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Stratigraphically important Spumellaria and Entactinaria from the lower Tuvalian (Upper Triassic) of the Huğlu Unit in the Mersin Mélange, southeastern Turkey

by

Heinz W. KOZUR¹, Patrice MOIX² and Péter OZSVÁRT³

Abstract.—KOZUR H.W., MOIX P. and OZSVÁRT P., 2007. Stratigraphically important Spumellaria and Entactinaria from the lower Tuvalian (Upper Triassic) of the Huğlu Unit in the Mersin Mélange, southeastern Turkey. *Bull. Soc. vaud. Sc. nat.* 90.3:175-195.

Two new genera, *Archaeoacanthocircus* n. gen. and *Huglusphaera* n. gen., comprising ten new species, are referred to the new Spumellarian family Archaeoacanthocircidae n. fam. These species are all very typical of the lower Tuvalian (Upper Triassic) *Spongortilispinus moixi* Zone of the Huğlu Unit in Turkey and partly also in the Tethys outside Turkey. Additionally, ten new species are described that belong in the Entactinarian genus *Kahlerosphaera*. These can be easily distinguished from upper Julian, upper Tuvalian and lower Norian *Kahlerosphaera* species.

Keywords: Spumellaria (radiolarians), Entactinaria (radiolarians), lower Tuvalian, Huğlu Unit, Mersin Mélange

Résumé.—KOZUR H.W., MOIX P. et OZSVÁRT P., 2007. Importants Spumellaires et Entactinaires du Tuvalien inférieur (Trias supérieur) de l'unité de Huğlu appartenant au mélange de Mersin (SE de la Turquie). *Bull. Soc. vaud. Sc. nat.* 90.3: 175-195.

Deux nouveaux genres, *Archaeoacanthocircus* n. gen. et *Huglusphaera* n. gen., comprenant 10 nouvelles espèces sont rapportés à une nouvelle famille de Spumellaires, les Archaeoacanthocircidae n. fam. Ces nouvelles espèces sont caractéristiques de la zone à *Spongortilispinus moixi* du Tuvalien inférieur (Trias supérieur) de l'unité de Huğlu en Turquie et également partiellement de la Téthys en dehors de Turquie. De plus, 10 nouvelles espèces appartenant au genre *Kahlerosphaera* des Entactinaires sont décrites. Celles-ci peuvent être facilement différenciées de celles du Julien supérieur, du Tuvalien supérieur et du Norien inférieur.

Mots clés: Spumellaires (radiolaires), Entactinaires (radiolaires), Tuvalien supérieur, Unité de Huğlu, Mélange de Mersin

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INTRODUCTION

MOIX *et al.* (2007) established the lower Tuvalian *Spongotortilispinus moixi* Zone from the Huğlu Unit of the Tavuşçayırı Block (MASSET and MOIX, 2004) in the Mersin Mélange, southeastern Turkey. The best-preserved and most diverse radiolarian fauna was obtained from sample G11, a limestone intercalation within thick tuffs that is the type stratum for all of the new radiolarian taxa described in the present paper. The geological setting is discussed in MOIX *et al.* (2007). The locality map and the position of sample G11 are presented in KOZUR *et al.* (this volume) and are therefore not repeated in the present paper, which describes more new radiolarians (Spumellaria and Entactinaria) characteristic of the *S. moixi* Zone. The illustrated material is deposited in the Hungarian Natural History Museum.

SYSTEMATICS

Order Spumellaria Ehrenberg, 1875

Superfamily Saturnaliacea Deflandre, 1953

Family Archaeoacanthocircidae n. fam.

Diagnosis: Shell spongy with numerous poorly defined layers around a microsphaere. The two flat, very rarely triangular polar spines have two flat wings that may be fused to a complete saturnalid ring, partly fused to an incomplete saturnalid ring or unfused. Both polar spines have a flat, triangular distal spine with two twisted edges that on one side point upward and on the other side point downward, in opposite directions on the two polar spines. The edges continue on the outer side of the wings or saturnalid ring as a distinct ridge. Because of the torsion and position of the edges on the distal spine, the ridge is on the upper side of one wing or one quarter of the saturnalid ring; on the other wing or adjacent quarter of the saturnalid ring it is situated on the lower side. In forms with unfused wings, the ridges are very rarely absent. A short or long, needle-like terminal spine is often present on the distal end of the polar spines and, in forms with a saturnalid ring, two further spines in a cross-like arrangement may be present at the margin of the ring perpendicular to the polar axis.

Occurrence: Common in the lower Tuvalian of the Tethys, especially in the Huğlu Unit of Turkey. Occurs rarely in the Tethyan upper Julian.

Assigned genera: *Archaeoacanthocircus* n. gen.; *Huglusphaera* n. gen.

Remarks: KOZUR and MOSTLER (1983, 1990) have shown that a saturnalid ring developed during the short upper Ladinian to middle Carnian interval in different lineages that are not closely related to each other. A part of

these Triassic forms with saturnalid rings belong to the Entactinaria (e.g. Spongosaturnaloididae KOZUR and MOSTLER 1983, Austrosaturnalidae KOZUR and MOSTLER 1983). The Saturnaliacea Deflandre, 1953 are Spumellaria with a spongy shell and a microsphaere. Under high magnification it can be easily seen that these forms have a microsphaere but no internal spicular system. Therefore the assignment of the Saturnaliacea to the Entactinaria by DUMITRICĂ (1985) and in De WEVER *et al.* (2001) cannot be confirmed by the inner structure of these forms. DUMITRICĂ (1985) attempted to show the monophyletic origin of the saturnalid radiolarians. However, he also placed the Austrosaturnalidae and Spongosaturnaloididae in different families than the representatives of the Saturnaliacea, though all were regarded as Entactinaria. The development of a saturnalid ring in different lineages of different orders within a short time interval in the Triassic is a good candidate for an example of horizontal gene transfer *sensu* DUMITRICĂ and GUÉX (2003).

