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# RADIOLARIANS AND FACIES OF THE MIDDLE TRIASSIC LOIBL FORMATION, SOUTH ALPINE KARAWANKEN MOUNTAINS (CARINTHIA, AUSTRIA)

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With 7 figures, 1 table and 13 plates

**Abstract:**

A geologic interpretation of the microfacies of Middle Triassic red pelagic limestones (Loibl Formation) of the South Alpine South Karawanken Mountains is given. The lowermost part of these limestones (Weiße Wand Member) contains a very rich radiolarian fauna. It has transitional character between the typical Illyrian radiolarian fauna of the upper *Paraceratites trinodosus* ammonoid zone and the typical Ladinian radiolarian fauna of the *Reitziites reitzi* ammonoid zone s.str. (defined by the first appearance of *Reitziites reitzi*), both well dated by ammonoids in the Felsőőrs section of the Balaton Highland (Hungary). Illyrian species clearly dominate, but first Ladinian species are subordinately present. Few species are restricted to this fauna. This association can be recognized also in the Balaton Highland (KOZUR & MOSTLER, 1994), in Slovenia (GORIČAN & RAMOVŠ, 1995), Japan (NAKASEKO & NISHIMURA, 1979) and in China (FENG, QINGLAI, 1992 and FENG, QINGLAI & LIU, BENPEI, 1993), in the two latter areas stratigraphically misinterpreted. The radiolarian fauna of the Weiße Wand Member defines the *Tiborella florida* Subzone of the *Spongosilicarmiger transitus* Zone and it is assigned to the uppermost Anisian (upper Illyrian), whereas, according to its conodont fauna, the largest part of the Loibl formation belongs to the Ladinian.

One new family, two new genera, 24 new species and two new subspecies are described.

**Zusammenfassung:**

Die Mikrofazies der mitteltriassischen roten pelagischen Kalke der Loibl Formation der südalpinen Südkarawanken wird beschrieben und geologisch interpretiert. Der unterste Teil dieser Kalke (Weiße-Wand-Member) enthält eine sehr reiche Radiolarienfauna. Sie hat Übergangscharakter zwischen der typisch illyrischen Radiolarienfauna der *Paraceratites trinodosus*-Ammonitenzone und der typisch ladinischen Radiolarienfauna der *Reitziites reitzi*-Ammonitenzone s.str. (Basis definiert mit dem ersten Einsetzen von *Reitziites reitzi*), die beide mit Ammoniten im Felsőőrs-Profil des Balaton-Hochlandes (Ungarn) gut definiert sind. Illyrische Arten dominieren bei weitem, aber erste ladinische Arten sind untergeordnet vorhanden. Wenige Arten sind auf diese Übergangsfauna beschränkt. Diese Radiolarien-Assoziation kann auch im Balaton-Hochland (KOZUR & MOSTLER, 1994), in Slowenien (RAMOVŠ & GORIČAN, 1995), in Japan (NAKASEKO & NISHIMURA, 1979) und in China (FENG, QINGLAI, 1992 and FENG, QINGLAI & LIU, BENPEI, 1993) nachgewiesen werden, wurde aber in den beiden letzteren Gebieten stratigraphisch fehlinterpretiert. Die Radiolarienfauna des Weiße-Wand-Members repräsentiert die *Tiborella florida*-Subzone der *Spongosilicarmiger transitus*-Zone. Sie wird in das obere Illyr (oberstes Anis) gestellt, während der größte Teil der Loibl-Formation nach der Conodontenfauna ins Ladin gehört.

Eine neue Familie, zwei neue Gattungen, 24 neue Arten und zwei neue Unterarten werden beschrieben

## 1. Introduction

The occurrence of red pelagic limestones in the South Alpine Triassic of the Karawanken Mountains was first mentioned by PREY (1973, 1975). From these limestones BAUER (1980) reported ammonites of Early Ladinian age from outcrops along the Zelenica forest road NW of the Loibltun-

nel in the central Karawanken Mountains. Despite a detailed sedimentological and stratigraphical analysis, these limestones have been compared and correlated with the Schreyeralm Limestone of the Northern Calcareous Alps and dated as Late Anisian - Early Ladinian (BAUER 1980, 1984).

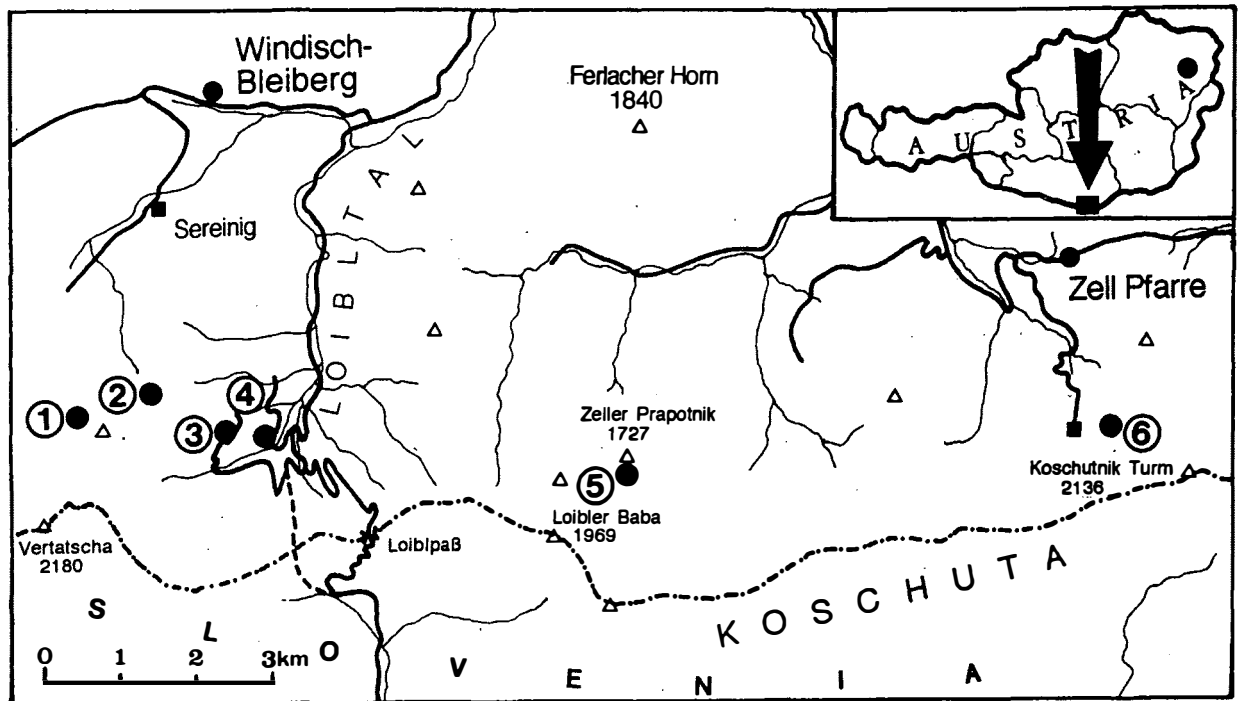KRAINER & MOSTLER (1992) introduced the term Loibl Formation for these red and grey lime-

**Fig. 1:** Location map of investigated sections and outcrops.
1 = Weiße Wand, 2 = Heilige Wand, 3 = Selenitza forest road, 4 = Selenischniak, 5 = Zeller Prapotnik, 6 = Grosalm.

stones, which occur on top of massive, light grey *Tubiphytes-Archaeolithoporella*-limestones (Contrin Formation). Two types of limestones can be distinguished in the Loibl Formation: (a) thin nodular limestones, known from only one locality at the Weiße Wand (Weiße Wand Member), and (b) massive to indistinctly bedded, partly nodular limestones (Selenischniak Member).

KRAINER & MOSTLER (1992) gave a detailed description of the Weiße Wand Member, which has been dated as Early Fassanian based on conodonts and radiolarians (*Spongosilicarmiger transitus* Subzone of the *Spongosilicarmiger italicus* Zone s.l.). KOZUR et al. (1994) assigned the conodont fauna of the Weiße Wand Member in the uppermost Illyrian. Subsequently, KOZUR (1995) elevated the *S. transitus* Subzone to zonal rank and correlated it with the *Kellnerites felsoeoersensis* ammonoid zone that he assigned to the latest Illyrian immediately below the *Reitziites reitzi* Zone s.str. (lower boundary defined with the first appearance of *Reitziites* reitzi) of Early Ladinian age. Thus, the conodont and radiolarian faunas give the same latest Illyrian age for the Weiße

Wand Member, whereas the Selenischniak Member displays Ladinian age.

The aim of the present paper is to characterize the limestones of the Loibl Formation, particularly of the Selenischniak Member in terms of regional distribution, facies, microfacies, microfauna (radiolarians of the Weiße Wand Member), to discuss the depositional environment and stratigraphic range of the Loibl Formation, and to describe the rich radiolarian fauna of the Weiße Wand Member, the richest radiolarian fauna of the *Tiborella florida* Subzone of the *Spongosilicarmiger transitus* Zone that is known so far.

## 2. Location of the investigated outcrops of the Loibl Formation

Pelagic limestones of the Loibl Formation are exposed in the central part of the southern Karawanken Mountains in southern Carinthia (Austria), which belong to the Southern Alps, and are separated from the Northern Karawan-

ken Mountains (Eastern Alps) by the Periadriatic Line.

The easternmost occurrence is a small outcrop at the Grosalm east of the Koschutahaus, the westernmost outcrop lies at the Weiße Wand south of the Märchenwiese. Outcrops studied in the present paper are located (1) at the Weiße Wand, (2) at the Heilige Wand, (3) along the Zelenica forest road, (4) near Selenischniak, (5) at the Zeller Prapotnik and (6) Grosalm. All locations are shown in Fig. 1.

## 3. Previous work and geologic setting

The first investigations of the Triassic sequence in the Karawanken Mountains date back to the last century (e.g. MOJSISOVICS, 1871, TELLER 1887, 1898), but until now little was known on the facies and stratigraphy of the Triassic, particularly the Middle Triassic sequence. TELLER (1898) already pointed out that the Triassic of the Southern Karawanken Mountains differs significantly from the Triassic of the Northern Karawanken Mountains, which are part of the Eastern Alps (Lician Drau Range). According to BAUER (1973, 1980, 1984) and BAUER et al. (1983), the Periadriatic Line, which separates these two tectonic units of the Southern and Northern Karawanken Mountains, does not represent a facies boundary concerning the Triassic of the two units.

