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Late Triassic (Early to Middle Norian) radiolarians from the Antalya Nappes, Antalya, SW Turkey

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ABSTRACT – The Gökdere Formation of the Alakircay Nappe (Antalya Nappes) mainly consists of cherty limestone and limestone with calciturbidite intercalations. Moderately to well-preserved radiolarians were obtained from the Gökcam section of the Gökdere Formation located to the west of Antalya City, southwestern Turkey. The radiolarians of the Gökdere Formation obtained in this study are comparable to the faunas described from the Queen Charlotte Islands, British Columbia and the Antalya Nappes, southwestern Turkey. The age range of the radiolarians is late Early Norian to early Middle Norian based on the co-occurrence of *Capnodoce serisa*, *Harsa siscwaiensis, Xiphosphaera fistulata* and an associated fauna. Three species (*Nodocapnuchosphaera altineri*, *Renzium whalenae and Enoplocampe*(?) *norica*) and one subspecies (*Kinyrosphaera helicata goekcamensis*) are defined as new. *J. Micropalaeontol.* **22**(2): 147–162, November 2003.

INTRODUCTION

The Antalya Nappes, in the Taurides of southern Turkey, include widely exposed Mesozoic radiolaria-bearing pelagic sediments. The middle (Alakircay) and upper (Tahtalidag) nappes of the Antalya Nappes are very important targets for detailed radiolarian biostratigraphic studies. The radiolarian biostratigraphy of the Gökdere Formation (Alakircay Nappe, Antalya Nappes) has been investigated by various workers. Early Norian radiolarians from this formation in the Ispartacay section (near Isparta City, western Taurides) have been reported by De Wever *et al.* (1979) and De Wever (1982). Detailed biostratigraphical work on the latest Carnian–earliest Norian to Early Norian radiolarians from the Gökdere Formation of the Gürleyikdere section (near Kemer Town, Antalya, western Taurides) have been undertaken by Tekin (1999). Tekin (2002a) recently documented the Late Norian–Rhaetian radiolarians from the Hocaköy section (near Akseki Town, Antalya, central Taurides).

The aim of the present study is to clarify the late Early to early Middle Norian radiolarians from the Gökdere Formation of the Gökcam section and correlate them with the previously described Tethyan and Circum-Pacific faunas.

GEOLOGICAL SETTING

The Taurides, one of the major components of the Alpine–Himalayan Orogenic belt, are located in the southern part of Turkey. They are composed of allochthonous and autochthonous units with a wide range of lithologies. Allochthonous units were assigned to 'nappes' by Brunn *et al.* (1971), whereas Özgül (1976, 1984) adopted the term 'tectonostratigraphic units' for both the allochthonous and autochthonous sequences.

The Antalya Nappes, as a part of the Taurides, were first described and named as a single nappe (Antalya Nappe) in the Antalya region by Lefevre (1967). Brunn *et al.* (1971) attempted to subdivide it into three slices; the 'Cataltepe Unit' (lower nappe), the 'Alakircay Unit' (middle nappe), and the 'Tahtalidag Unit' (upper nappe). Recently, Senel *et al.* (1992) have subdivided the Antalya Nappes into four units; the 'Cataltepe Nappe', the 'Alakircay Nappe', the 'Tahtalidag Nappe' and the 'Tekirova Ophiolitic Nappe'.

The Alakircay Nappe is extensively exposed between the Antalya Gulf and the Beydaglari Mountains, and is composed mainly of Triassic to Cretaceous pelagic sediments (Figs 1 & 2). In the study area, the Triassic rock units of the Alakircay Nappe include the Tesbihli, Candir and Gökdere formations (Senel, 1997a; Fig. 3A). These formations were first named and described by Kalafatcioglu (1973).

The Tesbihli Formation is composed of alternating thin- to medium-bedded, red to reddish brown cherts and shales. The age of the formation is reported to be Late Ladinian to Early Carnian (Senel, 1997a; Tekin, 1999). The Candir Formation consists of thin- to thick-bedded, grey-green, green and yellowish-green, plant-bearing sandstones, shales and claystones. Locally, basalt, conglomerate, limestone, and sandy-clayey limestone lenses occur as minor components. The Tesbihli Formation varies in age from Late Anisian to Norian in the region (Senel, 1997a).

The Gökdere Formation includes thin- to medium-bedded, beige-grey limestone and cherty limestone. It occasionally contains calcarenites, shales, bedded cherts, tuffs and pillow lavas. The Gökdere Formation varies in age from Carnian to Rhaetian (Tekin, 1999, 2002a).

In the study area, the Ballik and Kecili Formations are found in the Jurassic–Cretaceous part of the Alakircay Nappe (Senel, 1997a; Fig. 3A). The Ballik Formation was first described by Robertson & Woodcock (1981) and is characterized by thin- to medium-bedded, red, reddish-brown, green, grey and dark grey chert and shale interbeds with some limestone intercalations. Its age can be assigned to the Early Jurassic to Middle Cretaceous based on radiolaria obtained from the central Taurides (Hocaköy Radiolarite, equivalent of Ballik Formation; Tekin, 2002b). The Upper Cretaceous Kecili Formation was first named by Senel *et al.* (1981). It is represented by red, pink, green and grey limestones, cherty limestone, chert, shale and calciturbidite in the basal part and olistostromal unit in the upper levels (Senel, 1997a).

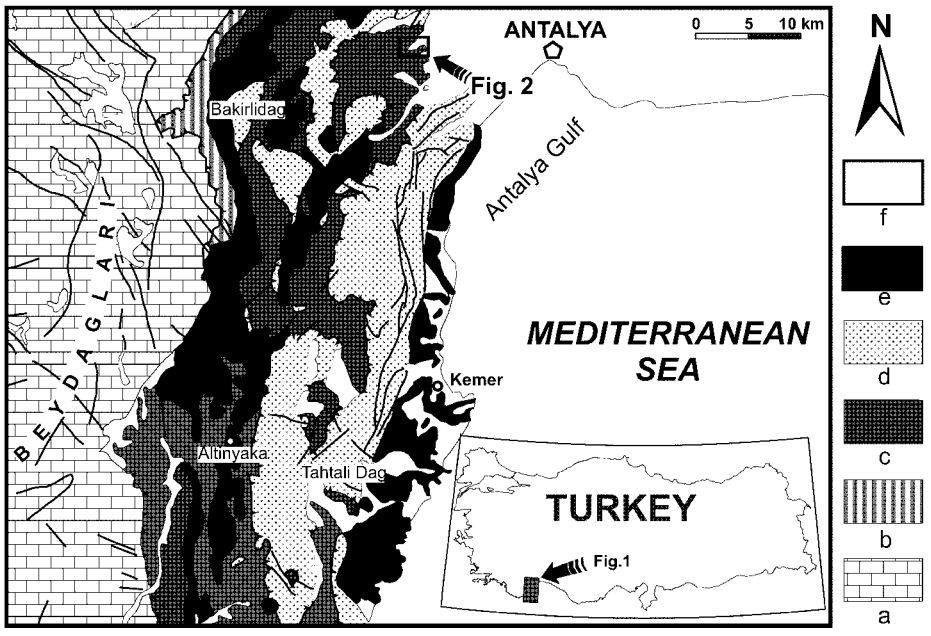


Fig. 1. Major tectonic units of the western part of the Antalya Gulf. Key: a, Beydaglari Autochthonous Unit; b–e, Antalya Nappes – b, Cataltepe Nappe; c, Alakircay Nappe; d, Tahtalidag Nappe; e, Tekirova Ophiolite Nappe including ophiolitic melange; f, post-Lower Miocene units (revised after Senel, 1997a, b).

