous 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 & Mosler 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 to 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 increasing 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.

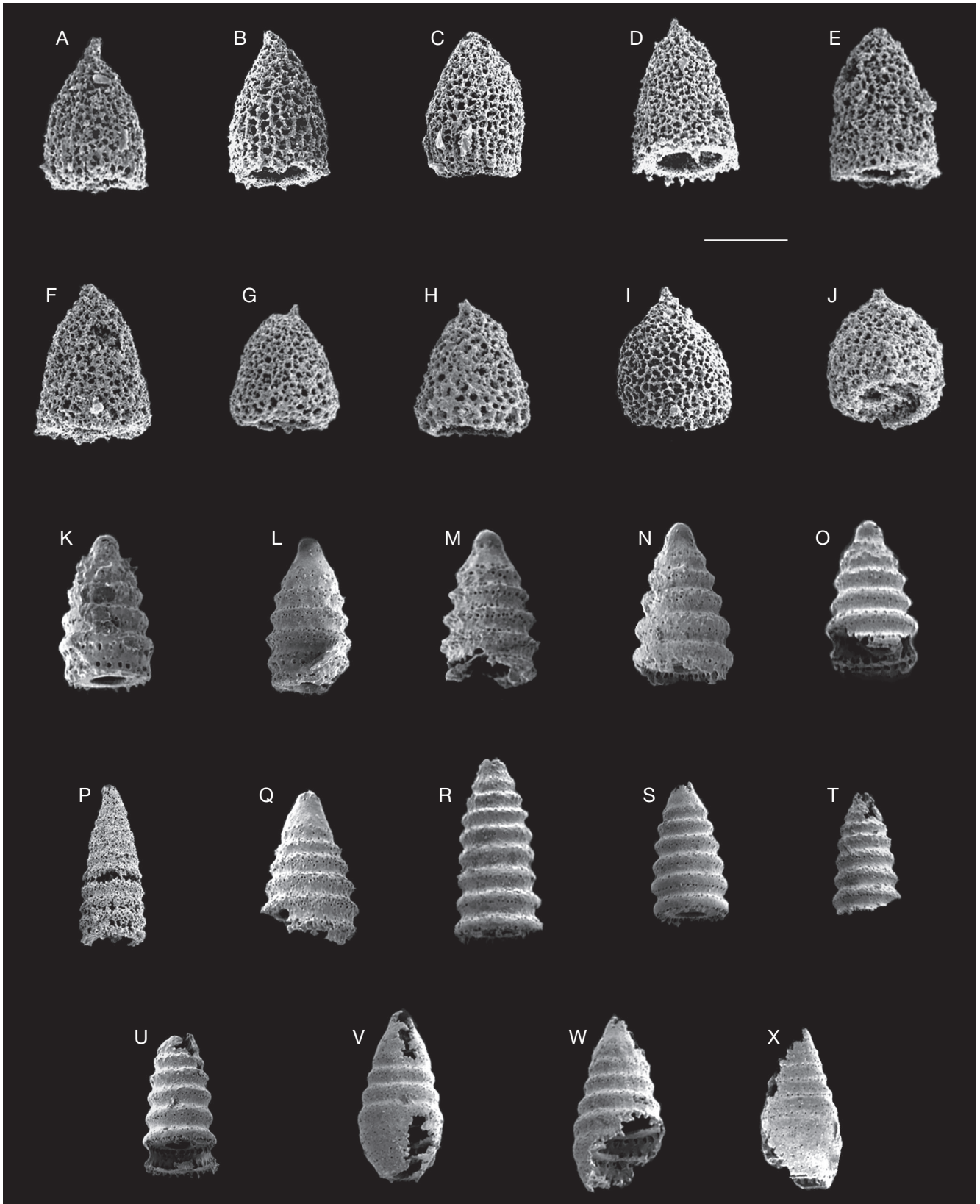


FIG. 11. — Photomicrographs of the radiolarians from the Orbuklukeli section; **A, B**, *Droltus* sp. aff. *D. eurasiaticus* Kozur & Mostler, 1990, Orbuk-32; **C**, *Droltus hecatensis* Pessagno & Whalen, 1982, Orbuk-32; **D-F**, *Droltus laseekensis* Pessagno & Whalen, 1982, Orbuk-27; **G-J**, *Trexus dodgensis* Whalen & Carter in Carter, Whalen & Guex, 1998, 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, multicyrtyd 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 hemispherical, 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 Zlam-bachgraben, Austria; Inuyama Area and Mino Terrane, central Japan; Sakhalin, Far-east Russia; Busuanga Island, Philippines; Ankara region, 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 & Spörl 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 hemispherical 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 hemispherical 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. — Gorican *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 Calceous 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 multicyrtrid, increasing in width distally except the last segment. Last segment decreasing in width. Cephalis hemispherical, 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 EUCYRTIDIAE 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 hemispherical with very rare, scattered 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 hemispherical 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 anatifformis (De Wever, 1982)
(Fig. 12W, X)