After BAUER (1980) and BAUER et al. (1983), the Middle Triassic of the Southern Karawanken Mountains is composed of the "Alpine Muschelkalk" (Anisian), overlain by "Bankkalke, Hornsteinkalke und Mergel" (Late Anisian – Ladinian), volcanic rocks, red and grey limestones (Schreyeralmkalk; Late Anisian – Ladinian) and Schlerndolomite (see also geological map of BAUER, 1985).

This stratigraphic scheme differs from the results of our investigations, which showed that the Middle Triassic of the Southern Karawanken Mountains displays a typical South Alpine character (Fig. 2, see KOZUR et al., 1994, MOSTLER & KRAINER 1994). The Middle Triassic begins with
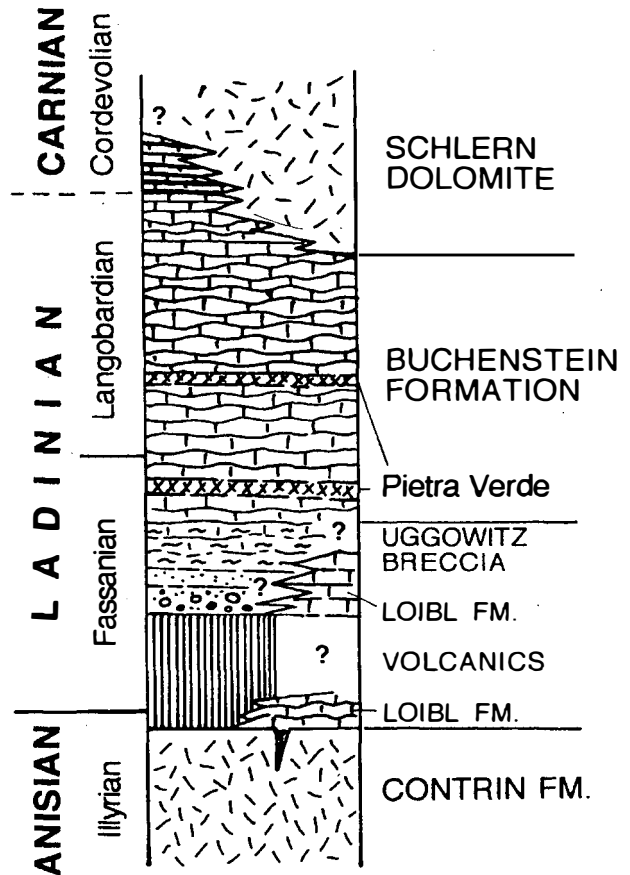


**Fig. 2:** Stratigraphy of the South Alpine Middle Triassic sequence in the central Karawanken Mountains (modified after KOZUR et al., 1994).

several hundred meters thick, well-bedded and partly evaporitic platform carbonates that are regarded as an equivalent of the Lower Sarl Formation of the Dolomites. They are overlain by dark grey, well-bedded and bioturbated marly limestones ("Wurstelkalke"), thin bedded, laminated dolomites and locally several meter-thick red marls with intercalated grey limestone beds. These red marls probably represent an equivalent of the Lower Peres Formation of the Dolomites. Laminated dolomites and red marls are overlain by massive, light grey platform carbonates of the Contrin Formation.

In the central Karawanken Mountains pelagic limestones of the Loibl Formation overlap the shallow water carbonates of the Contrin Formation; the boundary between both formations is very sharp. The Loibl Formation is a few meters to a
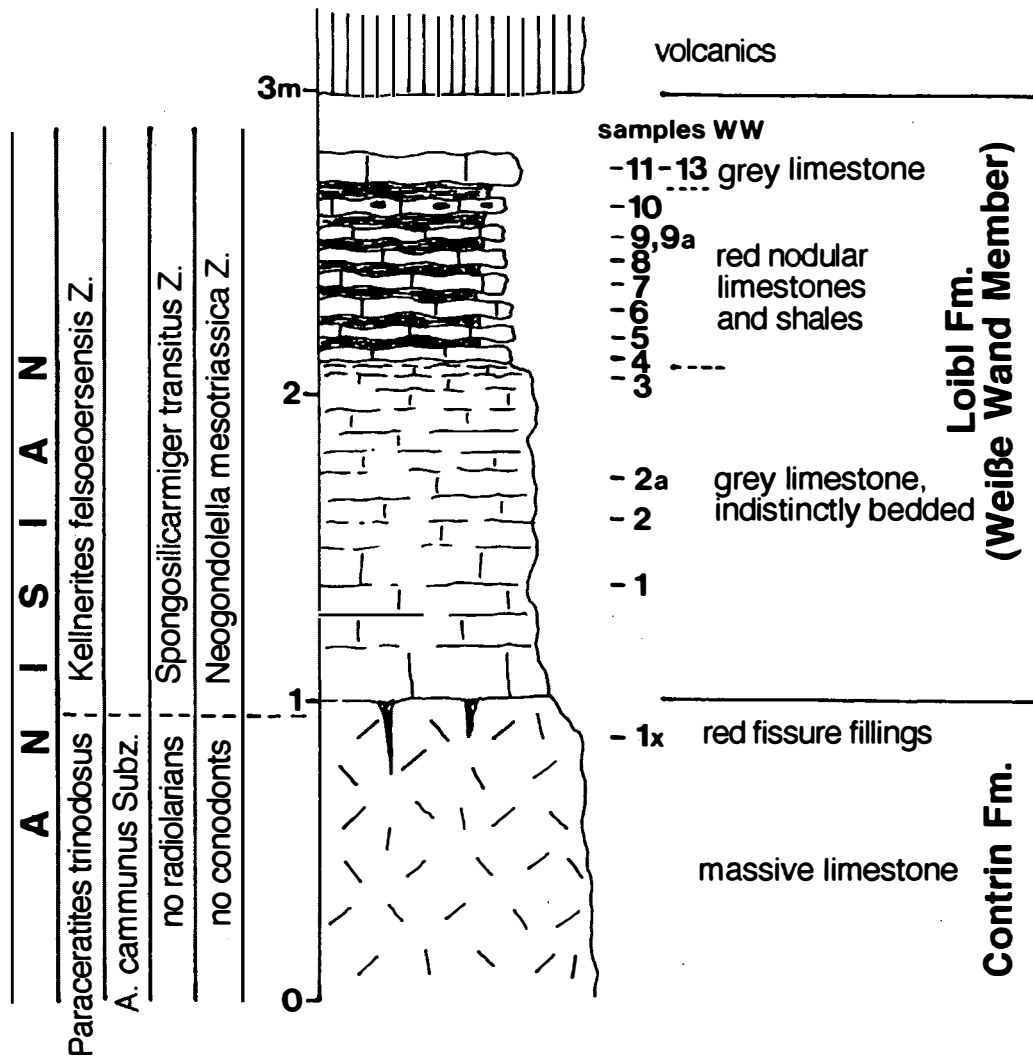
**Fig. 3:** Measured section through the Loibl Formation (Weiße Wand Member) at the Weiße Wand (modified after KRAINER & MOSTLER, 1992). Location see Fig. 1.

few tens of meters thick. It interfingers with and is overlain by volcanic rocks of andesitic to dacitic composition with a maximum thickness of about 100 m (OBENHOLZNER, 1985). Agglomerates at the base of the volcanic sequence contain a few red limestone clasts that were derived from the Loibl Formation, definitely demonstrating that parts of the Loibl Formation are older than the volcanic rocks. This is also proven in the Weiße Wand section, where volcanic rocks overlay the Weiße Wand Member of the Loibl Formation (Fig. 3). On the other hand, the middle part of the Selenischniak Member at Zelenitza forest road contains thin tuff layers and altered volcanic rock fragments in-

dicating that a part of the volcanism is older than this level (Fig. 2).

The volcanic rocks are overlain by polymict conglomerates and sandstones, which are an equivalent of the Uggowitz Breccia and not part of the "Alpine Muschelkalk" as proposed by BAUER (1980, 1985) and BAUER et al. (1983). The Uggowitz Breccia contains also reworked limestone clasts that were derived from the Loibl Formation, and abundant volcanic clasts from the underlying volcanic rocks.

The conglomerates and sandstones of the Uggowitz Breccia grade upward into marls and marly limestones, which are overlain by evenly bedded

and nodular cherty limestones and intercalated greenish tuffs (Pietra Verde) of the Buchenstein Formation. Conodonts and radiolarians from the Buchenstein Formation indicate Late Fassanian to Late Langobardian age (KOZUR et al. 1994, MOSTLER & KRAINER 1994).

Middle Triassic red pelagic limestones of the Southern Karawanken Mountains occur in two different stratigraphic horizons: (1) In the Loibl Formation (KRAINER & MOSTLER 1992) above massive, light grey, shallow water platform carbonates of the Contrin Formation, and (2) within the Buchenstein Formation.

Pelagic limestones of the Loibl Formation are exposed in the central Karawanken Mountains between the Grosalm and Weiße Wand, where the interfingering and overlying volcanic rocks reach their greatest thickness.

Two different types of limestones can be distinguished for which two members are discriminated:

## (a) Weiße Wand Member

A thin sequence of grey and red, partly cherty nodular limestones with thin marl intercalations. The limestones consist of wackestones rich in radiolarians and sponge spiculae. The sequence is exposed at the Weiße Wand, where it sharply overlays massive limestones of the Contrin Formation and is overlain by volcanic rocks.

The conodont fauna of the Weiße Wand Member was derived from a fissure filling of red pelagic limestones of the Weiße Wand Member in the underlying platform carbonates (Contrin Formation). It contains *Neogondolella balkanica* BUDUROV & STEFANOV, *Nicoraella kockeli* (TATGE), *Paragondolella ? pridaensis posteroacuta* KOZUR, KRAINER & MOSTLER, *Paragondolella* n. sp. ex gr. *excelsa* MOSHER and indicates latest Illyrian age. It corresponds to the conodont fauna of the same age (*Neogondolella mesotriassica* Zone or the contemporaneous *Paragondolella ? trammeri praetrammeri* Zone for the open sea pelagic facies) from Šmarna Gora near Lubljana, Slovenia (RAMOVŠ & GORIČAN, 1995).

## (b) Selenischniak Member

It consists of massive to indistinctly thick bedded red and grey limestones with a total thickness of a few tens of meters. Due to strong tectonic overprinting complete sections are not preserved. In the strongly disturbed section exposed along the Zelenica forest road, thin nodular limestones and decimetre thick tuffs are intercalated. The Selenischniak Member overlays also the Contrin Formation. Overlying volcanic rocks are not exposed.

The conodont fauna that was derived from limestones of the Selenischniak Member of the Loibl Formation contains *Paragondolella trammeri*, *P. alpina*, advanced *P. excelsa*, *Neogondolella cornuta ladinica*, *N. mesotriassica*, *N. longa*, *N. balkanica*, and in the upper part already primitive *Budurovignathus*. It indicates early to late Fassanian age.