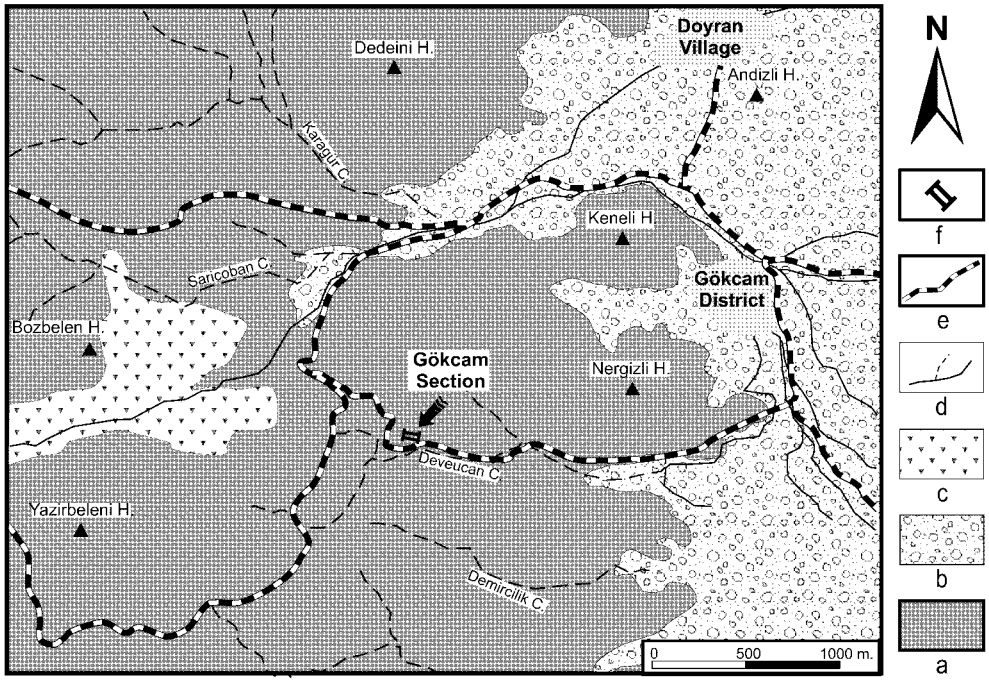


Fig. 2. Geological map of the Gökcam section and its surroundings. Key: a, undifferentiated Alakircay Nappe of the Antalya Nappes; b, Quaternary deposits; c, Quaternary slope debris; d, drainage systems; e, main roads; f, location of the section (revised after Senel, 1997b).

LITHOSTRATIGRAPHY OF THE GÖKCAM SECTION

The Gökcam section was measured and sampled through the Gökdere Formation of the Alakircay Nappe to the west of Antalya City (Fig. 1). It is situated in the O25a1 quadrangle approximately 2 km southwest of Gökcam District (Start Point: 40.85.250N, 2.79.500E; End Point: 40.85.275N, 2.79.400E) (Fig. 2). This section is named after the Gökcam District of Doyran village and is located on the northeast bank of the Deveucan Creek (Fig. 2). The Antalya Nappes are represented by several tectonic slices within the study area. The Gökcam section is measured from one of the slices that form the Gökdere Formation. The Gökdere Formation at this location is

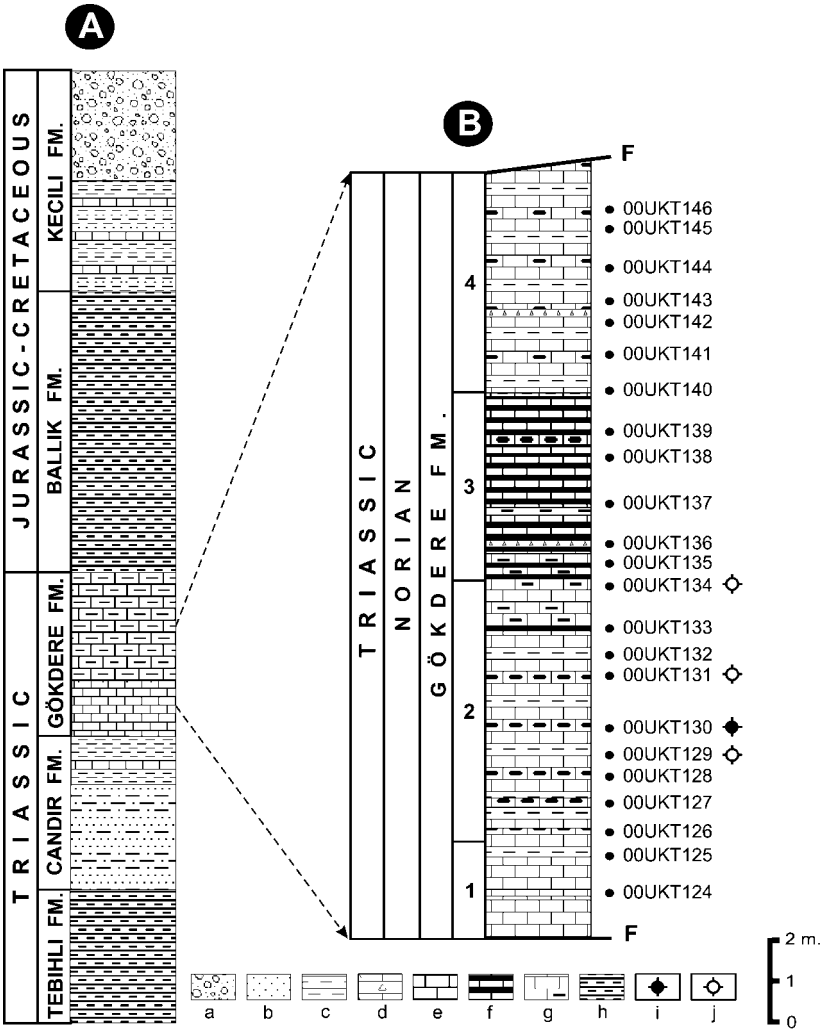


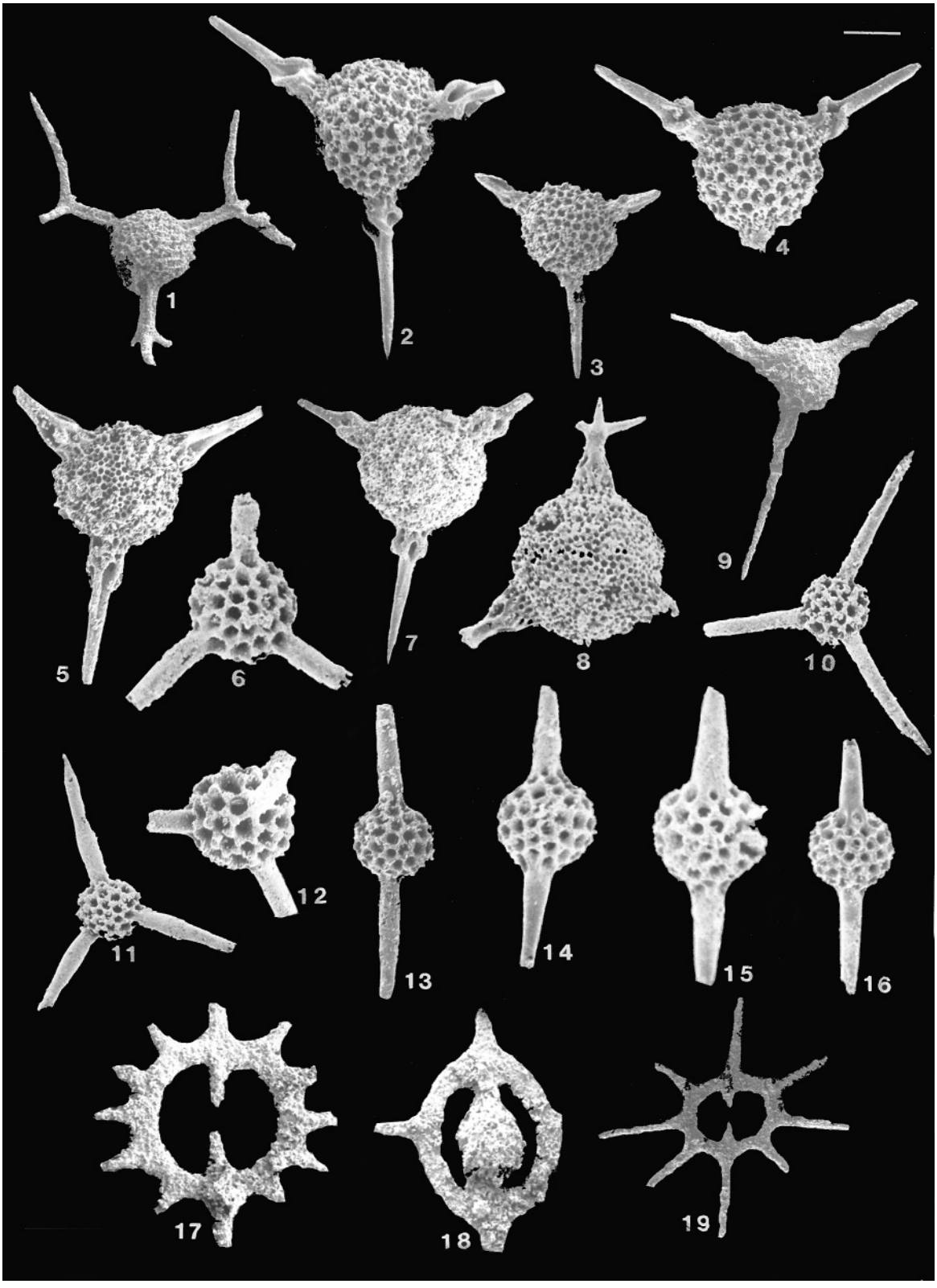
Fig. 3. (**A**) Generalized columnar section of the Alakircay Nappe of the Antalya Nappes in the study area (not to scale). (**B**) Gökcam section. Key: a, breccia and conglomerate; b, sandstone; c, shale; d, calciturbidite; e, limestone; f, limestone and chert alternations; g, limestone with chert nodules; h, chert and mudstone alternations; i, pyritized Radiolaria; j, normal Radiolaria.