The Parasaturnalidae Kozur & Mostler, 1972 emend. KOZUR & Mostler, 1983 have a flat ring which is always closed and lacks ridges. The Acanthocircidae Pessagno, 1977 always have a ridge on one side of the ring. They may have evolved from the Archaeoacanthocircidae but derivation from the Palaeosaturnalidae is also possible (KOZUR and MOSTLER 1990).

Genus Archaeoacanthocircus n. gen.

Type species: *Archaeoacanthocircus latiannulatus* n. gen. n. sp.

Diagnosis: With the characteristics of the family. The spongy shell partly reaches to the inner margin of the saturnalid ring or ends inside before reaching this margin. The saturnalid ring is always closed and widest perpendicular to the axis of the polar spines, which are often incorporated into the saturnalid ring (including the distal spines with the two twisted edges). Sometimes the saturnalid ring has the same width in the direction of the polar spines and perpendicular to this axis. The terminal spine of the polar spines can be short to very long and needle-like. Perpendicular to the polar spines, two additional spines in a cross-shaped arrangement may be present. In the four quadrants of the saturnalid ring, the strong ridge on its outer margin alternates between the upper and lower side of the ring.

Occurrence: Common in the lower Tuvallian of the Tethys, especially in the Huğlu Unit in Turkey.

Assigned species: *Archaeoacanthocircus latiannulatus* n. gen. n. sp.; *A. angustiannulatus* n. gen. n. sp.; *A. ovalis* n. sp.; *A. rectangularis* n. sp.; *A. transitus* n. gen. n. sp.

Remarks: The two lateral wings of the polar spines in *Huglusphaera* n. gen. are (at least on one side) not fused with the lateral wings of the opposite polar spine into a saturnalid ring. In *Acanthocircus* Squinabol, 1903 the ridge is continuous and only present on the upper side of the saturnalid ring.

Archaeoacanthocircus latiannulatus n. gen. n. sp.

(Plate 1, Figures 1, 2)

Derivatio nominis: In allusion to its wide saturnalid ring.

Holotypus: The specimen on Pl. 1, Fig. 1 (rep.-no. 23-9-04/VI-64). Material: More than 100 specimens.

Diagnosis: With the characteristics of the genus. The spongy shell does not reach to the inner margin of the saturnalid ring. Wide flat saturnalid ring subcircular, with a strong, relatively broad alternating ridge on its outer side. Polar spines incorporated in the saturnalid ring. Only the triangular distal flat spine of the polar spine with its two twisted edges extends beyond the saturnalid ring. This distal spine bears a needle-like terminal spine which is much longer on one polar spine than it is on the other. Perpendicular to the axis of the polar spine, there are also two needle-like, slightly twisted spines that are connected with the ends of the upper and lower ridge of two adjacent quarters of the saturnalid ring.

Occurrence: Common in the lower Tuvalian of the Tethys, especially in the Huğlu Unit of Turkey.

Remarks: The saturnalid ring in *Archaeoacanthocircus angustiannulatus* n. sp. is narrow, and has only the two spines in prolongation of the polar spines. Often it is widest perpendicular to the axis of the polar spines. *Archaeoacanthocircus ovalis* n. sp. has a wide oval saturnalid ring with the long axis perpendicular to the axis of the polar spines. *Archaeoacanthocircus rectangularis* n. sp. has a very wide rectangular saturnalid ring and the shell reaches to the inner margin of the saturnalid ring.

Archaeoacanthocircus angustiannulatus n. sp.

(Plate 1, Figures 5, 6)

Derivatio nominis: In allusion to its narrow saturnalid ring.

Holotypus: The specimen on Pl. 1, Fig. 5 (rep.-no. 23-9-04/V-142). Material: More than 100 specimens.

Diagnosis: With the characteristics of the genus. Saturnalid ring narrow, roundish oval to subcircular. On both sides of the flat polar spine the saturnalid ring is somewhat wider. The saturnalid ring is often widest perpendicular to the axis of the polar spines. The slender triangular distal, flat twisted spine of the polar spines bears a short needle-like terminal spine that is often not preserved. No additional spines are present on the saturnalid ring.

Occurrence: Common in the lower Tuvalian of the Huğlu Unit of Turkey.

Remarks: The saturnalid ring in *Archaeoacanthocircus latiannulatus* n. sp. is wide throughout and has four needle-like spines in a cross-like arrangement. *Archaeoacanthocircus transitus* n. sp. is similar, but on one side the fused

ends of the original adjacent wings of the opposite polar spines are still recognisable.

Archaeoacanthocircus ovalis n. sp.

(Plate 1, Figure 8)

Derivatio nominis: In allusion to its oval saturnalid ring.

Holotypus: The specimen on Pl. 1, Fig. 8 (rep.-no. 23-9-04/V-134). Material: 3 specimens.

Diagnosis: With the characteristics of the genus. The oval saturnalid ring is wide, flat with long axis perpendicular to the axis of the polar spines. Proximal part of the polar spines incorporated in the flat saturnalid ring, which has a strong, relatively broad, alternating ridge on its outer side. The elongated, triangular, flat distal part of the polar spine has two twisted edges that extend beyond the saturnalid ring. These distal parts of the polar spines bear a long needle-like terminal spine. Perpendicular to the axis of the polar spine, there are also two long needle-like, slightly twisted spines that connect to the ends of the upper and lower ridge of two adjacent quarters of the saturnalid ring.

Occurrence: Rare in the lower Tuvalian Huğlu Unit of the Mersin Mélange.