Best outcrops of the Selenischniak Member are located along the Selenitza forest road, along the road to the locality Selenischniak, and at the Zeller Prapotnik.

**Locality Selenitza forest road** (Fig. 4)

This forest road leads from Pamschbauer to the Selenitza Graben, the outcrops are located along the road at an altitude of 1120–1130 m (see BAUER, 1985, Geol. Karte der Westkarawanken).

The sequence is tectonically overprinted and strongly disturbed, the exposed thickness measures about 30 m. From base to top the sequence is composed of the following intervals:

(a) 12 m indistinctly thick bedded grey limestones with thin reddish nodular limestones intercalations.

(b) 10 m evenly bedded and nodular red limestones (10 m) with four intercalated tuff layers. The red limestones contain crinoid fragments and rarely ammonites.

(c) 6 m indistinctly bedded grey limestones with an intercalated thin conglomerate layer.

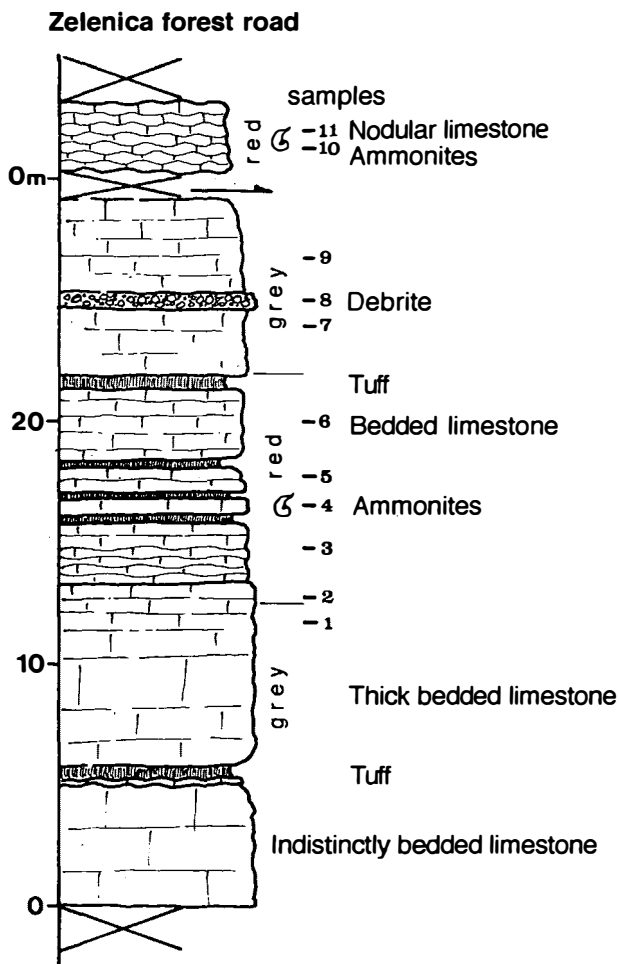(d) 3 m red nodular limestones with ammonites on top of the sequence (Pl. 12,Fig. 1).

**Zelenica forest road**

samples

$-11$ Nodular limestone
$-10$ Ammonites

0m—

$-9$

$-8$ Debrite
$-7$

Tuff

20— $-6$ Bedded limestone

$-5$

$-4$ Ammonites

$-3$

$-2$
$-1$

10—

Thick bedded limestone

Tuff

Indistinctly bedded limestone

0—

red
grey
red
grey

**Fig. 4:** Measured section through limestones of the Loibl Formation exposed along the Selenitza forest road. Location see Fig. 1.

**Microfacies of interval a:** The grey limestones are composed of laminated, locally bioturbated bioclastic wackestones with radiolarians, sponge spiculae and shell fragments being the most abundant bioclastic constituents. Subordinate are echinoderm fragments, foraminifers, gastropods and ostracods. The groundmass is composed of micrite. Up to a few cm large red and grey micritic intraclasts are sparsely distributed in this facies. These intraclasts contain less bioclasts (radiolarians, filaments, echinoderms, sponge spiculae, foraminifers and ostracods) than the surrounding rock. The intraclasts frequently display stylolithic grain contacts.

**Microfacies of interval b:** The red limestones consist of bioclastic wackestones/packstones and bioclastic grainstones. The bioclastic wackestones appear massive and contain echinoderms, radiolarians, sponge spiculae, shell fragments, foraminifers and ammonites. The crinoid fragments have a diameter up to 1 cm, some of them show borings. Three types of lithoclasts have been recognized: small, grey micritic clasts with algae and *Tubiphytes*, derived from shallow water environments, red micritic intraclasts with diameters up to 1 cm, and altered volcanic rock fragments (Pl. 12, Figs. 3 and 4).

The bioclastic grainstones/packstones contain abundant echinoderm and shell fragments, which are densely packed and cemented by calcite spar. Microstylolites indicate pressure solution. Small patches of micritic to microsparitic groundmass are present. The echinoderm fragments frequently display syntaxial overgrowths. Shell fragments are almost completely recrystallized. A few micritic lithoclasts containing radiolarians have been observed.

**Microfacies of interval c:** The grey limestone interval consists of bioclastic wackestones/packstones, which contain shell fragments, echinoderm fragments, ostracods, foraminifers, calcisponges, micritic algae and *Tubiphytes*. Some of the bioclasts are derived from shallow water environments. The groundmass consists of micrite and small patches of sparite. Locally the bioclasts display micritic envelopes. In some samples peloids and small intraclasts are present.

The intercalated conglomerate bed is 30 cm thick, poorly sorted and grain supported, and consists of angular to subangular clasts with stylolithic grain contacts and micritic groundmass (Pl. 12, Fig. 6). The following clast types have been recognized: ·
– Bioclastic wackestones with radiolarians, spiculae and echinoderms.
– Bioclastic wackestones, rich in echinoderms and shell fragments and a few micritic intraclasts.
– Shallow-water limestone clasts (grainstones).
– Bioclasts (crinoid fragments).
– Altered volcanic rock fragments.

**Microfacies of interval d:** The red nodular limestones on top of the sequence are composed of ·

bioturbated wackestones. The most frequent bioclasts are radiolarians, sponge spiculae and filaments. Subordinate are echinoderms, foraminifers, gastropods and ammonite fragments. A few micritic grey intraclasts are present too. This facies is very similar to the red nodular limestones of the Weiße Wand Member (see KRAINER & MOSTLER, 1992).

## Locality Selenischniak

Along the road to Selenischniak, NW of the bridge crossing the Zelenitza Graben, tectonically disturbed grey, red and beige limestones of the Selenischniak Member are exposed. The limestones are bedded (10 - 40 cm), nodular and indistinctly bedded to massive. In the field crinoids, brachiopods and solitary corals have been observed in red and beige limestones. The limestones of this locality are composed of the following microfacies:

(a) Filament packstones (Pl. 13, Fig. 1).
(b) Wackestones/packstones rich in radiolarians, filaments and spiculae.
(c) Bioclastic wackestones/packstones containing lithoclasts.
(d) Wackestones with bioclasts derived from shallow water environments. This type contains segmented and unsegmented calcisponges, sphinctozoans and hexactinellid sponges (Pl. 13, Figs. 2, 3) as well as solitary corals, echinoderms, shell fragments, foraminifers, gastropods and ostracods. Some of the larger bioclasts are encrusted by *Tubiphytes*. The groundmass is composed of micrite and rarely of sparite. Locally peloids and individual, cm-large lithoclasts are present. Lithoclasts are composed of micrite and a few bioclasts. Some of the lithoclasts have been identified as reworked red micritic limestones containing filaments, spiculae and ostracods.

## Locality Zeller Prapotnik

At the peak of the Zeller Prapotnik (1727 m) light grey, massive shallow water carbonates of the Contrin Formation are overlain by red limestones of the Loibl Formation. In the uppermost part of the Contrin Formation dm-thick and up to several m deep fissures filled with red limestones and tuffaceous material are developed. Breccias composed of grey limestone clasts embedded in red micritic matrix are exposed on top of the Contrin Formation. These breccias probably represent scarp fault breccias. The breccias and fissures developed during breakdown of the Contrin Platform.

A few meters south of the peak grey limestones of the Contrin Formation are overlain by a well developed hardground, which is superimposed by condensed red nodular limestones with an exposed thickness of 50 cm. The red limestones frequently contain crinoid fragments, rarely ammonites. BAUER (1984) reported the occurrence of *Kellnerites* sp. These red nodular limestones probably belong to the Weiße Wand Member.

The grey limestones of the Contrin Formation are composed of the following microfacies:

### (a) Algal-Tubiphytes bindstones
Algae and *Tubiphytes* form a framework with pore space filled in part with pelmicritic matrix, in part with calcite spar. Other bioclasts are shell fragments, gastropods, echinoderms, foraminifers and individual bryozoan fragments. Some bioclasts display a micritic envelope, some are encrusted by *Tubiphytes*.

### (b) Bioclastic grainstone
These limestones are indistinctly laminated, poorly to moderately sorted and contain echinoderm fragments, shell fragments and foraminifers. Bioclasts are frequently encrusted by micritic algae and *Tubiphytes*. Peloids are a common lithoclast type.

### (c) Bioclastic wackestones/packstones
These rocks contain shell fragments, echinoderms, foraminifers, gastropods, algae (partly dasycladaceans), *Tubiphytes* and *Olangocoelia*. Many bioclasts are incrusted by algae and *Tubiphytes*. These wackestones/packstones are relatively densely packed, the matrix consists of micrite.

In the overlying red limestones of the Loibl For-
mation the following microfacies have been reco-
gnized:

(a) Bioclastic packstone, locally bioturbated,
with abundant radiolarians and filaments, and a
few echinoderms, sponge spiculae, foraminifers,
gastropods and ostracods in a micritic matrix. Ra-
rely small voids filled with calcite spar or siltite are
present (Pl. 13, Fig. 5).

(b) Bioclastic wackestone/packstone contai-
ning abundant echinoderm fragments, particular-
ly crinoid ossicles up to 1 cm in diameter, some
being impregnated with Fe-hydroxids and/or sho-
wing borings. Other bioclasts are shell fragments,
brachiopods, gastropods foraminifers and ammo-
nites. Angular grey clasts from shallow water car-
bonates and volcanic rock fragments are present.
The matrix is composed of micrite.

(c) Bioclastic wackestone containing abundant
angular lithoclasts that were derived from shallow
water carbonates containing *Tubiphytes* (rewor-
ked Contrin Limestone). Rarely red limestone
clasts with radiolarians (reworked limestones of
the Loibl Formation) are also present. Bioclasts
are filaments, echinoderms and poorly preserved
fragments of ? radiolarians (Pl. 13, fig. 6).