18.50 m. thick and dominantly characterized by limestones. This section is subdivided into the following four units, from bottom to top (Fig. 3B):

- Unit 1, Limestone without Chert: the lowermost part of the section is mainly characterized by thin- to medium-, occasionally thick-bedded, yellowish-grey to dark grey limestone lacking chert.
- Unit 2, Cherty Limestone and Shale Alternation: limestones in this unit are thin to medium bedded and grey-beige to brownish beige in colour. Grey chert nodules are common in these limestones. Shale beds are very thin and mainly brown-yellow in colour. Well-preserved pyritized (sample 00UKT130) and moderately preserved normal late Early to early Middle Norian radiolarians (sample 00UKT129, 00UKT131 and 00UKT134) were obtained from the limestone beds of this unit.
- Unit 3, Chert and Limestone Alternation: the dominant lithologies in this unit are chert and limestone alternations with rare shale and calciturbidite intercalations. The limestones in this part of the succession are again thin to medium bedded, grey to beige in colour, while the cherts are thin bedded and dark grey in colour.
- Unit 4, Cherty Limestone and Shale Alternation with Calciturbidite Intercalations: this uppermost unit is similar to unit two. It is characterized by mainly thin- to medium-, occasionally thick-bedded, grey to beige-coloured limestone with dark grey chert nodules and thin-bedded green, greenish-grey shale interbeds. Rare thin-bedded, grey to beige calciturbidite intercalations are also encountered in this part of the succession.

MATERIALS, METHODS AND REPOSITORY

Twenty-three samples were collected both from chert nodules/bands and limestone beds of the Gökdere Formation in the Gökcam section. No radiolarians were obtained from the cherts. Moderately to well-preserved late Early to early Middle Norian radiolarians were extracted from four samples taken from the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limestone beds. Well-preserved pyritized radiolarians were found only in sample 00UKT130 (Fig. 3B).

While the limestone samples were processed with formic acid (5–10%), chert samples were etched with diluted hydrofluoric acid (5–10%) following the Pessagno & Newport (1972) method. The extracted radiolarians were studied with a stereoscopic microscope. The SEM microscope Zeiss DSM 940A in Innsbruck University, Austria was utilized for the precise identification and illustration of the radiolarians.

All holotypes and paratypes are deposited in the collection of the Natural History Museum, General Directorate of Mineral Research and Exploration, Ankara, Turkey.

SYSTEMATIC DESCRIPTIONS

In this section the following abbreviations are utilized for the measurements: HT, holotype; Min., minimum; Max., maximum; Av., average; Incl., including.

Phylum **Protozoa**
Subclass **Radiolaria** Müller, 1858
Order **Polycystina** Ehrenberg 1875
Suborder **Spumellaria** Ehrenberg, 1838
Family **Stylosphaeridae** Haeckel, 1882 emend. Kozur & Mostler, 1979
Genus *Kahlerosphaera* Kozur & Mostler, 1979

Type species. *Kahlerosphaera parvispinosa* Kozur & Mostler, 1979.

Kahlerosphaera norica Kozur & Mock, 1981
(Pl. 1, fig. 1)

1981 *Kahlerosphaera norica* Kozur & Mock in Kozur & Mostler: 36, pl. 15, fig. 4.
1997 *Kahlerosphaera norica* Kozur & Mock Group; Sugiyama: 181.
1999 *Kahlerosphaera norica* Kozur & Mock Group; Tekin: 65–66, pl. 1, figs 11–12.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian.

Occurrence. Western Carpathians; Mino Terrane, Central Japan; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Family **Capnuchosphaeridae** De Wever, 1979 emend. Pessagno, 1979 emend. Blome, 1983
Subfamily **Capnuchosphaerinae** De Wever, 1982
Genus *Kinyrosphaera* Bragin, 1999

Type species. *Kinyrosphaera trispinosa* Bragin, 1999.

Kinyrosphaera helicata Bragin, 1999
Kinyrosphaera helicata goekcamensis Tekin n. subsp.
(Pl. 1, figs 2–4)

Derivation of name. This species is named after the type locality, Gökcam District, Doyran village, Antalya City.

Diagnosis. Capnuchosphaerid with spherical, double-layered cortical shell. Outer layer of cortical shell consisting of large, polygonal pore frames with highly elevated nodes at pore frame vertices. Inner pore frames small and mainly not preserved. Three tumidispinae are situated in the same plane. Spinal tunnels of tumidispinae short, wide and strongly sinistrially twisted at distal end. Spinal shafts long and needle-like.

Holotype. From the sample 00UKT130, illustrated in Plate 1, figure 2.

Material. Nine specimens.

Type locality. Gökcam section, Antalya, southwest Turkey (see locality descriptions).

Horizon. Upper Triassic; upper Lower Norian–lower Middle Norian.

Description. Cortical shell, spherical with double-layered shell structure. Outer layer of meshwork consisting of large, polygonal (mainly hexagonal) pore frames with highly elevated nodes at pore frame vertices. Inner pore frames small, polygonal with circular to sub-circular pores. Inner pore frames occasionally observed. Three tumidispinae are situated in the same plane. Spinal tunnels of tumidispinae short, wide, sub-cylindrical with small to medium-sized pores arranged in longitudinal rows. Distal part of the spinal tunnels strongly twisted. Spinal tumours prominent. Spinal shaft, long, needle-like, circular in axial section. Usually one of the spinal shafts longer than the other spinal shafts.

Explanation of Plate 1. Scanning electron photomicrographs of late Early to early Middle Norian Spumellaria from the Gökdere Formation of the Gökcam section. Length of scale bar is number of micrometres (μm) for each figure. **fig. 1.** *Kahlerosphaera norica* Kozur & Mock, sample 00UKT130; scale bar 140 μm. **figs 2–4.** *Kinyrosphaera helicata goekcamensis* n. subsp.: **2,** holotype, sample 00UKT130, scale bar 100 μm; **3–4,** paratypes, both specimens from sample 00UKT130, scale bar 85 μm and 100 μm, respectively. **figs 5, 7.** *Nodocapnuchosphaera altineri* n. sp.: **5,** holotype, sample 00UKT130, scale bar 100 μm; **7,** paratype, sample 00UKT130, scale bar 100 μm. **fig. 6.** *Capnodoce crystallina* Pessagno, sample 00UKT130; scale bar 70 μm. **fig. 8.** *Nodocapnuchosphaera tuzcuae* Tekin, sample 00UKT130; scale bar 75 μm. **fig. 9.** *Sarla dumitricai* (Lahm), sample 00UKT129; scale bar 100 μm. **figs 10–11.** *Capnodoce serisa* De Wever, both specimens from sample 00UKT130; scale bar 140 μm and 125 μm, respectively. **fig. 12.** *Loffa* sp. A, sample 00UKT130; scale bar 75 μm. **fig. 13.** *Renzium adversum* Blome, sample 00UKT130; scale bar 75 μm. **figs 14–16.** *Renzium whalenae* n. sp.: **14,** holotype, sample 00UKT130, scale bar 55 μm; **15–16,** paratypes, both specimens from sample 00UKT130, scale bar 55 μm and 65 μm, respectively. **fig. 17.** *Palaeosaturnalis dumitricai* Tekin, sample 00UKT129; scale bar 55 μm. **fig. 18.** *Palaeosaturnalis latiannulatus* Kozur & Mostler, sample 00UKT129; scale bar 65 μm. **fig. 19.** *Praehexasaturnalis burnsensis* (Blome), sample 00UKT134; scale bar 150 μm.