Remarks: *Archaeoacanthocircus latiannulatus* n. sp. is distinguished by its subcircular saturnalid ring.

Archaeoacanthocircus rectangularis n. gen. n. sp.

(Plate 1, Figures 3, 4)

Derivatio nominis: In allusion to its rectangular saturnalid ring.

Holotypus: The specimen on Pl. 1, Fig. 3 (rep.-no. 23-9-04/VI-44). Material: More than 100 specimens.

Diagnosis: With the characteristics of the genus. The spongy shell reaches to the inner margin of the saturnalid ring, where it is connected with the saturnalid ring by the polar spines and irregular small auxiliary spines. The very wide flat saturnalid ring is rectangular. Polar spines incorporated into the flat saturnalid ring, with a high but alternating ridge on its outer side. Two long, needle-like spines are present at the outer margin of the saturnalid ring in the two corners of the rectangle that are situated in prolongation of the polar spines. One of these spines is much longer than the other. Perpendicular to the axis of the polar spine, there are also two long needle-like spines at the other two corners of the rectangle.

Occurrence: Common in the lower Tuvalian of the Huğlu Unit of the Mersin Mélange.

Remarks: This species is clearly distinguished from all other *Archaeoacanthocircus* species by the rectangular outline of its very broad saturnalid ring.

Archaeoacanthocircus transitus n. sp.

(Plate 1, Figure 7)

Derivatio nominis: In allusion to its transitional characteristics between *Archaeoacanthocircus* and *Huglusphaera*.

Holotypus: The specimen on Pl. 1, Fig. 7 (rep.-no. 8-12-03/I-27). Material: 4 specimens.

Diagnosis: With the characteristics of the genus. The roundish oval saturnalid ring is narrow, but slightly widened around the flat polar spines. The saturnalid ring is widest perpendicular to the axis of the polar spines. The distal slender, triangular, flat spine on the polar spines has two very high edges that continue in alternating ridges on the saturnalid ring. No additional spines are present on the saturnalid ring. Perpendicular to the axis of the polar spine, on one side the ends of the original wings can be recognised despite the fact that they are fused with each other in the saturnalid ring.

Occurrence: Rare in the lower Tuvalian of the Huğlu Unit of the Mersin Mélange.

Remarks: In the similar *Archaeoacanthocircus angustiannulatus* n. sp., the place of fusion of the two opposite wings is nowhere recognisable. *A. transitus* is a transitional form from *Huglusphaera* n. gen., in which at least on one side the ends of the wings are not yet fused to the saturnalid ring, and *Archaeoacanthocircus*, in which the place of the fusion is no longer recognisable.

Genus *Huglusphaera* n. gen.

Type species: *Huglusphaera weemsi* n. gen. n. sp.

Derivatio nominis: In reference to its occurrence in the Huğlu Unit of the Mersin Mélange.

Diagnosis: With the characteristics of the family. The spongy shell does not reach the inner margin of the wings or incomplete saturnalid ring. The polar spines are flat with two edges, rarely tricarinate with deep furrows between the ridges. Both polar spines have two large lateral wings that are mostly recurved, with their distal part generally touching or crossing the distal part of the wing from the opposite polar spine; a small to large gap between the distal ends of the wings may remain open. The distal parts of the wings are often unfused, but may be fused on one side to a half-saturnalid ring. A broad, triangular, flat distal spine on the polar spine always lies beyond the wings. It has two twisted, somewhat thickened edges, which continue on the outer margin of the wings as distinct high ridges that are situated on one wing on the upper side and on the opposite wing on the lower side. The polar spines may end in a short to long needle-like terminal spine.

Occurrence: Very rare in the upper Julian and common in the lowermost Tuvalian of the Tethys. In the stratigraphically oldest forms from the upper Julian, the distal spine of the polar spines is not twisted and no ridges are present on the outer side of the wings. In these forms, the outer side of the wings bears numerous short triangular spines.

Assigned species: *Huglusphaera weemsi* n. gen. n. sp.; *Dumitricasphaera planustyla* Lahm, 1984; *Huglusphaera aperta* n. sp.; *H. aspinosa* n. sp.; *H. yini* n. sp.; *H. zakharovi* n. sp.

Remarks: *Huglusphaera* n. gen. is transitional between *Dumitricasphaera* Kozur & Mostler, 1979 and *Archaeoacanthocircus* n. gen. *Dumitricasphaera* has tricarinate polar spines and three distal wings. In *Huglusphaera aperta*, the tricarinate character of the polar spines is still preserved, in all other *Huglusphaera* species the polar spines are flat like the wings, as is the case in *Archaeoacanthocircus*. Polar spines with three distal wings are not present in any of the *Huglusphaera* species. In *Archaeoacanthocircus*, the wings are fused to a saturnalid ring. Among the forms transitional to *Archaeoacanthocircus*, we assigned to *Huglusphaera* all species in which on one side the wings are fused to a half ring (as in *Archaeoacanthocircus*) but are unfused on the other side (as in typical *Huglusphaera*).

Angulocircus Lahm, 1984 also has an interrupted ring, but the outer side of the ring bears numerous long spines and the shell is not only fixed by the polar spines but also by numerous auxiliary spines. A ridge on the outer side of the saturnalid ring is never present.

Huglusphaera weemsi n. gen. n. sp.
(Figures 1A, C)

Derivatio nominis: In honour of Dr. Robert E. Weems, United States Geological Survey, Reston, Virginia for his excellent geological and palaeontological studies of the Newark Supergroup, and for his improvement of our paper.

Holotypus: The specimen on Fig. 1A (rep.-no. 23-9-04/V-133). Material: More than 100 specimens.