Intercalated beige limestones consist of biocla-
stic wackestones, which contain segmented and
unsegmented calcisponges, and subordinate he-
xactinellid sponges in a micritic matrix. Shell
fragments, foraminifers, ostracods and individual
red micritic intraclasts are present, too.

## 4. Interpretation of the microfacies data

Fissure fillings in the uppermost Contrin For-
mation (Weiße Wand, Heilige Wand, Zeller Pra-
potnik) and breccias indicate rapid breakdown and
drowning of the Contrin carbonate platform. Red
and grey limestones of the Loibl Formation com-
posed of wackestones rich in radiolarians, sponge
spicules and filaments represent pelagic deposits
formed by fallout from suspension. Siliceous
sponges in red nodular limestones of the Weiße
Wand Member represent an autochthonous soft-

ground fauna of an aphotic pelagic environment
with water depths around 200 m (KRAINER &
MOSTLER 1992). A pelagic environment is also in-
dicated by a hardground and condensed nodular li-
mestones at the Zeller Prapotnik, pointing to very
low sedimentation rates, an by the conodont and
radiolarian faunas. Intercalated are hemipelagic
sediments containing platform derived detritus
(bioclasts and lithoclasts) mixed with autochtho-
nous sediment.

The conglomerate bed, which is intercalated in
grey limestones of the Loibl Formation exposed
along the Zelenitza forest road, is interpreted as a
submarine debris flow. Intercalated tuff layers
point to volcanic activity during sedimentation of
the Loibl Formation. This is also indicated by the
volcanics overlying the uppermost Illyrian Weiße
Wand Member and by clasts of altered volcanics
in the Lower Ladinian Selenischniak Member.
Volcanic activity seems to be related to the break-
down of the carbonate platform and formation of
small intraplatform basins.

The facies of the Loibl Formation, composed of
a thin sequence of pelagic and hemipelagic sedi-
mentary rocks with a thin intercalated debris flow
may have been deposited in a transitional distal
slope to basin environment.

## 5. Comparison of Middle Triassic
## red pelagic limestones of the Southern
## and Northern Alps

In the Middle Triassic of the Southern Alps red
pelagic limestones occur in the following strati-
graphic levels:

(1) ASSERETO (1971) described a 10–20 m thick
sequence of red and grey marls and tuffaceous
marls with intercalated thin nodular dolomitic li-
mestones (*Trinodosus* layer auct. pro parte). This
sequence, exposed in the southeastern Dolomites
near Dont on top of the Dont limestone, has been
named the Mte. Bivera Formation (PISA 1972,
PISA et al., 1980). From the Mte. Bivera Formation
FARABEGOLI et al. (1984) described five subenvi-

ronments, and dated the sequence as Illyrian (*Trinodosus* Zone) based on ammonites and conodonts.

(2) In the Recoaro area red pelagic cherty limestones occur in the Buchenstein beds of Early Ladinian age.

(3) The third stratigraphic level containing red pelagic limestones is the Longobardian part of the Buchenstein Formation ("Roter Cephalopodenkalk", "Clapsavon Limestone"). These red, ammonite-bearing limestones are up to 45 m thick. They have first been recognized by STUR (1856) and described by MOJSISOVICS (1880). From these limestones MOJSISOVICS (1882) and TOMMASI (1899) described a rich ammonite fauna. They also contain radiolarians, bivalves, gastropods and echinoderm fragments. They locally overlie dolomitic limestones of the Mte. Tiarfin. At their base locally thin slump breccias are developed (PISA, 1972).

As mentioned above, in the South Karawanken Mountains, red pelagic limestones occur in the same stratigraphic levels, in the Loibl Formation of latest Illyrian to late Fassanian age and in the Buchenstein Formation of late Fassanian to late Longobardian age.

From the Middle Triassic of the Northern Calcareous Alps two types of red limestones are known: Schusterbergkalk and Schreyeralmkalk.

The Schusterbergkalk occurs outside of the Hallstatt Zone, particularly in the southern part of the western Northern Calcareous Alps. The Schusterbergkalk is composed of variegated, mostly red cherty nodular limestones, overlying the Reifling Formation. In the Öfenbach section near Saalfelden (Salzburg) the Schusterbergkalk represents the uppermost 5 m of the Reifling Formation and is regarded to be a variety of the Reifling Formation and dated as Fassanian (TOLLMANN, 1976; KRAINER & STINGL, 1986) although according to SCHNETZER (1934) the Schusterbergkalk contains an Illyrian ammonite fauna.

The Schreyeralmkalk is 10–15 m thick and consists of red, thick bedded, extremely condensed micritic limestones. The Schreyeralmkalk is restricted to the Hallstatt Zone. It is, like the Schusterbergkalk, partly developed on top of the Reifling Formation, partly it rests on shallow-water limestones. After TOLLMANN (1976) the Schreyeralmkalk is regarded as a variety of the Hallstatt Limestone. The ammonite and conodont faunas of the Schreyeralm Limestone indicate Pelsonian to Ladinian age.

As both limestone types may be developed on top of the Reifling Formation, Schreyeralmkalk and Schusterbergkalk are frequently used synonymously (TOLLMANN, 1976).

In the Middle Triassic of the Dobratsch Massif (Drau Range) variegated, frequently red pelagic limestones ("Buntkalke"), associated with volcanic rocks, are developed. In the lower block (Liegendscholle) the "Buntkalke" consist of grey, greenish and red nodular limestones. In the lowermost red limestone bed lies the boundary between the *Trinodosus* and *Reitzi* zones. The entire stratigraphic range is Illyrian to Late Langobardian. In the upper block (Hangendscholle) the „Buntkalke" are composed of *Michelinoceras* and ammonite-bearing limestones, bedded limestones and nodular limestones. The sequence is dated as latest Anisian to Langobardian (COLINS & NACHTMANN, 1974; BECHSTÄDT, 1978; BECHSTÄDT et al., 1976). "Buntkalke" and overlying volcanic rocks are only known from the Dobratsch Massif and lacking in all other parts of the Drau Range.

The facies, thickness and age of this sequence is surprisingly similar to the Loibl Formation and superposed volcanics of the Southern Karawanken Mountains.

## 6. Systematic part

If not stated otherwise, all figured specimens are from the Weiße Wand Member of the Loibl Formation at the type locality Weiße Wand west of the Loibl Pass, Southern Karawanken, Austria. This locality (locality 1 in Fig. 1) is the type locality of most of the described new species. Type stratum are the 60 cm thick red nodular limestones in

the upper part of the Weiße Wand Member. It belongs to the *Tiborella florida* Subzone of the *Spongosilicarmiger transitus* Zone of the upper Illyrian (uppermost Anisian). The section and the position of the samples are shown in Fig. 3. The material from the Weiße Wand Member is housed in the collection of the Institute of Geology and Paleontology of the Innsbruck University.

<div align="center">

Subclass Radiolaria MÜLLER, 1858
Order Polycystida EHRENBERG, 1838
Suborder Entactinaria KOZUR & MOSTLER, 1982
Superfamily Palaeoscenidiacea RIEDEL, 1967
emend. KOZUR & MOSTLER, 1982
Family Eptingiidae DUMITRICĂ, 1978a

</div>

**Genus *Eptingium* DUMITRICĂ, 1978a**

Type species: *Eptingium manfredi* DUMITRICĂ, 1978a

<div align="center">

***Eptingium manfredi manfredi***
**DUMITRICĂ, 1978a**
(Pl. 10, Figs. 1–4, 6, 10)

</div>

1978a   *Eptingium manfredi* n. sp., pars – DUMITRICĂ, p. 33-34, Pl. 3, Figs. 3, 4; Pl. 4, Figs. 1, 2, 3, 6, 7 (7), non ! Fig. 5
1979   *Eptingium manfredi* DUMITRICĂ – PESSAGNO, FINCH & ABBOTT, Pl. 6, Figs. 9–11
1980   *Eptingium manfredi manfredi* DUMITRICĂ, 1978 – DUMITRICĂ, KOZUR & MOSTLER, p. 19–20, Pl. 3, Figs. 1–3; Pl. 6, Figs. 5–7
1982   *Eptingium manfredi* DUMITRICĂ – DE WEVER, p. 275–276, Pl. 35, Fig. 5
1982   *Eptingium* cf. *manfredi* DUMITRICĂ – YAO et al., Pl. 1, Fig. 12
1982   *Eptingium* cf. *manfredi manfredi* DUMITRICĂ – TAKASHIMA & KOIKE, Pl. 1, Figs. 7, 8
1982   *Tripocyclia* (?) sp. β, pars – MIZUTANI & KOIKE, Pl. 3, Fig. 5
1982   *Tripocyclia* (?) sp. α, pars - MIZUTANI & KOIKE, Pl. 3, Fig. 7

1982   *Eptingium* cf. *manfredi* DUMITRICĂ – MATSUDA & ISOZAKI, Pl. 3, Fig. 25
1982   *Eptingium manfredi* DUMITRICĂ – SATO, NIZHIZONO & MURATA, Pl. 2, Fig. 13
1982   *Eptingium* cf. *manfredi* DUMITRICĂ – YAO, p. 55, Pl. 1, Fig. 17
1988   *Eptingium manfredi* DUMITRICĂ – BRAGIN, OLEJNIK & PARNJAKOV, Pl. 2, Fig. 5
1990   *Eptingium manfredi* DUMITRICĂ – YEH, p. 23, Pl. 6, Figs. 4, 5, 8, 9
1990   *Eptingium manfredi* DUMITRICĂ, 1978a – GORIČAN & BUSER, p. 144, Pl. 8, Figs. 7, 8
1991   *Eptingium manfredi* DUMITRICĂ, 1978 – BRAGIN, p. 109, Pl. 2, Figs. 12, 13
1991   *Eptingium manfredi* DUMITRICĂ, 1978 – KOLAR-JURKOVŠEK, p. 82–83, Pl. 10, Figs. 4 a, 4 b
1993   *Eptingium manfredi* DUMITRICĂ, 1978 – DOSZTÁLY, Pl. 1, Fig. 7
1993   *Eptingium manfredi* DUMITRICĂ, 1978 – FENG, QINGLAI & LIU BENPEI, p. 544–545, Pl. 1, Figs. 14, 15
1994   *Eptingium manfredi manfredi* DUMITRICĂ, 1978 – KOZUR & MOSTLER, p. 42, Pl. 1, Fig. 3
1994   *Eptingium* cf. *manfredi* DUMITRICĂ - NAKAZAWA, ISHIBASHI, KIMURA, KOIKE, SHIMIZU & YAO, Pl. 2, Fig. 6

**Occurrence:** *Spongosilicarmiger transitus* Zone (upper Illyrian) and Fassanian. Very common in Japan, Philippines and in the Tethys.