Dimensions (μm). Based on six specimens.

	HT	Min.	Max.	Av.
Diameter of the cortical shell	208	178	225	199
Width of tumidispinae (proximally)	50	48	62	53
Length of tumidispinae (incl. tips)	267	238	275	260

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Kinyrosphaera helicata goekcamensis* Tekin n. subsp. differs from *K. helicata helicata* Bragin by having highly elevated outer pore frames with prominent nodes at pore frame vertices, shorter spinal tunnels and long, unequal spinal shafts.

Kinyrosphaera helicata helicata Bragin, 1999

1995 *Capnuchosphaera* ? sp. Halemic & Gorican: pl. 2, fig. 10.
1999 *Kinyrosphaera helicata* Bragin *in* Bragin & Krylov: 551, figs 5F, H, 6A.
1999 *Capnuchosphaera deweveri* Kozur & Mostler: Tekin; 70–71, pl. 3, figs 12–13.

Stratigraphic range. Late Triassic; Early Norian–early Middle Norian.

Occurrence. Croatia; Agia Varvara ViIIage, Mamonia CompIex, Cyprus; Yaylakuzdere section, Antalya, southwest Turkey.

Genus *Nodocapnuchosphaera* Tekin, 1999 emend. herein

Type species. *Nodocapnuchosphaera tuzcuae* Tekin, 1999.

Emended definition. Spinal tunnels of tumidispinae mainly very short, porous. Pores on spinal tunnels arranged in longitudinal rows. Spinal shaft may be branched off at its terminations.

Remarks. *Nodocapnuchosphaera* Tekin differs from *Kinyrosphaera* Bragin by having uniform, large nodular nodes on cortical shell.

Nodocapnuchosphaera altineri Tekin n. sp.
(Pl. 1, figs 5, 7)
1998 *Acaeniotyle* ? sp. A Cordey: 54, pl. 13, fig. 1.

Derivation of name. This species is named after Prof. Dr Demir Altiner, Middle East Technical University, Ankara, Turkey, in honour of his great contribution to the knowledge of Palaeozoic and Mesozoic foraminiferal biostratigraphy.

Diagnosis. Capnuchosphaerid with spherical, double-layered cortical shell. Three tumidispinae situated in same plane. Spinal tunnels very short, porous. Straight spinal tumours ended with spinal shafts. One of the spinal shafts longer than the others.

Holotype. From the sample 00UKT130, illustrated in Plate 1, figure 5.

Material. 11 specimens.

Type locality. Gökcam section, Antalya, southwest Turkey (see locality descriptions).

Horizon. Upper Triassic; upper Lower Norian–lower Middle Norian.

Description. Cortical shell large, spherical and double layered. Outer layer of meshwork consisting of large, polygonal pore frames. Inner pore frames with mainly hexagonal, sometimes pentagonal, smaller pore frames. Surface of cortical shell undulated related to occurrence of large, uniform nodes. Nodes separated from each other by relatively shallow depressions. Three tumidispinae extend out from cortical shell, situated in the same plane. Spinal tunnels very short, cylindrical with big pores arranged in longitudinal rows. Spinal tumours straight, not twisted. Spinal pores prominent, large, sub-circular. Spinal shaft long, triradiate in proximal part then needle like, circular in cross-section. One spinal shaft usually longer than the other spinal shafts.

Dimensions (μm). Based on five specimens.

	HT	Min.	Max.	Av.
Diameter of the cortical shell	192	192	200	197
Width of tumidispinae (proximally)	58	50	58	54
Maximum length of tumidispinae	233	216	233	223

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Hozameen Complex, British Columbia; Gökcam section, Antalya, southwest Turkey.

Remarks. *Nodocapnuchosphaera altineri* Tekin n. sp. differs from *N. tuzcuae* Tekin in having a slightly smaller cortical shell, longer tumidispinae and an absence of branching spinal shafts.

Nodocapnuchosphaera tuzcuae Tekin, 1999
(Pl. 1, fig. 8)
1999 *Nodocapnuchosphaera tuzcuae* Tekin: 81, pl. 6, figs 10–14.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian.

Occurrence. Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Subfamily **Sarlinae** De Wever, 1982
Genus *Sarla* Pessagno, 1979

Type species. *Sarla prietoensis* Pessagno, 1979.

Sarla dumitricai (Lahm, 1984)
(Pl. 1, fig. 9)
1984 *Triactoma dumitricai* Lahm: 73, pl. 13, fig. 1.
pars 1999 *Vinassaspongus transitus* Kozur & Mock; Bragin &

Krylov: 546, fig. 6D non fig. 6F (=*Sarla transitus* (Kozur & Mock).
1999 *Sarla dumitricai* (Lahm); Tekin: 86, pl. 8, figs 6, 10.

Stratigraphic range. Middle Triassic; Early Ladinian–Late Triassic; early Middle Norian.

Occurrence. Recaoro, Italy; Mamonia Complex, Cyprus; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Family **Pantanelliidae** Pessagno, 1977 emend. Pessagno & Blome, 1980
Subfamily **Capnodocinae** Pessagno, 1979 emend. Blome, 1983

Genus *Capnodoce* De Wever, 1979 emend Pessagno, 1979

Type species. *Capnodoce anapates* De Wever, 1979.

Capnodoce crystallina Pessagno, 1979 Group
(Pl. 1, fig. 6)
1979 *Capnodoce crystallina* Pessagno *in* Pessagno, Finch & Abbott: 176, pl. 1, figs 1–3.
1983 *Capnodoce antiqua* Blome: 24, pl. 5, figs 4, 12, 17.
1984 *Capnodoce antiqua* Blome; Blome: 33, pl. 4, fig. 6.
1984 *Capnodoce crystallina* Pessagno; Blome: 34.
1986 *Capnodoce antiqua* Blome; Yoshida: pl. 10, figs 4, 5.
1986 *Capnodoce crystallina* Pessagno; Sato, Murata & Yoshida: figs 16 (11–12).
1986 *Capnodoce antiqua* Blome; Bragin: pl. 2, fig. 1.
1991 *Capnodoce antiqua* Blome; Bragin: 83, pl. 6, fig. 10.
1997 *Capnodoce* cf. *antiqua* Blome; Knipper, Satian & Bragin: pl. 1, fig. 2.
1997 *Capnodoce crystallina* Pessagno Group; Sugiyama: 175, fig. 49 (17).
1999 *Capnodoce crystallina* Pessagno Group; Tekin: 92–93, pl. 11, figs 2–3.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian–?late Middle Norian.

Occurrence. Baja California Sur, Mexico; southwest and central Japan; East-Central Oregon, USA; Far east Russia; Sevan-Akera, Lesser Caucasus; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Capnodoce serisa De Wever, 1979
(Pl. 1, figs 10–11)
pars 1979 *Capnodoce serisa* De Wever *in* De Wever, San Flippo, Riedel & Gruber: 82, pl. 2, fig. 9 non pl. 2, fig. 8 (=*Loffa* sp.).
1979 *Capnodoce serisa* De Wever; Nakaseko & Nishimura: 75, pl. 6, figs 1, 2.
non 1981 *Capnodoce serisa* De Wever; Kozur & Mostler: pl. 63, fig. 2 (=*Capnodoce longibrachium* Tekin).
1982 *Capnodoce serisa* De Wever; De Wever: 143–145, pl. 3, figs 1–3.
1982 *Capnodoce serisa* De Wever; Yao: pl. 2, fig. 24.
1982 *Capnodoce serisa* De Wever; Yao, Matsuoka & Nakatani: pl. 1, fig. 22.
1982 *Capnodoce serisa* De Wever; Kishida & Sugano: pl. 2, fig. 6.
1982 *Capnodoce serisa* De Wever; Sato, Nishizono & Murata: pl. 2, fig. 6.
1983 *Capnodoce serisa* De Wever; Nishizono & Murata: pl. 2, fig. 9.
1983 *Capnodoce fragilis* Blome: 26, pl. 6, figs 4, 10, 18, pl. 11, fig. 5.
1984 *Capnodoce fragilis* Blome; Blome: 34, pl. 4, fig. 11.
1986 *Capnodoce serisa* De Wever; Sato, Murata & Yoshida: fig. 16 (10).
1986 *Capnodoce fragilis* Blome; Yoshida: pl. 10, fig. 6.
1989 *Capnodoce fragilis* Blome; Carter, Orchard & Tozer: pl. 1, fig. 10.
1991 *Capnodoce fragilis* Blome; Carter: 199, pl. 1, figs 1, 6.
1996 *Capnodoce fragilis* Blome; Yeh & Cheng: pl. 10, figs 1, 5.
1997 *Capnodoce serisa* De Wever; Sugiyama: 175, fig. 49 (16).
1999 *Capnodoce serisa* De Wever; Tekin: 94–95, pl. 11, figs 12–13.