Diagnosis: With the characteristics of the genus. The polar spines are flat, with their distal triangular spine beyond the wings having a long or short, needle-like terminal spine. The 4 wings are arranged in a subcircular manner. The distal ends of opposite wings touch each other and often cross each other, but they are always unfused.

Occurrence: Lower Tuvalian of Tethys.

Remarks: *Huglusphaera aspinosa* n. sp. has no terminal needle-like spine on the polar spines and a small gap is present between the distal ends of the opposite wings, which do not touch or cross each other.

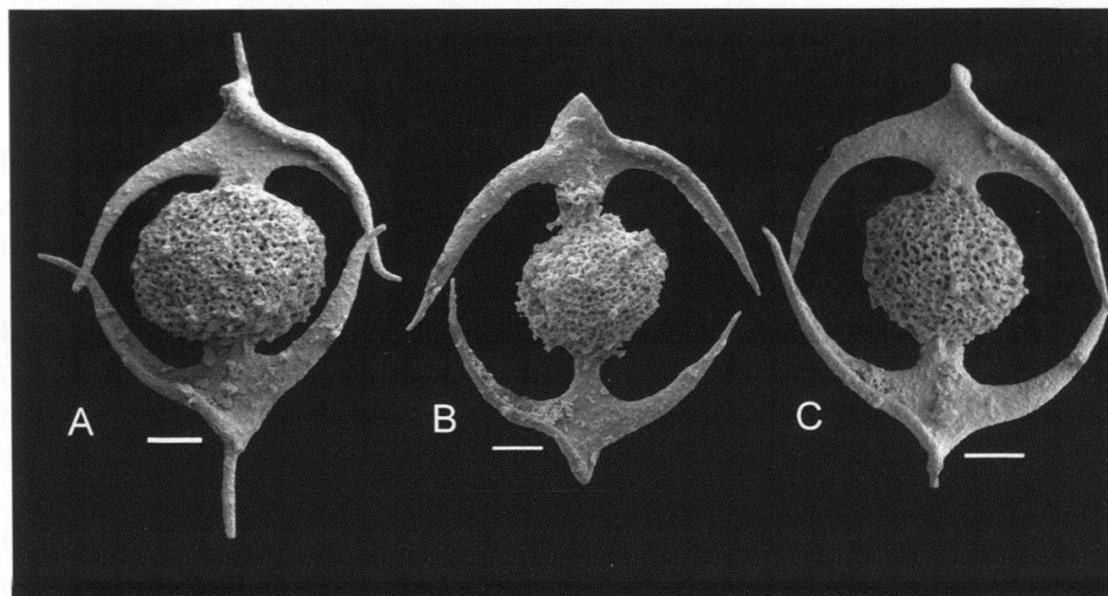


Figure 1.—A, C: *Huglusphaera weemsi* n. gen. n. sp.; A: holotype, rep. no. 23-9-04/V-133; C: rep.-no. 23-9-04/V-148.

B: *Huglusphaera aspinosa* n. sp., holotype, rep.-no. Ko-8-12-03/I-32.

Scale: 50 μ m

Huglusphaera aperta n. sp.

(Plate 1, Figure 13)

Derivatio nominis: In allusion to the large gap between the distal ends of opposite wings.

Holotypus: The specimen on Pl. 1, Fig. 13 (rep.-no. 23-9-04/I-22). Material: One specimen.

Diagnosis: With the characteristics of the genus. Polar spines tricarinate between the shell and the inner part of the wings, and flat in the outer part of the wings and beyond them. The flat triangular distal spine of the polar spines beyond the wings bears a long, needle-like terminal spine. The wings are narrow, even adjacent to the polar spines. Their distal ends are strongly recurved outward, and therefore do not approach each other in opposite wings, leaving a large gap.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Tavuşçayırı Block of the Mersin Mélange.

Remarks: Despite the fact that only one specimen is present, it is described as a new species because it represents an important link with *Dumitricasphaera* Kozur & Mostler, 1979 in having tricarinate polar spines inside the wings, which is unique for the Archaeoacanthocircidae. However, instead of three wings as in *Dumitricasphaera*, it has only two wings as is typical for *Huglusphaera* (and the Archaeoacanthocircidae).

Huglusphaera aspinosa n. sp.

(Figure 1B)

Derivatio nominis: In allusion to the absence of the terminal needle-like spine on the polar spines.

Holotypus: The specimen on Fig. 1B (rep.-no. 8-12-03/I-32). Material: 12 specimens.

Diagnosis: With the characteristics of the genus. The broad triangular flat spine that extends the polar spines beyond the wings has no terminal needle-like spine. The distal ends of the wings do not touch or cross each other and thus leave a small gap.

Occurrence: Rare in the Huğlu Unit of the Mersin Mélange.

Remarks: *Huglusphaera aperta* n. sp. has tricarinate polar spines between the shell and the wing. The distal ends of the wings are recurved and outwardly directed leaving a large gap. *Huglusphaera weemsi* n. sp. usually has a long, but sometimes short needle-like terminal spine on the polar spines.

Huglusphaera yini n. sp.

(Plate 1, Figures 10, 12)

Derivatio nominis: In honour of Prof. Dr. Yin Hongfu, Wuhan, for his outstanding contributions to the Permian and Triassic stratigraphic research.

Holotypus: The specimen on Pl. 1, Fig. 10 (rep.-no.23-9-04/V-138). Material: 23 specimens.

Diagnosis: With the characteristics of the genus. Polar spines flat, lacking terminal spines or with only very short needle-like terminal spines. The four wings are arranged in an incomplete saturnalid ring that is subcircular or oval with the long axis perpendicular to the polar spines. On one side two opposite wings are fused to half of a saturnalid ring. On the other side, they touch or cross each other but are not fused.