**Remarks:** *Eptingium manfredi manfredi* is characterized by unequal angles between the spines and very broad blades with narrow and deep secondary median furrow that may be as deep and wide as the primary furrows between the blades. The distal ends of the spines are pointed or narrowly rounded.

*Eptingium manfredi japonicum* (NAKASEKO & NISHIMURA, 1979) displays the same unequal angles between the three spines and the same shape of the spines. However, the slightly twisted spines have undivided, narrow to moderately wide blades.

*Eptingium manfredi robustum* KOZUR & MOSTLER, 1980 (in DUMITRICĂ et al., 1980) displays spi-

nes with broadly rounded distal end and well separated terminal needle-like spine.

These three subspecies have different stratigraphic ranges. *E. manfredi japonicum* is restricted to the Illyrian, *E. manfredi manfredi* begins in the upper Illyrian *S. transitus* Zone and ranges throughout the Fassanian and *E. manfredi robustum* is restricted to the Fassanian.

The Illyrian *Eptingium nakasekoi* KOZUR & MOSTLER, 1994, has equal angles between the spines and the undivided blades are narrow.

The likewise Illyrian *Eptingium ramovsi* n. sp. has distinctly twisted spines with narrow, undivided blades.

### Eptingium manfredi japonicum
### NAKASEKO & NISHIMURA, 1979
(Pl. 10, Fig. 7)

1979    *Tripocyclia japonica* NAKASEKO and NISHIMURA, n. sp., pars – NAKASEKO & NISHIMURA, p. 73, Pl. 4, Figs. 4, 5, non ! Fig. 6

1993    *Eptingium manfredi* DUMITRICĂ, 1978 – SASHIDA, NISHIMURA, IGO, KAZAMA & KAMATA, p. 82, 84, Figs. 6–1, 2

1993    *Eptingium* ? sp., pars – SASHIDA, NISHIMURA, IGO, KAZAMA & KAMATA, p. 84, only Fig. 6–5

1995    *Eptingium nakasekoi* KOZUR & MOSTLER, 1994 - RAMOVŠ & GORIČAN, p. 185, Pl. 5, Figs. 9 (?), 10

**Occurrence:** Upper part of *T. laevis* Zone and *S. transitus* Zone (upper Illyrian) of Japan, Austria, Hungary, Italy and Slovenia.

**Remarks:** RAMOVŠ & GORIČAN (1995) assigned the holotypus of *"Tripocyclia" japonica* NAKASEKO & NISHIMURA, 1979, and one of the paratypes to *E. manfredi*, the other paratype with strongly twisted main spines to a different species *Eptingium* sp. A. We agree with this assignment and describe *Eptingium* sp. A as *Eptingium ramovsi* n. sp. The holotype of *"T." japonica* can be maintained as primitive subspecies of *E. manfredi* that is transitional between *E. nakasekoi* and *E. manfredi*.

One angle between the three main spines is in general considerably larger than the other two angles, as in typical *E. manfredi manfredi* and the form of the spines is also identical with those of *E. manfredi manfredi*. However, the nominate subspecies has a deep, in primitive forms narrow, in advanced forms broad secondary median furrow on the very broad blades. The holotype has proximally broad, flat blades on the spines, but without median furrow. The paratype (NAKASEKO & NISHIMURA, 1979, Pl. 4, Fig. 4) has a short, very shallow deepening in the proximal part of the blades, but no real median furrow. Such forms can be regarded as transitional forms to *E. manfredi manfredi*.

RAMOVŠ & GORIČAN (1995) assigned a typical *E. manfredi japonicum* and a transition form to *E. nakasekoi* to the latter species.

### Eptingium nakasekoi KOZUR & MOSTLER, 1994
(Pl. 11, Fig. 11)

1979    *Tripocyclia* cf. *acythus* DE WEVER – NAKASEKO & NISHIMURA, p. 72–73, Pl. 4, Figs. 1–3

1982    *Tripocyclia* sp. cf. *T. acythus* DE WEVER – KIDO, Pl. 1, Fig. 7

1989    *Eptingium* (?) sp. A – CHENG, p. 147, Pl. 6, Fig. 9

1993    *Eptingium* ? sp., pars – SASHIDA, NISHIMURA, IGO, KAZAMA & KAMATA, p. 84, Figs. 3, 4

1994    *Eptingium nakasekoi* n. sp. - KOZUR & MOSTLER, p. 43, Pl. 1, Fig. 5

**Occurrence:** Lower and middle Illyrian, advanced forms rarely in the lower *S. transitus* Zone; Japan, Philippines, Austria.

**Remarks:** For the first time the spicular system of *E. nakasekoi* was recognized. As in the other *Eptingium* species, it consists of a short median bar and 7 spines that originate from the ends of the median bar. All bars are connected by arches. The three blades of each main spine originate from one spine and two arches of the spicular system

*E. nakasekoi* is the stratigraphically oldest species of the *E. manfredi* lineage. Typical forms occur

in the lower and middle Illyrian. The angles between the main spines are all equal and the blades of the main spines are very narrow. Advanced forms, in which the blades are slightly broader, but also in the proximal part not yet flat, occur in the lower *S. transitus* Zone of the upper Illyrian. In the upper *T. laevis* Zone the first *E. manfredi japonicum* appear. This subspecies is a transitional form between *E. nakasekoi* and *E. manfredi manfredi* that appeared in the *S. transitus* Zone. In typical *E. manfredi japonicum* one angle between the main spines is considerably larger than the other two angles. The blades are proximally broad and in the flat middle part a very shallow grove may be present. Transitional forms to *E. nakasekoi* have still three equal angles between the main spines, transitional forms to *E. manfredi manfredi* have already a shallow grove in the median part of the blades. In *E. manfredi manfredi* a narrow, but deep median grove is present. In advanced forms and above all in the Lower Ladinian *E. manfredi robustum* these secondary groves become as wide as the primary ones. Moreover, in *E. manfredi robustum* the distal ends of the main spines are broadly rounded and display a clearly separated needle-like terminal spine.

### *Eptingium ramovsi* n. sp.
(Pl. 4, Fig. 13; Pl. 10, Fig. 8)

1979    *Tripocyclia japonica* NAKASEKO and NISHIMURA, n. sp., pars – NAKASEKO & NISHIMURA, p. 73, Pl. 4, Fig. 6, non ! Figs. 4, 5

1994    *Eptingium manfredi japonicum* (NAKASEKO & NISHIMURA, 1979) – KOZUR & MOSTLER,, p. 42-43, Pl. 1, Fig. 4

1995    *Eptingium* sp. A – RAMOVŠ & GORIČAN, p. 185, Pl. 5, Figs. 4, 5

**Derivatio nominis:** In honour of Prof. Dr. A. RAMOVŠ for his outstanding work on Paleozoic and Triassic microfaunas of Slovenia.

**Holotypus:** The specimen figured by RAMOVŠ & GORIČAN (1975) on Pl. 5, Fig. 5; rep.-no. 650629.

**Locus typicus:** Tourist path from Tacen through Spodnja Kuhinja to the top of Šmarna Gora,

about 10 km NNW of the centre of Ljubljana, Slovenia, see RAMOVŠ & GORIČAN (1995, Fig. 1).

**Stratum typicum:** Red cherty limestone, sample 3R (see RAMOVŠ & GORIČAN (1995, Fig. 2); *S. transitus* Zone (uppermost Illyrian).

**Material:** 14 specimens.

**Diagnosis:** *Eptingium* with twisted main spines, in which the three blades are narrow and always undivided. On angle between the main spines is nearly 180°, the other two angles are distinctly smaller.

**Description:** The shell is subspherical and double-layered. The vertices of the outer pore frames have nodes. The inner layer has very small pores. The three main spines are broad and short. They are mostly somewhat shorter than the shell diameter, only exceptionally somewhat longer. They are three-bladed and distinctly twisted. The blades are narrow, without median grove, and separated by deep and wide furrows. The spicular system is bar-centred. At one end of the bar there are three, on the other end four spines. The three blades of the main spines are each connected with one spine and two arches between the spines.

**Measurements:**

Diameter of shell: 90–135 µm
Length of main spine: 75–135 µm
Basal diameter of main spines: 45–60 µm

**Occurrence:** *T. laevis* Zone and *S. transitus* Zone (Illyrian) of Japan, Hungary, Austria, Italy and Slovenia.

**Remarks:** The figured material by RAMOVŠ & GORIČAN (1995) is better preserved and therefore the holotype was chosen from this material.

*Eptingium nakasekoi* KOZUR & MOSTLER, 1994, is most similar to the new species, but the main spines are untwisted or only slightly twisted and the size of all three angles between the main spines is the same.

Some specimens of *Eptingium manfredi* DUMITRICĂ, 1978a, have twisted main spines, but in these forms the very broad blades have a deep median furrow.

## Genus *Cryptostephanidium*
### DUMITRICĂ, 1978a

Type species: *Cryptostephanidium cornigerum*
DUMITRICĂ, 1978a


### *Cryptostephanidium cornigerum*
### DUMITRICĂ, 1978a
(Pl. 10, Fig. 12)

1978a  *Cryptostephanidium cornigerum* n. sp. –
DUMITRICĂ, p. 31, Pl. 1, Figs. 1–4; Pl. 4,
Fig. 4
1982  *Cryptostephanidium* cf. *cornigerum* DU-
MITRICĂ – YAO, Pl. 1, Fig. 16
1990  *Cryptostephanidium cornigerum* DUMI-
TRICĂ, 1978a – GORIČAN & BUSER, p. 142,
Pl. 8, Figs. 1-3
1990  *Cryptostephanidium cornigerum* DUMI-
TRICĂ – YEH, p. 22-23, Pl. 5, Figs. 11, 15;
Pl. 11, Fig. 5
1995  *Cryptostephanidium cornigerum* DUMI-
TRICĂ, 1979 – RAMOVŠ & GORIČAN,
p. 184, Pl. 5, Fig. 3
**Occurrence:** Upper Anisian and Lower Ladinian;
Japan, Philippines. Austria, Hungary, Italy, Roma-
nia, Slovenia.