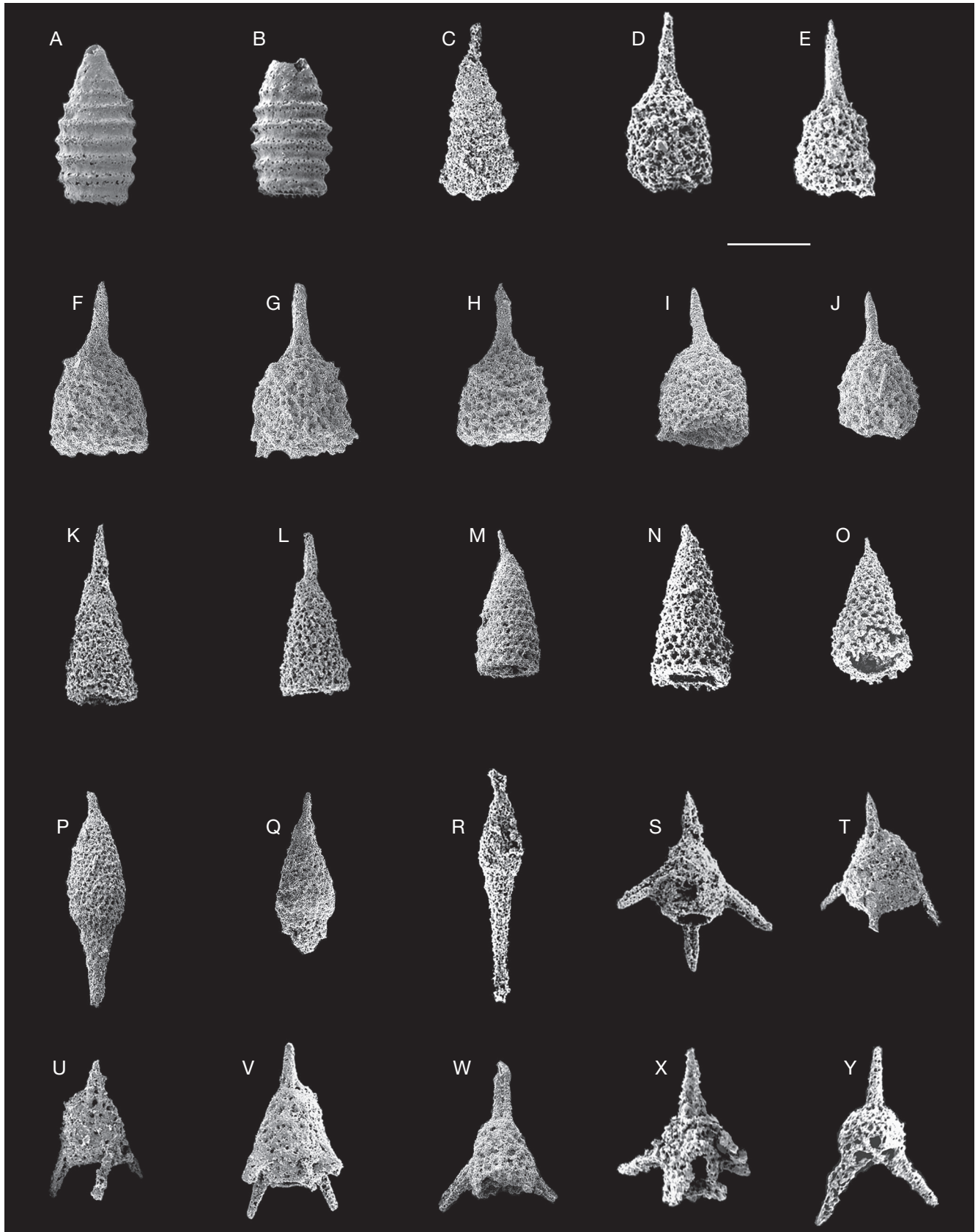
Jacus ? *anatifformis* De Wever, 1982a: 205, pl. 11, figs 10-15; 1982b: 343, pl. 54, figs 1-5; pl. 58, figs 1, 2, 6. — Carter *et al.* 1998: 74, pl. 18, figs 13-14, 17-19, 27. — Yeh & Cheng 1998: 32, pl. 6, fig. 10. — Hori & Wakita 2002: pl. 3, fig. 7. — Whalen & Carter 2002: 138, pl. 8, fig. 8.