Stratigraphic range. Late Triassic; Early Norian–Late Norian.

Occurrence. Sicily, Italy; Ispartacay, Isparta and Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey; southwest and central Japan; East-Central Oregon, USA; Queen Charlotte Islands, British Columbia, Canada; Busuanga Island, Philippines.

Genus *Loffa* Pessagno, 1979

Type species. *Loffa mulleri* Pessagno, 1979.

Loffa sp. A
(Pl. 1, fig. 12)

Description. Cortical shell with coarse pentagonal and hexagonal pore frames with massive nodes at vertices. Primary spines short, tubular, straight and maintaining approximately same diameter over all length.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Loffa* sp. A in this study differs from *L. vesterensis* Blome in having a spherical cortical shell and shorter primary spines that are the same diameter over all their length.

Genus *Renzium* Blome, 1983

Type species. *Renzium webergorum* Blome, 1983.

Renzium adversum Blome, 1983
(Pl. 1, fig. 13)
1983 *Renzium adversum* Blome: 40, 42, pl. 10, figs 1, 6, 7, 12.
1984 *Renzium adversum* Blome; Blome: 36, pl. 5, fig. 2.
1999 *Renzium adversum* Blome; Tekin: 96, pl. 12, fig. 5.

Stratigraphic range. Late Triassic; Early Norian–early Middle Norian–?late Middle Norian.

Occurrence. East-Central Oregon, USA; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Renzium whalenae Tekin n. sp.
(Pl. 1, figs 14–16)

Derivation of name. This species is named after Dr Patricia A. Whalen, University of Arkansas, USA, in honour of her contribution to the study of Liassic radiolarian biostratigraphy.

Diagnosis. A species of *Renzium* with a spherical to sub-spherical cortical shell. Meshwork consisting of pentagonal and hexagonal pore frames. Primary spines moderately long, tubular, unequal, tapering distally.

Holotype. From the sample 00UKT130, illustrated in Plate 1, figure 14.

Material. Eight specimens.

Type locality. Gökcam section, Antalya, southwest Turkey (see locality descriptions).

Horizon. Upper Triassic; upper Lower Norian–lower Middle Norian.

Description. Cortical shell small, spherical to sub-spherical in outline. Meshwork consists of a mixture of pentagonal and hexagonal (predominantly hexagonal) pore frames. Pore frame vertices with very short, rounded nodes. Bars of pore frames thinner along Y than Z. Six to seven pores visible on cortical shell along an axis in line with polar spines. Primary spines moderately long, tubular, unequal and tapering distally. No triradiate distal portion visible.

Dimensions (μm). Based on five specimens.

	HT	Min.	Max.	Av.
Diameter of the cortical shell (perpendicular to main spines)	93	91	100	95
Length of short primary spines	80	80	83	81
Length of long primary spines	93	86	118	102
Max. width of primary spines	20	20	27	24

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Renzium whalenae* Tekin n. sp. differs from *Renzium adversum* Blome in having unequal, shorter and tapering main spines.

Family **Acanthocircidae** Pessagno, 1977
Genus *Palaeosaturnalis* Donofrio & Mostler, 1978 emend. Kozur & Mostler, 1983

Type species. *Spongosaturnalis triassicus* Kozur & Mostler, 1972.

Palaeosaturnalis dumitricai Tekin, 1999
(Pl. 1, fig. 17)

1991 *Palaeosaturnalis karnicus* (Kozur & Mostler); Bragin: 92, pl. 6, fig. 11.
1999 *Palaeosaturnalis dumitricai* Tekin: 109, pl. 16, figs 4–6.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian.

Occurrence. Far East Russia; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Palaeosaturnalis latiannulatus Kozur & Mostler, 1983
(Pl. 1, fig. 18)

1983 *Palaeosaturnalis latiannulatus* Kozur & Mostler: 20, pl. 5, fig. 1.
1999 *Palaeosaturnalis latiannulatus* Kozur & Mostler; Bragin & Krylov: 556, fig. 9D.
1999 *Palaeosaturnalis latiannulatus* Kozur & Mostler; Tekin: 110, pl. 11, figs 1–2.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian.

Occurrence. Western Carpathians; Agia Varvara Village, Mamonia Complex, Cyprus; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Genus *Praehexasaturnalis* Kozur & Mostler, 1983

Type species. *Palaeosaturnalis tenuispinosus* Donofrio & Mostler, 1978.

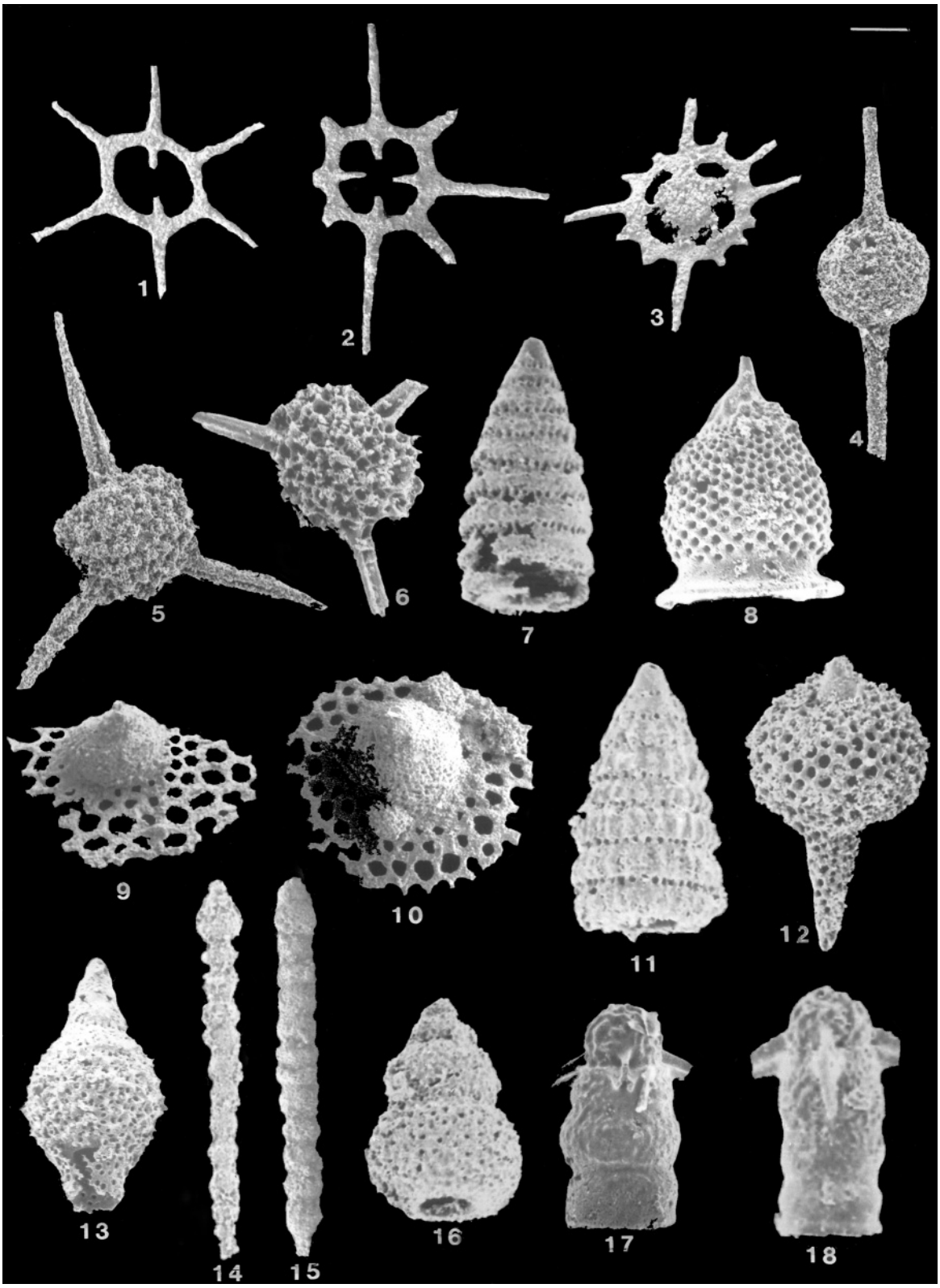
Praehexasaturnalis burnsensis (Blome, 1984)
(Pl. 1, fig. 19)