## Genus *Spongostephanidium*
### DUMITRICĂ, 1978a emend.

Type species: *Spongostephanidium spongiosum*
DUMITRICĂ, 1978a
**Remarks:** *Spongostephanidium* was separated
originally from other Eptingiidae DUMITRICĂ,
1978a, by its spongy shell and missing spine D in
the entactinarian spicular system. The spongy
shell developed by fusion of irregular apophyses
and short oblique spines at the vertices of a latti-
ced shell. In the most similar genus *Cryptostep-
hanidium* DUMITRICĂ, 1978a, spine D of the ent-
actinarian spicular system is very short and some-
times missing within the same species. On the
other hand, in few specimens of *S. spongiosum*, a
very short spine D is present. Consequently, both

features chosen by DUMITRICĂ (1978a) to separa-
te *Spongostephanidium* from *Cryptostephanidi-
um* (and other Eptingiidae) cannot be used. Ho-
wever, *Spongostephanidium* is used herein for a
very distinctive species group with round, needle-
like spines. *Cryptostephanidium* is distinguished
by three-bladed spines. This difference could not
be estimated by DUMITRICĂ (1978a), because in
that time only one species of *Spongostephanidi-
um* and two species of *Cryptostephanidium* were
known. *Spongostephanidium* in the new scope
occurs from the Olenekian up to the Lower Carni-
an. It is very common in the Olenekian and Anisi-
an, but very rare in Lower Ladinian and younger
beds. *Cryptostephanidium* evolved in lowermost
Anisian from *Spongostephanidium* and occurs in
the entire Middle and Upper Triassic. The transiti-
on form between *Spongostephanidium* and Cryp-
tostephanidium, the Lower Anisian *Cryptostep-
hanidium* n. sp. aff. *C. verrucosum* DUMITRICĂ
sensu SUGIYAMA (1992) displays proximally bla-
ded and distally round spines. Blades at the very
base of the spines as continuations of the connec-
ting spine and arches of the spicular system are pre-
sent in all *Spongostephanidium* species, but in the
new form figured by SUGIYAMA (1992, Fig. 13–3)
these blades occupy the entire Lower third of the
main spines.


### *Spongostephanidium japonicum*
### (NAKASEKO & NISHIMURA, 1979)
(Pl. 6, Figs. 1–3)

1979  *Trilonche japonica* NAKASEKO and NISHI-
MURA, n. sp. – NAKASEKO & NISHIMURA,
p. 72, Pl. 4, Figs. 8, 10
1989  *Cryptostephanidium* sp. E – CHENG, p. 148,
Pl. 7, Fig. 6
1989  Spumellaria gen. et spec. indet. A –
CHENG, p. 147, Pl. 6, Fig. 8; Pl. 7, Figs. 1, 2
1989  *Cryptostephanidium* sp. E – CHENG, p.
148, Pl. 7, Fig. 6
1990  *Cryptostephanidium japonicum* (NAKA-
SEKO & NISHIMURA) – YEH, p. 22, Pl. 4,
Fig. 10; Pl. 5, Figs. 1, 2, 7; Pl. 10, Fig. 11;
Pl. 11, Fig. 18

1995 *Cryptostephanidium japonicum* (NAKA-SEKO & NISHIMURA, 1979) – RAMOVŠ & GORIČAN, p. 184, Pl. 5, Fig. 1

**Occurrence:** Upper Anisian of Japan, Philippines, Austria, Hungary, Italy, Slovenia, Turkey. The Lower Ladinian specimen figured by GORIČAN & BUSER (1990) is a new species distinguished by a subquadratic shell.

**Remarks:** *S. japonicum* is characterized by a spherical shell with very strong and high nodes on the vertices of the pores frames and round, mainly equidistant main spines of the same size that display a slight widening in their middle part. Some of the nodes may be replaced by short, broad, rounded spinules. The widening of the main spines in their middle part is not always distinct and sometimes the spines are cylindrical in their proximal half without recognizable widening.

The main difference from *S. longispinosa* SASHIDA are the high and broad nodes at the vertices and the aequidistant and aequisized main spines.

### *Spongostephanidium longispinosum*
### SASHIDA, 1991
(Pl. 6, Figs. 4, 5, 6 [?], 8 [?], 11 [?])

1989 *Cryptostephanidium* (?) sp. F – CHENG, p. 148, Pl. 7, Fig. 13
1991 *Spongostephanidium longispinosum* SAS-HIDA, n. sp. – SASHIDA, p. 694–695, Figs. 7 - 1–8
1992 *Cryptostephanidium longispinosum* (SAS-HIDA) – SUGIYAMA, p. 1205–1207, Figs. 13 - 1, 2
1993 *Cryptostephanidium longispinosum* (SAS-HIDA) – NAGAI & MIZUTANI, p. 8, Pl. 2, Figs. 1 (?), 2, 3
1993 *Cryptostephanidium* spp. – NAGAI & MI-ZUTANI, Pl. 2, Figs. 6, 7
? 1995 *Cryptostephanidium longispinosum* (SAS-HIDA) – RAMOVŠ & GORIČAN, p. 5, Fig. 2

**Occurrence:** Common in the Upper Olenekian and Anisian, Japan, Philippines, Austria, Hungary, Italy, Slovenia.

**Remarks:** According to the above remarks to the genus, this species is again assigned to *Spongostephanidium* as originally proposed by SASHIDA (1991).

Typical of *S. longispinosum* are a spherical shell with short, often oblique spinules or irregular, sometimes branching apophyses at the vertices of the pore frames and needle-like round spines that are not widened in their middle part. In the upper Anisian material the spinules or short, irregular apophyses at the vertices of the pore frame are shorter than in the Upper Olenekian type material, but also in the upper Olenekian such forms are present (SU-GIYAMA, 1992, Fig. 13 - 2) indicating that these differences are intraspecific variability. However, these Upper Anisian forms may also have slight widening of the spines in their middle part. Whether they are an independent taxon can only be decided, if very well preserved material from the Anisian forms will be available. The spine D of the spicular system is partly absent, partly very short.

In the Lower Ladinian *Spongostephanidium spongiosum* DUMITRICĂ, 1978a the oblique spinules or short irregular apophyses at the vertices join to a second layer producing a loose spongy shell.

The middle to upper Anisian *Spongostepha-nidium japonicum* (NAKASEKO & NISHIMURA, 1979) has elongated nodes or short broad spines at the vertices of the pore frames and the round spines are slightly widened in their middle part.

### *Spongostephanidium austriacum* n. sp.
(Pl. 6, Figs. 7, 9)

1989 *Cryptostephanidium* sp. A – CHENG, p. 148, Pl. 6, Fig. 3
1989 *Cryptostephanidium* (?) sp. C – CHENG, p. 148, Pl. 6, Fig. 11
? 1995 *Cryptostephanidium longispinosum* (SAS-HIDA) - RAMOVŠ & GORIČAN, p. 184, Pl. 5, Fig. 2

**Derivatio nominis:** According to the occurrence in Austria.

**Holotypus:** The specimen on Pl. 6, Fig. 9; rep.-no. KKM 1995/I-4.

**Material:** 23 specimens.

**Diagnosis:** *Spongostephanidium* with irregular subtriangular to subrectangular shell in equatorial view, large pores, high pore frames without or indistinct nodes at the vertices and three round, not widened main spines of generally unequal length.

**Description:** The cortical shell has an irregular subtriangular to subrectangular outline in equatorial view. The pores are large and are of different shape. The pore frames are very high, but at the vertices either no nodes or only very small nodes are present. The three round main spines are become slowly but continuously narrower towards the distal end. One spine is generally somewhat to distinctly longer than the other two. The position of the spines is nearly equidistant to distinctly inaequidistant. The arches of the spicular system are very high, overreach often parts of the shell in equatorial view and form three ridges at the base of the spines.

**Measurements:**

Diameter of shell: 80–100 μm

Length of main spines: 52–76

Maximum width of main spines (without basal blades): 13–16 μm

**Occurrence:** *S. transitus* Zone (upper Illyrian) of Austria, Hungary, Slovenia and Philippines.

**Remarks:** *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA, 1979) displays a spherical shell with high nodes at the vertices of the pore frames. Moreover, the main spines are mostly widened in their middle part.

*Spongostephanidium longispinosum* SASHIDA, 1991, displays a spherical shell and the pore frames have distinct spines or partly branching apophyses at the vertices of the pore frames.

## Genus *Triassistephanidium* DUMITRICĂ, 1978a

Type species: *Triassistephanidium laticorne* DUMITRICĂ, 1978a, nom. corr.

## *Triassistephanidium anisicum* n. sp.
(Pl. 10, Figs. 9, 13, 14, 15 [cf.])

**Derivatio nominis:** According the occurrence in the Anisian.

**Holotypus:** The specimen on Pl. 10, Fig. 9; rep.-no. KKM 1995/I-3.

**Material:** 34 specimens, fragile shell mainly destroyed.

**Diagnosis:** *Triassistephanidium* with broad, but distally pointed spines that have the same width throughout their proximal part.

**Description:** The shell is in lateral view subtriangular. The pore frames between the wall-inserted arches are fragile and therefore often broken away. The pores are large and of irregular shape. The three main spines are very broad, throughout their proximal part of the same width and distally pointed; rarely the distal end of one or two main spines is narrowly rounded. The blades are very broad and one is subdivided by a shallow furrow. The furrows between the blades are wide, through-like and deep.

The spicular system has a median bar with three and four spines at its ends. All spines are connected by arches that are inserted in the wall. The blades of the main spines are connected with a spine and with three arches; the subdivided main spine (with shallow median furrow) has two connections. Therefore, the spines may be regarded perhaps as four-bladed.

**Measurements:**

Diameter of shell: 90–105 μm

Length of main spines: 80–120 μm

Maximum width of main spines: 36–50 μm

**Occurrence:** *S. transitus* Zone (upper Illyrian) of Austria, Hungary and Italy.

**Remarks:** The lower Ladinian *Triassistephanidium laticorne* DUMITRICĂ, 1978a displays main spines with rounded or blunt distal ends (in general one main spine displays a broadly rounded, the other two a blunt distal end). Moreover, they are distinctly widened somewhat behind the midlength. In transitional forms one or two main spines have rounded distal ends, but also in these forms the main spines are not widened behind the midlength. They are determined as *Triassistephanidium* cf. *anisicum*.

## Eptingiidae DUMITRICĂ, 1978; – n. gen. n. sp.
(Pl. 6, Fig. 10)

**Remarks:** A new genus of four-spined Eptingiidae is present in our material that is distinguished

from the four-spines *Tetrarhopalus* SUGIYAMA, 1992, by the arrangement of all 4 spines in one plane. Unfortunately, the shell are all so much recrystallized that the inner structure could not be observed. Therefore, this new genus cannot yet be described.