Occurrence: Lower Tuvalian of Huğlu Unit in Turkey.

Remarks: *Huglusphaera zakharovi* n. sp. has an oval incomplete saturnalid ring with the long axis in direction of the polar spines.

Huglusphaera zakharovi n. sp.

(Plate 1, Figures 9, 11)

Derivatio nominis: In honour of Prof. Dr. Yuri Zakharov, Vladivostok, for his outstanding work on Triassic ammonoids and stratigraphy.

Holotypus: The specimen on Pl. 1, Fig. 11 (rep.-no. 23-9-04/VI-70). Material: 15 specimens.

Diagnosis: With the characteristics of the genus. Polar spines flat, either lacking terminal spines or possessing only a very small needle-like terminal spine. The wings are narrow, but slightly widened around the polar spines. The four wings are arranged in an oval but incomplete saturnalid ring with the long axis in the direction of the polar spine. On one side the two opposite wings are fused to half of a saturnalid ring. On the other side the distal parts or ends of the wings touch or cross each other but are not fused.

Occurrence: Lower Tuvalian part of the Huğlu Unit of the Mersin Mélange.

Remarks: *Huglusphaera yini* n. sp. has a subcircular or oval incomplete saturnalid ring with the long axis perpendicular to the axis of the polar spines.

Order Entactinaria Kozur and Mostler, 1982

Family A n. fam.

Remarks: This family will be described in another paper because additional studies of the inner structure of genera similar to *Kahlerosphaera* must be done which also may belong to this family.

Genus *Kahlerosphaera* Kozur and Mostler, 1979

Type species: *Kahlerosphaera parvispinosa* Kozur and Mostler, 1979

Emended description: Cortical shell in upper view circular, subcircular or triangular, mostly double-layered. The outer layer has large triangular, tetragonal, hexagonal or polygonal pore frames, which may bear very small spines on the surface. Inner layer mostly has small to medium-sized circular, subcircular or oval pores. Rarely the inner layer has rather large pores and the pore frames of the outer layer are only insignificantly higher than the pore frames of the inner layer. In this case the cortical shell looks single-layered with high pore frames. The three tricarinate main spines are situated in one plane and, with the exception of one species, are arrayed radially at 120 degrees from each other. They have high narrow ridges that may be elevated in the middle part of the spine, and deep, wide furrows, with a big pore in the shell where each furrow meets the shell. In the distal part three outwardly directed, often curved secondary spines are present. They are needle-like, but may be in the proximal part wing-like, elevated, and may bear additional spines at that part. After the secondary spines, the three main spines are mostly reduced to a needle-like, proximally tricarinate terminal spine that may be very small to very large. Their ridges in the proximal part may be strongly elevated. The three main spines continue on the inner side of the shell almost to the centre, where they are connected by a hexastylacean entactinarian spicular system.

Occurrence: Carnian to middle Norian.

Remarks: The entactinarian spicular system is very fragile and only preserved in one specimen. Partial recrystallisation makes its reconstruction difficult, but it is surely not a pentactine.

Kahlerosphaera abnormis n. sp.

(Plate 2, Figure 1)

Derivatio nominis: In allusion to its irregularly arranged primary spines.

Holotypus: The specimen on Pl. 2, Fig. 1 (rep.-no. 23-9-04/II-174). Material: 3 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell globular, double-layered. The outer layer has large polygonal pore frames bearing very small spines. Inner layer with medium-sized subcircular, oval and triangular pores. Two of the three broad main spines are situated much closer to each other than to the third main spine. Their ridges become lower shortly before the secondary spines; in the third main spine they are somewhat elevated in the middle part. The secondary spines are relatively short, slender and triangular.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: *Kahlerosphaera abnormis* n. sp. differs from all other *Kahlerosphaera* species by the arrangement of the main spines.

Kahlerosphaera faludyi n. sp.

(Plate 2, Figure 3)

Derivatio nominis: In honour of György Faludy, the Hungarian-born poet.

Holotypus: The specimen on Pl. 2, Fig. 3 (rep.-no. 23-9-04/VI-102). Material: 25 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell imperfectly double-layered, in upper view subcircular to triangular. Pores medium-sized, pore frames high, triangular to polygonal with some very small spines. The ridges of the broad main spines are distinctly elevated in the middle part and become very low in the distal part. The secondary spines are medium-sized, needle-like, and slightly curved downward. Terminal spine very small.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: The double-layered shell of *Kahlerosphaera karinthyi* n. sp. has numerous small spines, and the terminal spine is somewhat longer than in *K. faludyi* n. sp. In *K. rejtoei* n. sp., the ridges of the main spines are slightly twisted, not elevated in the middle part and not as low in the distal part. The secondary spines are straight and the main spines continue somewhat beyond the secondary spines.

Kahlerosphaera hamvasi n. sp.

(Plate 2, Figure 2)

Derivatio nominis: In honour of Béla Hamvas, the Hungarian-born novelist.

Holotypus: The specimen on Pl. 2, Fig. 2 (rep.-no. 23-9-04/I-76). Material: More than 50 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell subglobular, double-layered with outer layer displaying triangular to polygonal pore frames and inner layer with small circular, oval or triangular pores. Main spines are slender, with ridges of the same height throughout. The large, needle-like secondary spines are directed slightly downward or curved and bear a triangular denticle on their proximal part. Terminal spine long and needle-like.

Occurrence: Lower Tuvalian of the Huğlu Unit of Turkey.

Remarks: The main spines of *Kahlerosphaera longispinosa* Kozur & Mostler, 1979 are longer, the secondary spines are shorter and directed straight outward.

Kahlerosphaera karinthyi n. sp.

(Plate 2, Figure 4)

Derivatio nominis: In honour of Ferenc Karinthy, the Hungarian-born novelist.