1984 *Acanthocircus burnsensis* Blome: 21–22, pl. 1, figs 1, 11.
1984 *Acanthocircus lupheri* Blome: 23–24, pl. 1, figs 10, 18.
1984 *Acanthocircus macoyensis* Blome: 24, pl. 2, figs 1, 12.
1984 *Acanthocircus ochocoensis* Blome: 24, pl. 2, figs 2, 13.
1984 *Acanthocircus prinevillensis* Blome: 24, pl. 2, figs 3, 14.
1990 *Praehexasaturnalis burnsensis* (Blome); Kozur & Mostler: 194.
1991 *Palaeosaturnalis prinevillensis* (Blome); Yang & Mizutani: 66–67, pl. 2, figs 7, 8; pl. 3, figs 3, 5, 9.
1998 *Palaeosaturnalis prinevillensis* (Blome); Carter, Whalen & Guex: 54, pl. 14, figs ?19, 23.
1999 *Praehexasaturnalis burnsensis* (Blome); Tekin: 111–112, pl. 18, fig. 1.

Stratigraphic range. Late Triassic; late Early Norian–Early Jurassic; Sinemurian.

Occurrence. East-Central Oregon, USA; northeast China; Queen Charlotte Islands, British Columbia, Canada; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Praehexasaturnalis tenuispinosus (Donofrio & Mostler, 1978)
(Pl. 2, fig. 1)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1978 *Palaeosaturnalis tenuispinosus* Donofrio & Mostler: 37–38, pl. 7, figs 1–3, 8.
1979 *Spongosaturnalis* sp. cf. *S. elegans* Kozur & Mostler; De Wever, San Flippo, Riedel & Gruber: 81, pl. 2, figs 3, 4.
1982 *Palaeosaturnalis* aff. *tenuispinosus* Donofrio & Mostler; Yao: pl. 3, fig. 17.
1982 *Acanthocircus tenuispinosus* (Donofrio & Mostler); De Wever: 206–207, pl. 13, figs 3–5.
1983 *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler); Kozur & Mostler: 30.
1984 *Acanthocircus vigrassi* Blome: 26, pl. 2, figs 9–10.
1986 *Acanthocircus* cf. *A. elegance* Kozur & Mostler; Yoshida: pl. 15, figs 8, 9.
1990 *Acanthocircus tenuispinosus* (Donofrio & Mostler); Yeh: 17, pl. 13, fig. 3.
1990 *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler); Kozur & Mostler: 194.
1997 *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler); Sugiyama: 185, figs. 51 (9, 10).
1999 *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler); Tekin: 112, pl. 18, fig. 2.

Stratigraphic range. Late Triassic; late Early Norian–Early Jurassic; Hettangian.

Occurrence. Poetschen, Austria; Ispartacay Formation, Isparta and Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey; East-Central Oregon, USA; Inuyama Area, Gifu Prefecture and Mino Terrane Central Japan; Busuanga Island, Philippines.

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

Type species. *Pseudoheliodiscus concordis* De Wever, 1981.

Stauroacanthocircus dickinsoni (Yeh, 1989) n. comb.
(Pl. 2, fig. 2)
1989 *Quadrisaturnalis dickinsoni* Yeh: 50, pl. 13, fig. 18.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. East-Central Oregon, USA; Gökcam section, Antalya, southwest Turkey.

Remarks. *Quadrisaturnalis* Yeh, 1989, with four polar spines in cross-section is a junior synonym of *Stauroacanthocircus* Kozur & Mostler, 1983.

Stauroacanthocircus ?poetschensis Kozur & Mostler, 1990
(Pl. 2, fig. 3)
1990 *Stauroacanthocircus ?poetschensis* Kozur & Mostler: 199–200, pl 7, fig. 8, pl. 8, figs 1, 4.
1999 *Stauroacanthocircus ?poetschensis* Kozur & Mostler; Tekin: 116, pl. 19, figs 7–8.

Stratigraphic range. Late Triassic; Early Norian–Middle Norian.

Occurrence. Pötschenwand, Austria; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Spumellariina Incertae Sedis
Genus *Harsa* Carter, 1991

Type species. *Harsa siscwaiensis* Carter, 1991.

Harsa siscwaiensis Carter, 1991
(Pl. 2, fig. 5)
1991 *Harsa siscwaiensis* Carter: 199–200, pl. 1, fig. 2.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Queen Charlotte Islands, British Columbia; Gökcam section, Antalya, southwest Turkey.

Harsa sp. aff. *H. siscwaiensis* Carter, 1991
(Pl. 2, fig. 6)
1991 *Harsa* sp. aff. *H. siscwaiensis* Carter: 200, pl. 1, fig. 3.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Queen Charlotte Islands, British Columbia; Gökcam section, Antalya, southwest Turkey.

Genus *Xiphosphaera* Haeckel, 1882

Type species. *Xiphosphaera tredicomporata* Rüst, 1885.

Explanation of Plate 2. Scanning electron photomicrographs of late Early to early Middle Norian Spumellaria and Nassellaria from the Gökdere Formation of the Gökcam section. Length of scale bar is number of micrometres (μm) for each figure. **fig. 1.** *Praehexasaturnalis tenuispinosus* (Donofrio & Mostler), sample 00UKT134; scale bar 120 μm. **fig. 2.** *Stauroacanthocircus dickinsoni* (Yeh), sample 00UKT134; scale bar 130 μm. **fig. 3.** *Stauroacanthocircus* ? *poetschensis* Kozur & Mostler, sample 00UKT134; scale bar 130 μm. **fig. 4.** *Xiphosphaera fistulata* Carter, sample 00UKT129; scale bar 65 μm. **fig. 5.** *Harsa siscwaiensis* Carter, sample 00UKT130; scale bar 100 μm. **fig. 6.** *Harsa* sp. aff. *H. siscwaiensis* Carter, sample 00UKT130; scale bar 75 μm. **fig. 7.** *Japonocampe nova* (Yao), sample 00UKT130; scale bar 75 μm. **fig. 8.** *Deflandrecyrtium parvus* Tekin, sample 00UKT130; scale bar 50 μm. **figs 9–10.** *Haeckelicyrtium* sp. A: **9,** sample 00UKT134, scale bar 120 μm; **10,** sample 00UKT129, scale bar 100 μm. **fig. 11.** *Whalenella regia* (Blome), sample 00UKT130; scale bar 75 μm. **fig. 12.** *Syringocapsa* sp. aff. *S. batodes* De Wever, sample 00UKT130; scale bar 75 μm. **fig. 13.** *Syringocapsa* sp. A, sample 00UKT130; scale bar 50 μm. **fig. 14.** *Xiphotheca longa* Kozur & Mock, sample 00UKT130; scale bar 100 μm. **fig. 15.** *Xiphotheca pseudolonga* Tekin, sample 00UKT134; scale bar 110 μm. **fig. 16.** *Canesium lentum* Blome, sample 00UKT130; scale bar 55 μm. **figs 17–18.** *Enoplocampe*(?) *norica* n. sp.: **17,** holotype, sample 00UKT130, scale bar 45 μm; **18,** paratype, sample 00UKT130, scale bar 45 μm.