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. 1.

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 anatififormis – 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. *anatififormis* – Gawlick *et al.* 2001: pl. 2, fig. 16.

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

Jacus? aff. *anatififormis* – 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? *anatififormis* – Matsuoka 2004: fig. 145.

OCCURRENCE. — Lower Jurassic, middle Hettangian-middle Toarcian of Gümüşlü 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 north-eastern British Columbia, Canada; Oregon, United States; 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.

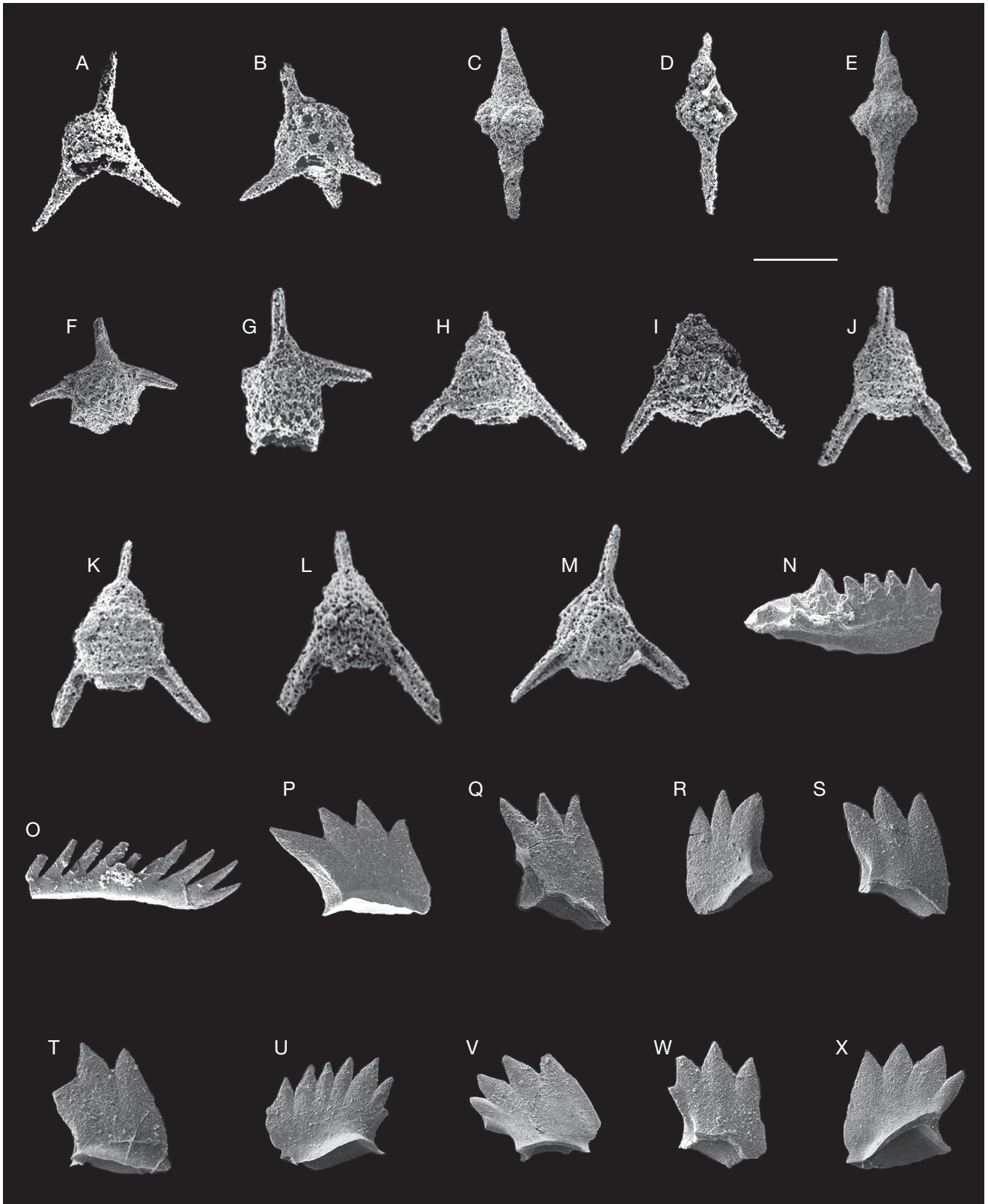


FIG. 13. — Photomicrographs of the radiolarians and conodonts from the Orbuklukeli section: **A**, *Saitoum* sp. aff. *S. triumphense* Whalen & Carter in Carter, Whalen & Guex, 1998, Orbuk-32; **B**, *Saitoum* sp. A, Orbuk-32; **C-E**, *Katroma ninstintsi* Carter in Carter, Cameron & Smith, 1988, Orbuk-46; **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 μ m; N-X, 150 μ m; C-E, 180 μ m.

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 lithological characteristics of the Tavuscayiri Block is correlative to the Gümüşlü 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.

		Radiolarian zonations						Ammonoid zonations	Conodont zonations			
		U A	Carte 1993	U A	Carte <i>et al.</i> 1998	U A	Carte <i>et al.</i> 2010	Carte <i>et al.</i> 1998, 2010	Carte <i>et al.</i> 1998			
LOWER JURASSIC	Toarcian					33	<i>Elodium pessagnoii/Hexasaturnalis hexagonus</i>	<i>Yakounensis</i>				
						32		<i>Hillebrandti</i>				
						31		<i>Crassicosta</i>				
						30		<i>Planulata</i>				
						29						
						28		<i>Kanense</i>				
						27	<i>Napora relicae/Eucyrtidiellum disparile</i>					
						26						
						25						
						24						
	Pliensbachian					23	<i>Eucyrtidiellum nagaiae/Praeparvicingula tlelensis</i>	<i>Carlottense</i>				
						22		<i>Kunae</i>				
						21	<i>Gigi fustis/Lantus sixi</i>	<i>Freboldi</i>				
						20						
						19						
						18						
						17						
						16	<i>Hsuum mulleri/Trillus elkhornensis</i>	<i>Whiteavesi</i>				
						15						
						14						
						13						
						12						