## Family Hindeosphaeridae
### KOZUR & MOSTLER, 1981

### Genus *Hindeosphaera*
### KOZUR & MOSTLER, 1979

Type species: *Hindeosphaera foremanae* KOZUR & MOSTLER, 1979

### *Hindeosphaera spinulosa*
### (NAKASEKO & NISHIMURA, 1979)
(Pl. 4, Figs. 4, 8)

1979 *Archaeospongoprunum spinulosum* NA-KASEKO and NISHIMURA, n. sp. – NAKASE-KO & NISHIMURA, p. 69, Pl. 2, figs. 3, 4, 6

1982 *Archaeospongoprunum spinulosum* NA-KASEKO & NISHIMURA – TAKASHIMA & KOIKE, Pl. 2, Fig. 4

1982 "*Archaeospongoprunum*" *spinulosum* NA-KASEKO & NISHIMURA – MATSUDA & ISOZA-KI, Pl. 3, Figs. 27, 28

? 1982 *Archaeospongoprunum spinulosum* NA-KASEKO and NISHIMURA – MIZUTANI & KOIKE, Pl. 3, Fig. 4

1982 *Stylosphaera* (?) *spinulosa* NAKASEKO & NISHIMURA – KISHIDA & SUGANO, Pl. 1, Figs. 16, 17 (?)

1982 *Archaeospongoprunum spinulosum* NAKA-SEKO & NISHIMURA – SATO, NISHIZONO & MURATA, Pl. 2, Fig. 4

1989 *Pseudostylosphaera* sp. cf. *P. spinulosa* (NAKASEKO and NISHIMURA) – CHENG, p. 143, Pl. 6, Fig. 2, Pl. 7, Figs. 8, 9

1989 *Hindeosphaera foremanae* KOZUR et MOSTLER, 1979, *in* B. LAHN, 1984, Pl. 5, Fig. 11 – MARTINI, DE WEVER, ZANINETTI, DENELIAN & KITO, p. 150, Pl. 1, Fig. 15

1989 *Hindeosphaera* sp. – MARTINI, DE WEVER, ZANINETTI, DENELIAN & KITO, p. 150, Pl. 3, Fig. 17

1989 *Hindeosphaera spinulosa* (NAKASEKO et NISHIMURA, 1979) – MARTINI, DE WEVER, ZANINETTI, DENELIAN & KITO, p. 150, Pl. 3, Fig. 8

1989 gen. sp. indet. – MARTINI, DE WEVER, ZA-NINETTI, DENELIAN & KITO, p. 158, Pl. 3, Fig. 15

1990 *Pseudostylosphaera spinulosa* (NAKASE-KO and NISHIMURA) – YEH, p. 15, Pl. 4, Fig. 14

1990 *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA, 1979) – DE WEVER, MARTINI & ZANINETTI, p. 586, Pl. 1, Fig. 1

1991 "*Stylosphaera*" *spinulosa* (NAKASEKO et NISHIMURA) – BRAGIN, p. 91, Pl. 3, Figs. 4, 5, 9

1993 *Pseudostylosphaera spinulosa* (NAKASE-KO and NISHIMURA) – SASHIDA, NISHIMU-RA, IGO, KAZAMA & KAMATA, p. 92, Figs. 7-15, 17, 20 (?)

1995 *Hindeosphaera* ? *spinulosa* (NAKASEKO & NISHIMURA, 1979) – RAMOVŠ & GORIČAN, p. 185, Pl. 3, Figs. 6-8

**Occurrence:** Illyrian (*Paraceratites trinodosus* and *Kellnerites felsoeoersensis* ammonoid zones, *Tetra-spinocyrtis laevis* and *Spongosilicarmiger transitus* radiolarian zones) of Japan, Philippines, southeast Siberia, Italy, Slovenia, Hungary, Austria.

**Remarks:** This important Illyrian guide form has variable spines, but a very broad, three-bladed polar spine is always present that is considerably lager than the other spines. Its length, however, is variable. Opposite to this polar spine, but mostly oblique to its axis, a considerably shorter, but in general also broad spine is present. This is the reason that this species was sometimes assigned to *Pseudostylosphaera* KOZUR & MOSTLER, 1981. However, this spine is often not lager than the short by-spines in the antapical hemisphere as typical for *Hindeosphaera*. The vertices of the pore frames bear short spines of different size, but in general they are distinctly larger in the antapical hemisphere, where they may be as long as the antapical spine.

*Hindeosphaera spinulosa* is the stratigraphically oldest *Hindeosphaera* near *to* the branching point from *Pseudostylosphaera*. For this reason, some specimens are still similar to those *Pseudostylosphaera* species that have polar spines of different size. However, the size differences of the polar spines in *Pseudostylosphaera* are never so strong as in *H. spinulosa*. Moreover, in some specimens the by-spines are as large as the antapical polar spine that is often distinctly moved out of the antapical position. Such forms are already typical *Hindeosphaera*, similar to the advanced Carnian forms.

High variability is often characteristic for the early species of a genus near to its branching point from its ancestral taxon. Because of this high variability, MARTINI et al. (1989) and DE WEVER et al. (1990) assigned *H. spinulosa* to 4 different taxa, two of them in open nomenclature. A rather typical *H. spinulosa* was assigned to *H. foremanae* KOZUR & MOSTLER, 1979 sensu LAHM (1984, Pl. 5, Fig. 11)). However, the specimen figured by LAHM (1984) is a typical middle Carnian *H. foremanae* with slender, distinctly twisted polar spine, totally different from the Anisian *H. spinulosa*.

### Genus *Pseudostylosphaera* KOZUR & MOSTLER, 1981

Type species: *Pseudostylosphaera gracilis* KOZUR & MOSTLER, 1981

### *Pseudostylosphaera coccostyla acrior* (BRAGIN, 1986)
(Pl. 6, Figs. 12–14)

1979  *Archaeospongoprunum compactum* NA-KASEKO and NISHIMURA, n. sp., pars – NA-KASEKO & NISHIMURA, p. 68, Pl. 1, Fig. 3, non ! Fig. 7

1982  *Archaeospongoprunum* sp. cf. *A. japonicum* NAKASEKO and NISHIMURA, 1979 – KOJIMA, Pl. 2, Fig. 7

1982  *Archaeospongoprunum compactum* NA-KASEKO and NISHIMURA – MIZUTANI & KOIKE, Pl. 3, Fig. 1

1982  *Stylosphaera* (?) *japonica* (NAKASEKO et NISHIMURA, 1979), pars – KISHIDA & SU-GANO, Pl. 2, Fig. 13

1982  *Archaeospongoprunum compactum* NA-KASEKO & NISHIMURA – SATO, NISHIZONO & MURATA, Pl. 2, Fig. 3

1986  *Archaeospongoprunum (?) acrior* sp. nov. – BRAGIN, p. 69, Pl. 2, Fig. 5

1988  *"Archaeospongoprunum" acrior* BRAGIN – BRAGIN, OLEJNIK & PARNJAKOV, p. 25, Pl. 2, Fig. 4

1989  *Pseudostylosphaera coccostyla* RÜST, pars – MARTINI, DE WEVER, ZANINETTI, DENELIAN & KITO, p. 150, Pl. 1, Fig. 17, Pl. 2, Figs. 11, 12, 16, Pl. 3, Figs. 10, 11

1990  *Pseudostylosphaera compacta* (NAKASE-KO and NISHIMURA) – YEH, p. 15, Pl. 4, Figs. 3, 4, 20

1991  *Pseudostylosphaera coccostyla* (RÜST) – DOSZTÁLY, Pl. 4, Fig. 3

1992  *Archaeospongoprunum compactum* NA-KASEKO et NISHIMURA – FENG, QINGLAI, Pl. 2, Fig. 5

1993  *Pseudostylosphaera japonica* (NAKASE-KO and NISHIMURA) - SASHIDA, NISHINURA, IGO, KAZAMA & KAMATA, p. 89, 7-9, 15

1993  *Archaeospongoprunum compactum* NAKA-SEKO et NISHIMURA, 1979 – FENG, QINGLAI & LIU BENPEI, p. 542, Pl. 1, Figs. 1, 2

1993  *Archaeospongoprunum japonicum* NA-KASEKO & NISHIMURA, 1979 – FENG, QINGLAI & LIU BENPEI, p. 542, Pl. 1, Fig. 3

1994  *Pseudostylosphaera coccostyla compacta* (NAKASEKO & NISHIMURA, 1979) – KOZUR & MOSTLER, p. 44, Pl. 1, Fig 8

**Occurrence:** Illyrian (common) and Lower Ladinian (rare) of Japan, Philippines, SE Siberia, Austria, Hungary and Italy.

**Remarks:** *Pseudostylosphaera coccostyla coccostyla* (RÜST, 1892) displays a secondary furrow in the ridges of the polar spines.

*Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA, 1979) emend. has longer polar spines.

## *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA, 1979) emend.
### (Pl. 6, Fig. 17)

1979    *Archaeospongoprunum compactum* NA-
        KASEKO andNISHIMURA, n. sp. – NAKASE-
        KO & NISHIMURA, p. 68, Pl. 1, Fig. 7, non !
        Fig. 3
1982    *Archaeospongoprunum compactum* NA-
        KASEKO & NISHIMURA – TAKASHIMA &
        KOIKE, Pl. 2, Fig. 3

**Occurrence:** Illyrian of Japan, Austria, Hungary and Italy.

**Remarks:** NAKASEKO & NISHIMURA (1979) figured under *Archaeospongoprunum compactum* two different species.

The paratype is a very robust form with broad polar spines that are about 1.2 x longer than the axial diameter of the cortical shell. These forms are closely related to *P. coccostyla* (RÜST, 1892), but have a more subspherical shell and the blades of the robust main are rounded and have no secondary furrow. The polar spines are mostly somewhat longer than the axial diameter of the shell, but partly of the same length (length of polar spine: axial diameter of shell = 1:1; 3:1).

The holotype has a subspherical shell and rather long polar spines (about 1.5 x longer than the axial diameter of the shell). The polar spines are at least in the proximal half parallel-sided and only in the distal half there width decreases. *P. compactum* is restricted to these forms that are transitional forms between *P. coccostyla* (RÜST, 1892) and *P. longispinosa* KOZUR & MOSTLER, 1981. *P. coccostyla* has broader and shorter spines, in typical (Lower Ladinian) forms with a median furrow on the blades of the polar spines and an ellipsoidal cortical shell.

The Lower Ladinian *P. longispinosa* displays longer spines (around twice as long as the axial diameter of the globular shell) and the spines are more slender. Transitional forms form the basal Ladinian displays polar spines as slender as in *P. longispinosa* that are around 1.7 x longer than the axial diameter of the shell („*Stylosphaera*" compacta sensu BRAGIN, 1991).