Xiphosphaera fistulata Carter, 1991
(Pl. 2, fig. 4)

1991 *Xiphosphaera fistulata* Carter: 200, pl. 1, figs 4, 5, 7, 8, 9, 10.
?1996 Unnamed Spumellaria Yeh & Cheng: pl. 11, figs 11, 16.
1997 *Xiphosphaera fistulata* Carter; Sugiyama: 188, fig. 50 (27).
1999 *Xiphosphaera fistulata* Carter; Tekin: 123, pl. 23, figs 4–6.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Queen Charlotte Islands, British Columbia, Canada; ?Busuanga Island, Philippines; Mino Terrane, Central Japan; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Suborder **Nassellaria** Ehrenberg, 1875
Family **Canoptidae** Pessagno, 1979
Genus *Japonocampe* Kozur, 1984

Type species. *Triassocampe nova* Yao, 1982.

Japonocampe nova (Yao, 1982) Group
(Pl. 2, fig. 7)

1980 *Dictyomitrella* sp. B Yao, Matsuda & Isozaki: pl. 3, figs 1–3.
1982 *Triassocampe nova* Yao: 59–60, pl. 2, figs 1–4.
1982 *Triassocampe nova* Yao; Yao, Matsuoka & Nakatani, pl. 1, fig. 14.
1984 *Japonocampe nova* (Yao); Kozur: 72.
1986 *Triassocampe nova* Yao; Bragin: pl. 3, fig. 4.
1986 *Triassocampe nova* Yao; Yoshida: pl. 4, figs 7, 8.
1991 *Triassocampe nova* Yao; Bragin: 101, pl. 5, figs 12, 16.
non 1995 *Triassocampe nova* Yao; Blome & Reed: 62, pl. 2, fig. 17.
1997 *Japonocampe nova* (Yao); Sugiyama: 181, fig. 50 (1)
1999 *Japonocampe nova* (Yao) Group; Tekin: 138, pl. 29, figs 3–5.

Stratigraphic range. Late Triassic; Late Carnian–Middle Norian.

Occurrence. Inuyama Area, Gifu Prefecture and Mino Terrane, Central Japan; Sahalin, Sikhote-Alin, far eastern Russia; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Family **Deflandrecyrtiidae** Kozur & Mostler, 1979
Genus *Deflandrecyritium* Kozur & Mostler, 1979

Type species. *Deflandrecyritium popofskyi* Kozur & Mostler, 1979.

Deflandrecyrtium parvus Tekin, 1999
(Pl. 2, fig. 8)

pars 1979 Unnamed Nassellaria Pessagno, Finch & Abbott: pl. 5, only fig. 6.
1982 *Squinabolella* (?) sp. B Yao: pl. 2, fig. 20.
1996 Unnamed Nassellaria Yeh & Cheng: pl. 11, figs (?)1, (?)2, (?)12, 14 and 15.
1997 *Haeckelicyrtium* sp. A Sugiyama: 156, fig. 41 (9).
1999 *Deflandrecyrtium parvus* Tekin: 141–142, pl. 30, figs 9–10.
?2000 *Haeckelicyrtium* sp. A Carter & Orchard: pl. 2, fig. 12.

Stratigraphic range. Late Triassic; Late Carnian–early Middle Norian–?late Middle Norian.

Occurrence. Baja California Sur, Mexico**;** Inuyama Area and Mino Terrane, Central Japan; Busuanga Island, Philippines; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey; ?Queen Charlotte Islands, British Columbia.

Genus *Haeckelicyrtium* Kozur & Mostler, 1979 emend. Carter, 1993

Type species. *Haeckelicyrtium austriacum* Kozur & Mostler, 1979.

Haeckelicyrtium sp. A
(Pl. 2, figs 9–10)

Description. Cephalis dome shaped, imperforate without horn. Thorax bonnet shaped with small pores. Short abdomen flaring to mainly flat and wide post-abdominal skirt. Three rows of pores situated on post-abdominal skirt. Pore size increasing in width distally.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Haeckelicyrtium* sp. A differs from *H. subcircularis* Tekin by having three rows of pores on abdominal skirt instead of four rows of pores. The former is also differentiated from the latter in having big circular pores on the last row instead of perpendicularly arranged ellipsoidal pores.

Family **Syringocapsidae** Foreman, 1973 emend. Pessagno, 1977
Genus *Syringocapsa* Neviani, 1900

Type species. *Theosyringium robustum* Vinassa, 1901.

Syringocapsa sp. aff. *S. batodes* De Wever, 1979
(Pl. 2, fig. 12)

aff. 1979 *Syringocapsa batodes* De Wever *in* De Wever, San Filippo, Riedel & Gruber: 292–293, pl. 6, figs 10–12.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. This form differs from *Syringocapsa batodes* De Wever by having very short proximal (cephalis, thorax and abdomen) part.

Syringocapsa sp. A
(Pl. 2, fig. 13)

Description. Test as for genus. Cephalis is dome shaped, imperforate without horn. Thorax and abdomen are sub-cylindrical, imperforate with nodes. Post-abdominal segment inflated with scattered small sub-circular to circular pores. Remnant of tube is at the distal end with small sub-circular pores.

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Syringocapsa* sp. A differs from *S. turgida* Blome in having less inflated post-abdominal segment with small, scattered pores instead of pentagonal pore frames with large pores.

Family **Xiphotecidae** Kozur & Mostler, 1981
Genus *Xiphotheca* De Wever, 1979

Type species. *Xiphotheca karpenissionensis* De Wever, 1979.

Xiphotheca longa Kozur & Mock, 1981 emend. Tekin, 1999
(Pl. 2, fig. 14)

1979 *Xiphotheca* sp. Pessagno, Finch & Abbott: pl. 5, fig. 5.
1981 *Xiphotheca longa* Kozur & Mock *in* Kozur & Mostler: 113–114, pl. 41, fig. 2.
1986 *Xiphotheca karpenissionensis* De Wever; Sato, Murata & Yoshida: fig. 16 (14).
1989 *Xiphotheca longa* Kozur & Mock; Yeh: 71, pl. 8, fig. 1.
1992 *Xiphotheca karpenissionensis* De Wever; Otsuka, Kajima & Hori: pl. 3, figs 17–18.
1992 *Xiphotheca* cf. *longa* Kozur & Mock; Otsuka, Kajima & Hori: pl. 3, fig. 19.
1999 *Xiphotheca longa* Kozur & Mock; Bragin & Krylov: 567, figs. 13 (E–G).
emend. 1999 *Xiphotheca longa* Kozur & Mock; Tekin: 174, pl. 42, figs 13–14.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian–?late Middle Norian.

Occurrence. Baja California, Mexico; West Karpats; Oman; East-Central Oregon, USA; Kyushu, Japan; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Xiphotheca pseudolonga Tekin, 1999
(Pl. 2, fig. 15)

1999 *Xiphotheca pseudolonga* Tekin: 174–175, pl. 42, figs 8–11.

Stratigraphic range. Late Triassic; Early Norian–early Middle Norian.

Occurrence. Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

Nassellaria Incertae Sedis
Genus *Canesium* Blome, 1984

Type species. *Canesium lentum* Blome, 1984.

Canesium lentum Blome, 1984
(Pl. 2, fig. 16)

1979 *Eucyritidium* (?)sp. A Nakaseko & Nishimura: 78, pl. 9, figs 5, 9.
1982 *Eucyritidium* (?)sp. A Yao: pl. 2, figs 9–10.
1982 *Eucyritidium* (?)sp. A Yao, Matsuoka & Nakatani: pl. 1, fig. 17.
1984 *Canesium lentum* Blome: 53–54, pl. 14, figs 3, 8, 11; pl. 17, figs 13.
1986 *Canesium lentum* Blome; Yoshida: pl. 6, figs 1, 2.
1999 *Canesium lentum* Blome; Tekin: 177, pl. 43, fig. 12.
2000 *Canesium lentum* Blome; Carter & Orchard: pl. 2, fig. 6

Stratigraphic range. Late Triassic; Late Carnian–early Middle Norian–?late Middle Norian.

Occurrence. Inuyama Area and Gifu Prefecture, Central Japan; East-Central Oregon, USA; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey; Queen Charlotte Islands, British Columbia.

Genus *Enoplocampe* Sugiyama, 1997

Type species. *Enoplocampe yehae* Sugiyama, 1997.

Enoplocampe (?) *norica* Tekin n. sp.
(Pl. 2, figs 17–18)

Derivation of name. This species is named after its appearance in the Norian.

Diagnosis. Cylindrical form with one or two post-abdominal segments. All segments imperforate with small nodes. Cephalis, hemispherical to dome shaped, with or without a very rudimentary horn. The remainder of the segments are barrel shaped. Thorax with three short to moderately long tricarinate arms.