						11	<i>Zartus mostleri/Pseudoristola megaglobosa</i>	<i>Imlayi</i>				
						10						
					9							
					8	<i>Canutus tipperi/Katroma clara</i>	<i>Tetraspidoceras</i>					
					7							
					6							
					5							
					4							
					3							
					2							
					1							
	Sinemurian				25	<i>Jacus ? sandspitensis</i>		<i>Harbledownense</i>				
					24	<i>Canutus rockfishensis/Wrangellium thurstonense</i>		<i>Varians</i>				
					23							
					22							
					21							
					20							
					19	<i>Parahsuum simplum</i>		<i>Arnouldi</i>				
					18							
					17							
					16							
					15							
					14			<i>Coroniceras</i>				
				13								
				12								
				11								
				10	<i>Crucella hettangica</i>	<i>Canadensis</i>						
				9								
			8									
			7									
			6									
			5		<i>Doetzkirchineri</i>							
			4									
			3			<i>Pantanellium browni</i>						
			2			<i>Protokatroma aquila</i>						
			1	<i>Canoptum merum</i>		<i>Psiloceras</i>						
UPPER TRIASSIC	Rhaetian	27	3	<i>Globolaxtorum tozeri</i>			<i>Crickmayi</i>	<i>Posthernsteini</i>				
		26										
		25										
		24										
		23										
		22										
		21										
		20										
		19										
		18										
	17	2d										
	16											
	15											
	14											
	13											
	12											
	11											
	10											
	9											
	8							2c	<i>Proparvicingula monoliformis</i>			
7												
6												
5												
4												
3												
2												
1												
2a	1											
27												
26												
25												
24												
23												
22												
21												
20												
19												
18	1	<i>Betracium deweveri</i>										
17												
16												
15												
14												
13												
12												
11												
10												
9							<i>Pantanellium silberlingi</i>					
8												
7												
6												
5												
4												
3												
2												
1												
1d.- Upper Norian	<i>Capnodoce</i>											
							<i>Columbianus</i>	<i>Serrulata</i>				
								<i>Postera</i>				
								<i>Elongata</i>				
								<i>Spiculata</i>				

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.

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