Holotypus: The specimen on Pl. 2, Fig. 4 (rep.-no. 8-12-03/I-18). Material: 31 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell double-layered, in upper view subcircular to subtriangular. Outer layer with tetragonal to polygonal pore frames, with very small spines. Inner layer with medium-sized subcircular and oval pores. The ridges of the broad main spines are elevated in the middle part and become suddenly low in the distal part. The medium-sized, slightly downward-curved secondary spines are proximally moderately high, distally needle-like. The terminal spine is short and needle-like. Sometimes two needle-like terminal spines are present.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: See *Kahlerosphaera faludyi* n. sp. for differences from this species.

Kahlerosphaera kerteszi n. sp.

(Plate 2, Figure 5)

Derivatio nominis: In honour of Imre Kertész, the Nobel Prize-winning Hungarian novelist.

Holotypus: The specimen on Pl. 2, Fig. 5 (rep.-no. 23-9-04/IV-105). Material: More than 100 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell double-layered, in upper view triangular. Outer layer with polygonal pore frames. Inner layer with small circular or oval pores. Main spines moderately wide, ridges slightly twisted, with constant height. Secondary spines large, needle-like, somewhat curved upward. At least two of them have a short conical denticle. Proximal spine very long, proximally tricarinate and then needle-like.

Occurrence: Lower Tuvalian of Tethys.

Remarks: *Kahlerosphaera longispinosa* Kozur and Mostler, 1979 has longer main spines.

Kahlerosphaera koestleri n. sp.

(Plate 2, Figure 6)

Derivatio nominis: In honour of Arthur Koestler, the Hungarian-born novelist and philosopher.

Holotypus: The specimen on Pl. 2, Fig. 6 (rep.-no. 23-9-04/I-125). Material: More than 100 specimens

Diagnosis: With the characteristics of the genus. Test large with cortical shell double-layered, in upper view subcircular to subtriangular. Outer layer with large polygonal pore frames, with some minute spines. Inner layer with small to medium-sized circular or oval pores. Main spines slender, relatively short, with ridges of the same height until the secondary spines, which are very long, needle-like, proximally flat with shallow furrows, distally mostly curved upward and longer than the main spine. Terminal spine very long, for the most part needle-like, but proximally with three very high ridges that are twisted in a propeller-like manner.

Occurrence: Lower Tuvalian of the Tethys, one of the most characteristic species of the *S. moixi* Zone.

Remarks: *Kahlerosphaera koestleri* n. sp. differs from all other species of *Kahlerosphaera* by the twisted propeller-like proximal part of the terminal spine that lies beyond the secondary spines.

Kahlerosphaera pamuki n. sp.

(Plate 2, Figure 7)

Derivatio nominis: In honour of Orhan Pamuk, the Nobel Prize-winning Turkish novelist.

Holotypus: The specimen on Pl. 2, Fig. 7 (rep.-no. 23-9-04/III-6). Material: 9 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell double-layered,

in upper view triangular. Outer layer with large polygonal pore frames. Inner layer with medium-sized oval or triangular pores. Main spines broad, their high ridges become rapidly lower in the distal third. Secondary spines medium-sized, in the outer part curved slightly downward. Terminal spine long, needle-like.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: The similar *Kahlerosphaera faludyi* n. sp. and *K. karinthyi* n. sp. are distinguished by a distinct elevation of the ridges on the middle part of the main spines, by small to minute terminal spines, and *K. karinthyi* n. sp. additionally has numerous very small spines on the shell.

Kahlerosphaera rejtoei n. sp.

(Plate 2, Figure 8)

Derivatio nominis: In honour of Jenő Rejtő (P. Howard), the Hungarian-born novelist.

Holotypus: The specimen on Pl. 2, Fig. 8 (rep.-no. 23-9-04/I-58). Material: 7 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell imperfectly double-layered, in upper view subtriangular. Large polygonal pore frames of the outer layer only insignificantly elevated above the pore frames of the inner layer with large triangular, oval or roundish pores. Main spines moderately wide. Their high, proximally broad ridges are slightly twisted and gradually decrease in height in the distal direction. The sharply pointed low secondary spines are directed straight outward. There is a very low tricarinate continuation of the main spines beyond the secondary spines that has a wide, blunt end with a very small, needle-like terminal spine in its centre.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: The similar *Kahlerosphaera szerbi* n. sp. has distinctly elevated pore frames on the outer layer, smaller pores on the inner layer and the tricarinate continuation of the main spines beyond the secondary spines is longer.

Kahlerosphaera szerbi n. sp.

(Plate 2, Figure 9)

Derivatio nominis: In honour of Antal Szerb, the Hungarian-born novelist.

Holotypus: The specimen on Pl. 2, Fig. 9 (rep.-no. 23-9-04/I-36). Material: 18 specimens.

Diagnosis: With the characteristics of the genus. Cortical shell double-layered, in upper view triangular. Outer layer with large polygonal pore frames. Inner layer with medium-sized triangular, oval or roundish pores. Main spines broad,

their high ridges are slightly twisted and their height decreases in the distal third. The sharply pointed, moderately long secondary spines are directed straight outward. The tricarinate continuation of the primary spines beyond the secondary spines is relatively long and a minute, needle-like terminal spine is present in the centre of their blunt ends.

Occurrence: Lower Tuvalian of the Huğlu Unit in the Mersin Mélange.

Remarks: See *Kahlerosphaera rejtoei* n. sp. for differences from this species.

Kahlerosphaera vonneguti n. sp.

(Plate 2, Figure 10)

Derivatio nominis: In honour of Kurt Vonnegut, the American-born novelist, critic and philosopher.