Holotype. From the sample 00UKT130, illustrated in Plate 2, figure 17.

Material. Six specimens.

Type locality. Gökcam section, Antalya, southwest Turkey (see locality descriptions).

Horizon. Upper Triassic; upper Lower Norian–lower Middle Norian.

Description. Test mainly cylindrical in outline with one or two post-abdominal segments. All segments of the form are imperforate with small nodes. Cephalis, hemispherical to dome shaped, with or without a very rudimentary horn. Thorax barrel shaped with three, short to moderately long triradiate arms with wide grooves and thin ridges, curved inside. Both collar and lumbar strictures marked by shallow depressions. Abdomen barrel shaped, sometimes more inflated than the other segments. The shape of the post-abdominal segments are the same as the thorax and abdomen.

Dimensions (μm). Based on four specimens.

	HT	Min.	Max.	Av.
Total length of the form	183	172	183	178
Max. width of the form	96	78	96	86

Taxa	Sample Number 00UKT129	00UKT130	00UKT131	00UKT134
Kahlerosphaera norica	+	+	+	+
Kinyrosphaera helicata goekcamensis n. subsp.	+	+	?	+
Nodocapnuchosphaera altineri n. sp.	+	+	?	+
Nodocapnuchosphaera tuzcuae	+	+		
Sarla dumitricai	+			
Capnodoce crystallina	+	+	+	+
Capnodoce serisa	+	+	+	+
Loffa sp. A		+		
Renzium adversum	+	+		
Renzium whalenae n. sp.	+	+	+	+
Palaeosaturnalis dumitricai	+	+	+	+
Palaeosaturnalis latiannulatus	+	+	+	+
Praehexasaturnalis burnsensis	+	?	+	+
Praehexasaturnalis tenuispinosus	+	+	+	+
Stauroacanthocircus dickinsoni	+	?	?	+
Stauroacanthocircus ?poetschensis	+	?	+	+
Harsa siscwaiensis		+	+	+
Harsa sp. aff. *H. siscwaiensis*		+	?	+
Xiphosphaera fistulata	+	+	?	+
Japonocampe nova		+	?	+
Deflandrecyrtium parvus		+	?	+
Haeckelicyrtium sp. A	+	?	?	+
Whalenella regia	+	+		
Syringocapsa sp. aff. *S. batodes*		+		
Syringocapsa sp. A		+		
Xiphotheca longa	+	+	+	+
Xiphotheca pseudolonga	+	+	+	+
Canesium lentum		+	?	+
Enoplocampe ?norica n. sp.		+		

Table 1. Distribution of the late Early to early Middle Norian radiolarians from the Gökdere Formation of the Gökçam section

Stratigraphic range. Late Triassic; late Early Norian–early Middle Norian.

Occurrence. Gökcam section, Antalya, southwest Turkey.

Remarks. *Enoplocampe* (?) *norica*Tekin n. sp. is differentiated from *E. yehae* Sugiyama in having a cephalis without a horn or a rudimentary horn, and shorter and wider arms extending out from thorax. This form is tentatively assigned to *Enoplocampe* Sugiyama due to absence or presence of a very rudimentary apical horn.

Genus *Whalenella* Kozur, 1984

Type species. *Dictyomitra arrecta* Hinde, 1908.

Whalenella regia (Blome, 1984)
(Pl. 2, fig. 11)

1984 *Corum regium* Blome: 51, pl. 13, figs 3, 8, 15.
1986 *Corum regium* Blome; Yoshida: pl. 5, fig. 4.
1993 *Corum regium* Blome; Fujii, Hattori & Nakajima: pl. 3, fig. 7.
1994 *Corum regium* Blome; Aita & Spörli: pl. 7, fig. 5.
1995 *Whalenella* cf. *regia* (Blome); Halemic & Gorican: pl. 1, figs 21–22.
?1997 *Corum regium* Blome; Sugiyama: 176, fig. 49 (4).
1999 *Corum regium* Blome; Tekin: 153, pl. 35, figs 10–11.

Stratigraphic range. Late Triassic; latest Carnian/earliest Norian–early Middle Norian–?late Middle Norian.

Occurrence. East-Central Oregon, USA; Gifu Prefecture and (?) Mino Terrane, Central Japan; Yaylakuzdere and Gökcam sections, Antalya, southwest Turkey.

DATING AND COMPARISION OF THE RADIOLARIAN FAUNA

A rich radiolarian fauna has been recovered from the Gökdere Formation of the Gökcam section. Twenty-nine radiolarian taxa have been determined within this fauna (Table 1). Radiolarians obtained from the section are comparable to faunas from the Queen Charlotte Islands, British Columbia (Carter, 1991) and the Yaylakuzdere section, Kemer, Antalya, southwest Turkey (Tekin, 1999).

Within the fauna, *Capnodoce serisa*, *Harsa siscwaiensis*, *Xiphosphaera fistulata* and Saturnalids are very common. According to Carter (1991), Sugiyama (1997) and Tekin (1999), *Xiphosphaera fistulata* is restricted to the late Early to early Middle Norian in central Japan, the Queen Charlotte Islands (British Columbia) and southwest Turkey. Both *Harsa siscwaiensis* and *H.* sp. aff. *H. siscwaiensis* are only known from the upper Lower to lower Middle Norian strata of the Queen Charlotte Islands (British Columbia). This is similar to *Xiphosphaera fistulata* (Carter, 1991).

According to Carter (1991), although *Capnodoce fragilis* (junior synonym of *C. serisa*) has a range from the Early Norian (*E. abneptis* Conodont Zone) to the Middle Norian; its acme occurs in the late Early Norian (*E. triangularis* Conodont Zone) in Queen Charlotte Islands (British Columbia). Similarly, Tekin (1999) has observed that *C. serisa* first occurs at the top of *E. abneptis* Zone, and then becomes abundant in the *E. triangularis* Conodont Zone.

Saturnalids such as *Praehexasaturnalis burnsensis*, *P. tenuispinosus* and *Stauroacanthocircus ?poetschensis* are very abundant within the fauna from Gökdere Formation in Gökcam section. Both *Praehexasaturnalis burnsensis* and *P. tenuispinosus* first appear in the late Early Norian (*E. triangularis* Conodont Zone) (Tekin, 1999). According to Tekin (1999), *Stauroacanthocircus ?poetschensis* first appears in the upper part of the *E. abneptis* Conodont Zone, and becomes abundant in the *E. triangularis* Conodont Zone in the southwest Turkey. The common occurrence of *Paleosaturnalis lupheri*, *P. macoyoensis* (junior synonym of *Praehexasaturnalis burnsensis*) and *P. vigrassi* (junior synonym of *Praehexasaturnalis tenuispinosus*) is also reported from the upper Lower Norian strata of the Queen Charlotte Islands, British Columbia (Carter, 1991).

Based on these data, the age of the fauna obtained from the Gökdere Formation of the Gökcam section can be assigned a late Early Norian to early Middle Norian age and the radiolarian association of '*Capnodoce serisa* (senior synonym of *C. fragilis*)–*Harsa siscwaiensis*–*Xiphosphaera fistulata*' suggested by Carter (1991) for upper Lower Norian to lower Middle Norian strata can be adopted in this study.

CONCLUSIONS

The Gökdere Formation in the Alakircay Nappe of the Antalya Nappes is represented by limestone and cherty limestone with chert bands and calciturbidite intercalations. Moderately to well-preserved radiolarians were obtained from the limestone horizons in the Gökdere Formation of the Gökcam section, to the west of Antalya City, southwest Turkey.

Radiolarians obtained from the section are correlated with faunas from the Queen Charlotte Islands, British Columbia (Carter, 1991) and the Yaylakuzdere section, Kemer, Antalya, southwest Turkey (Tekin, 1999). The co-occurrence of *Capnodoce serisa*, *Harsa siscwaiensis*, *Xiphosphaera fistulata* and saturnalids, such as *Praehexasaturnalis burnsensis*, *P. tenuispinosus*, *Stauroacanthocircus ?poetschensis*, clearly indicates a late Early Norian to early Middle Norian age for this part of the Gökdere Formation.

Within the radiolarian fauna, four taxa have been determined as new (*Kinyrosphaera helicata goekcamensis*, *Nodocapnuchosphaera altineri*, *Renzium whalenae*, *Enoplocampe* (?) *norica*).

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