Holotypus: The specimen on Pl. 2, Fig. 10 (rep.-no. 23-9-04/III-49). Material: 42 specimens.

Diagnosis: With the characteristics of the genus. Test large with cortical shell globular, double-layered. Outer layer with high, triangular to polygonal pore frames with very short spines. Inner layer with small triangular, oval or roundish pores. The main spines are long slender, with equal width between the shell and the long, needle-like, distally slightly upward curved secondary spines. Terminal spine very long, proximally tricarinate, distally needle-like.

Remarks: *Kahlerosphaera norica* Kozur & Mock, 1981 (in KOZUR and MOSTLER 1981) is distinguished by shorter main spines and a short terminal spine.

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PLATES 1-2

All illustrated specimens are from sample G11, a limestone intercalation within thick tuffs of the Tuvuřayırı Block in the Mersin Mélange, southeastern central Turkey (see Figure 1 of KOZUR *et al.*, this volume), lower Tuvalian *Spongotortilispinus moixi* Zone.

Plate 1

Figures 1, 2.—*Archaeoacanthocircus latiannulatus* n. gen. n. sp.; Fig. 1: holotype, rep.-no. 23-9-04/VI-64; Fig. 2: rep.-no. 23-9-04/III-98.

Figures 3, 4.—*Archaeoacanthocircus rectangularis* n. sp., Fig. 3: holotype, rep.-no. 23-9-04/VI-44; Fig. 4: rep.-no. 23-9-04/VI-42.

Figures 5, 6.—*Archaeoacanthocircus angustiannulatus* n. sp.; Fig. 5: holotype, rep.-no. 23-9-04/V-142; Fig. 6: rep.-no. 23-9-04/V-145.

Figure 7.—*Archaeoacanthocircus transitus* n. sp., holotype, rep.-no. Ko 8-12-03/I-27.

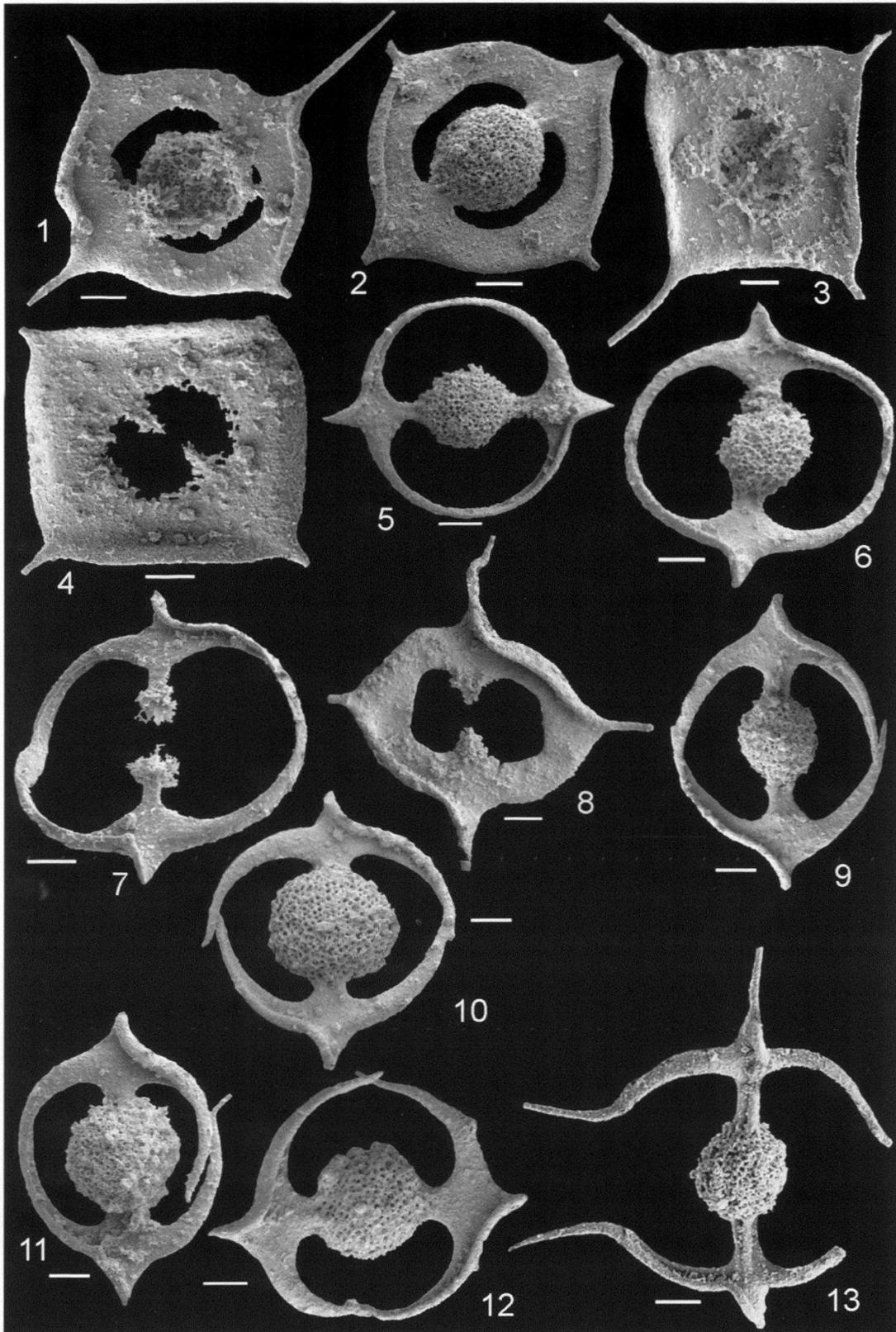
Figure 8.—*Archaeoacanthocircus ovalis* n. sp., holotype, rep.-no. 23-9-04/V-134.

Figures 9, 11.—*Huglusphaera zakharovi* n. sp.; Fig. 9: rep.-no. 23-9-04/V-144; Fig. 11: holotype, rep.-no. 23-9-04/VI-70.

Figures 10, 12.—*Huglusphaera yini* n. sp.; Fig. 10: holotype, rep.-no. 23-9-04/V-138; Fig. 12: 23-9-04/V-143.

Figure 13.—*Huglusphaera aperta* n. sp., holotype, rep.-no. 23-9-04/I-22.

Plate 1



Scale 50 μ m

Plate 2

Figure 1.—*Kahlerosphaera abnormis* n. sp., holotype, rep.-no. 23-9-04/II-174

Figure 2.—*Kahlerosphaera hamvasi* n. sp., holotype, rep.-no. 23-9-04/I-76

Figure 3.—*Kahlerosphaera faludyi* n. sp. holotype, rep.-no. 23-9-04/VI-102

Figure 4.—*Kahlerosphaera karinthyi* n. sp. holotype, rep.-no. Ko 8-12-03/I-18

Figure 5.—*Kahlerosphaera kerteszi* n. sp. holotype, rep.-no. 23-9-04/IV-105

Figure 6.—*Kahlerosphaera koestleri* n. sp. holotype, rep.-no. 23-9-04/I-125

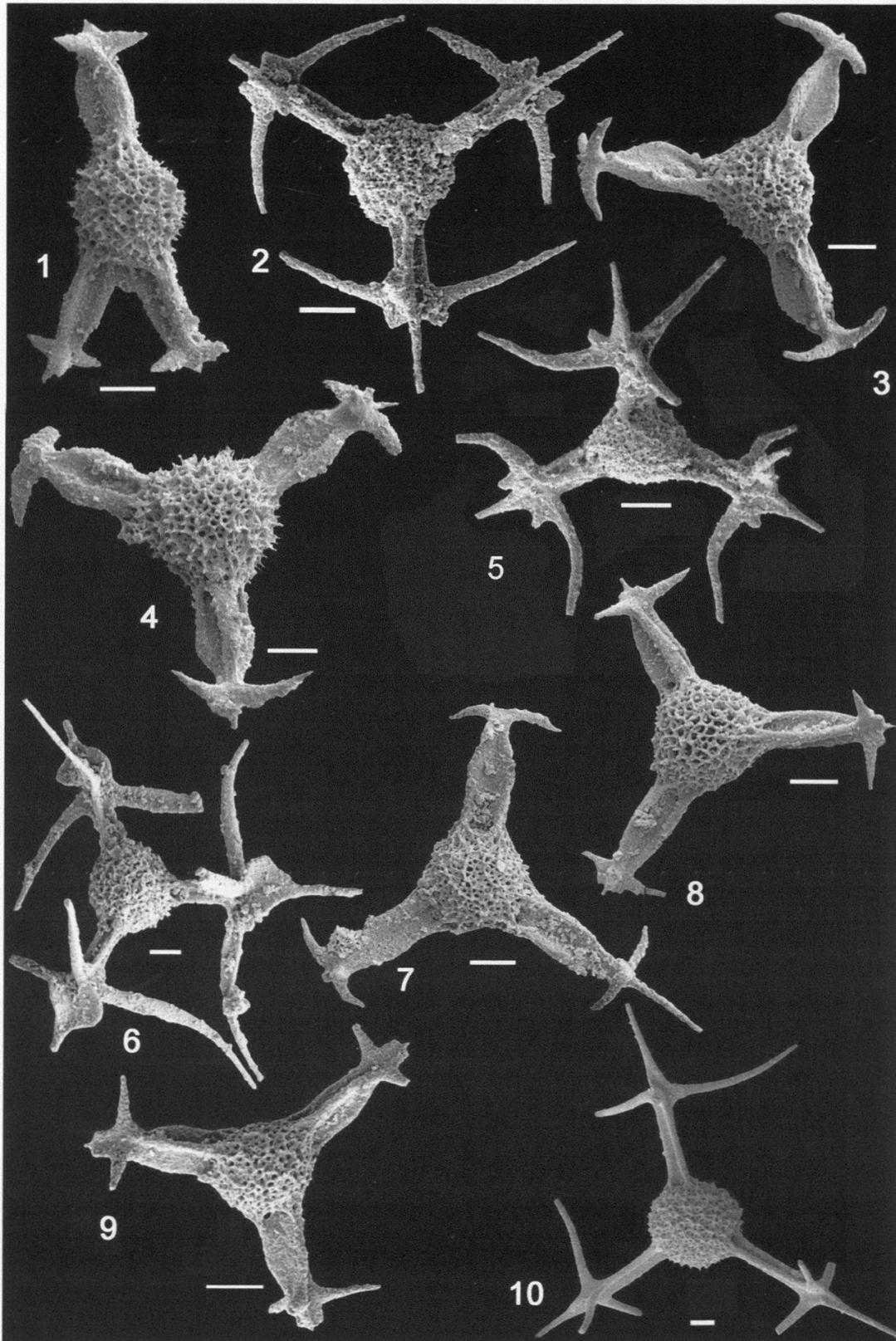
Figure 7.—*Kahlerosphaera pamuki* n. sp. holotype, rep.-no. 23-9-04/III-6

Figure 8.—*Kahlerosphaera rejtoei* n. sp. holotype, rep.-no. 23-9-04/I-58

Figure 9.—*Kahlerosphaera szerbi* n. sp. holotype, rep.-no. 23-9-04/I-36

Figure 10.—*Kahlerosphaera vonneguti* n. sp. holotype, rep.-no. 23-9-04/III-49

Plate 2



Scale 50 μ m