## *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA, 1979)
### (Pl. 6, Fig. 15)

1979    *Archaeospongoprunum japonicum* (NAKA-
        SEKO and NISHIMURA, n. sp. – NAKASEKO &
        NISHIMURA, p. 68-69, Pl. 1, figs. 2, 4, 9 (?)
1981    *Pseudostylosphaera japonica* (NAKASE-
        KO & NISHIMURA, 1979) – KOZUR &
        MOSTLER, 1981, p. 32
1982    *Archaeospongoprunum japonicum* NA-
        KASEKO and NISHIMURA – MIZUTANI &
        KOIKE, Pl. 3, Fig. 3
1982    *Stylosphaera* (?) *japonica* (NAKASEKO et
        NISHIMURA, 1979), pars – KISHIDA & SU-
        GANO, Pl. 2, Figs. 10, 12
1982    *Archaeospongoprunum japonicum* NA-
        KASEKO & NISHIMURA – SATO, NISHIZONO
        & MURATA, Pl. 2, Figs. 1, 2
1982    *Archaeospongoprunum japonicum* NA-
        KASEKO and NISHIMURA – YAO, p. 55, Pl. 1,
        Fig. 21
1988    "*Archaeospongoprunum*" *japonicum* NA-
        KASEKO, NISHIMURA – BRAGIN, OLEJNIK &
        PARNJAKOV, Pl. 2, Fig. 3
1989    *Pseudostylosphaera japonica* (NAKASE-
        KO and NISHIMURA, 1979)- CHENG, p. 143,
        Pl. 6, Fig. 1, Pl. 7, Fig. 7
1990    *Pseudostylosphaera japonica* (NAKASE-
        KO & NISHIMURA)- YEH, p. 15, Pl. 4,
        Figs. 5–7
1991    "*Stylosphaera japonica*" (NAKASEKO et NIS-
        HIMURA), pars – BRAGIN, p. 91, Pl. 1, Fig. 11
1991    *Pseudostylosphaera coccostyla* (RÜST),
        pars – KOLAR—JURKOVŠEK, p. 75, 76,
        Pl. 5, Figs. 4 a, 4 b
1994    *Pseudostylosphaera japonicum* NAKAZA-
        WA, ISHIBASHI, KIMURA, KOIKE, SHIMIZU
        & YAO, Pl. 2, Fig. 7

**Occurrence:** Illyrian (Upper Anisian) of Japan, Philippines, SE Siberia, Hungary, Austria.

**Remarks:** This species was in general correctly determined, but sometimes the Lower Ladinian *P. postjaponica* KOZUR & MOSTLER, 1994, that has the same shape of the polar spines (broadest in or somewhat behind the midlength) was determined as *P. japonica* (e.g. LAHM, 1984). In this species

the polar spines are distinctly longer than the long axis of the cortical shell.

## *Pseudostylosphaera goricanae* n. sp.

1995   *Pseudosepsagon* ? aff. *illyricus* KOZUR & MOSTLER, 1994, pars – RAMOVŠ & GORIČAN, p. 189, Pl. 2, Figs. 1–5, non ! Figs. 6–9

**Derivatio nominis:** In honour of Dr. Š. GORIČAN, Ljubljana, for her outstanding radiolarian studies.

**Holotypus:** the specimen figured by RAMOVŠ & GORIČAN (1995) on Pl. 2, Fig. 2; rep.-no. 951204.

**Locus typicus:** Tourist path from Tacen through Spodnja Kuhinja to the top of Šmarna Gora, about 10 km NNW of the centre of Ljubljana, Slovenia, see RAMOVŠ & GORIČAN (1995, Fig. 1).

**Stratum typicum:** Red cherty limestone, sample 3R/3 (see RAMOVŠ & GORIČAN , 1995, Fig. 2); *S. transitus* Zone (uppermost Illyrian).

**Diagnosis:** *Pseudostylosphaera* with two-layered globular shell and twisted three-bladed polar spines that are about as long as the shell diameter. Blades of the polar spines narrow and furrows between them wide and deep.

**Description:** The cortical shell is globular, double layered. The outer pore frames encloses moderately large, triangular to pentagonal pores. The inner layer displays small pores. The vertices of the outer pore frames bear nodes. The polar spines have about the same length as the shell diameter, but they may have a long, needle-like round terminal spine. They are widest in the beginning of the distal third. The polar spines have three twisted narrow blades. The furrows between them are broad and deep. Inner structure not known.

**Measurements:**

Diameter of shell: 93–133 µm

Length of polar spines (without terminal needle-like spine: 93–113 µm

Maximum width of polar spines: 29–47 µm

**Occurrence:** *S. transitus* Zone (uppermost Illyrian) of Hungary, Austria and Slovenia.

**Remarks:** In our material only badly preserved fragments of this species are present that are, however determinable because of the twisted polar spines. For this reason a fully preserved specimen of the material figured by RAMOVŠ & GORIČAN (1995) was taken as holotype.

*Pseudostylosphaera* with twisted spines are typical for the Upper Triassic, especially for the Carnian. They have all deep, but narrow furrows between the at least proximally broad blades. The only other Middle Triassic *Pseudostylosphaera* with distinctly twisted spines is the Longobardian *P. helicata* (NAKASEKO & NISHIMURA, 1979). This species displays also narrow blades and wide deep furrows between them. However, it has an ellipsoidal cortical shell and the spines are distinctly longer than the long axis of the shell.

RAMOVŠ & GORIČAN (1995) assigned *Pseudostylosphaera goricanae* together with six-rayed forms to *Pseudosepsagon* ? aff. *illyricus* KOZUR & MOSTLER, 1994. *P. illyricus* is a three-rayed form with 2 additional needle-like spines that belongs to the Sepsagonidae and not to the Hindeosphaeridae as *Pseudostylosphaera*. Forms with polar spines cannot be assigned to this genus. Specimens with two polar spines, but with additionally 4 spines, in which all spines are arranged in three axis that are perpendicular to each other, are assigned to *Hexatortilisphaera* n. gen. They are transitional forms between this genus and *Pseudostylosphaera*.

## Genus *Hexatortilisphaera* n. gen.

**Derivatio nominis:** According to the 6 twisted spines and the spherical cortical shell.

Type species: *Hexatortilisphaera aequispinosa* n. gen. n.sp.

**Diagnosis:** The cortical shell is spherical, single or double-layered. The 6 main spines are arranged in 3 perpendicular axis. Two opposite spines may be stronger and form polar spines. The main spines are three-bladed, at least the polar spines and a part of the other main spines are twisted. A medullary shell is present, but its structure is unknown.

**Occurrence:** *S. transitus* Zone (upper Illyrian) of Austria, Hungary and Slovenia. ? Lower Ladinian of Hungary and Italy.

**Assigned species:**

*Hexatortilisphaera aequispinosa* n. gen. n.sp.

? *Hexalonche mesotriassica* KOZUR & MOSTLER, 1981

*Hexatortilisphaera bipolaris* n. sp.

**Remarks:** *Hexatortilisphaera bipolaris* n. sp. is a transitional form between the new genus and *Pseudostylosphaera* KOZUR & MOSTLER, 1981. This species displays distinct twisted polar spines as in *Pseudostylosphaera goricanae* n. sp. Additionally, four further spines are present and all spines are arranged in three axis that are perpendicularly to each other as in *Hexatortilisphaera* n. gen. These spines are smaller than the polar spines and only the larger ones among them are twisted. In *Hexatortilisphaera aequispinosa* n. gen. n. sp. all spines have the same size and are twisted.

## *Hexatortilisphaera aequispinosa* n. gen. n.sp.
(Pl. 8, Fig. 7)

**Derivatio nominis:** According to the main spines of equal length.

**Holotypus:** The specimen on Pl. 8, Fig. 7; rep.-no KKM 1995/I-21.

**Material:** 7 specimens.

**Diagnosis:** The single-layered cortical shell is spherical, has very high pore frames and moderately large subtriangular to pentagonal, partly roundish pores. The six three-bladed twisted main spines of equal length are situated in three axis that are perpendicular to each other.

**Description:** The single layered cortical shall is spherical. The pore frames are high, but without spines or distinct nodes on the vertices. The pores are somewhat variable in diameter, moderately large, subtriangular to pentagonal, partly roundish. The six main spines are situated in three axis that are arranged perpendicularly to each other. They are moderately broad and rather short, but somewhat longer than the radius of the cortical shell. They are three-bladed and distinctly twisted. The blades are narrow and the furrows between them broad and deep. A needle-like terminal spine may be pre-

sent. The structure of the medullary shell is unknown.

**Measurements:**

Diameter of the shell: 120–125 µm

Length of polar spines: 66–75 µm

Maximum width of polar spines: 25–30 µm

**Occurrence:** *T. florida* Subzone of the *S. transitus* Zone (upper Illyrian) of Austria.

**Remarks:** The Lower Ladinian *Hexatortilisphaera* ? *mesotriassica* (KOZUR & MOSTLER, 1981) is larger (diameter of shell ca. 200 µm) and displays relatively shorter (not longer than the shell radius), only slightly twisted main spines. The assignment of this species to *Hexatortilisphaera* is doubtful.

## *Hexatortilisphaera bipolaris* n. sp.

1995  *Pseudosepsagon* ? aff. *illyricus* KOZUR & MOSTLER, 1994, pars – RAMOVŠ & GORIČAN, p. 189, Pl. 2, Figs. 6–9, non ! Figs. 1–5

**Derivatio nominis:** According to the bipolar arrangement of the two larger main spines.

**Holotypus:** The specimen figured by RAMOVŠ & GORIČAN (1995) on Pl. 2, Fig. 8; rep.-no. 950727.

**Locus typicus:** Tourist path from Tacen through Sopdnja Kuhinja to the top of Ämarna Gora, about 10 km NNW of the centre of Ljubljana, Slovenia, see RAMOVŠ & GORIČAN (1995, Fig. 1).

**Stratum typicum:** Red cherty limestone, sample 3R (see RAMOVŠ & GORIČAN (1995, Fig. 2); *S. transitus* Zone (upper Illyrian).

**Diagnosis:** The spherical cortical shell is double-layered. Two of the six main spines are larger than the other ones, always twisted and bipolarly arranged. The smaller main spines are situated in two axis perpendicularly to the polar axis and to each other and partly untwisted.

**Description:** The cortical shell is spherical and thick-walled. It consists of two layers. The pore frames of the outer layer have nodes on the vertices. The pores of the outer layer are moderately large. The inner layer has very small pores. The main spines are situated in three axis that are perpendicular to each other. The polar axis is pronounced by distinctly larger, above all broader polar spines that are always twisted. The other spines are slender and

often also shorter than the polar spines. They are also three-bladed, but only the larger one are twisted. The blades are narrow, the furrows between them are broad and deep. Inner structure unknown.

**Measurements:**
Diameter of shell: 87–107 µm
Length of Polar spines: 73–127 µm
Maximum width of polar spines: 33-47 µm
Length of second order main spines: 47-80 µm
Maximum width of second order main spines: 13–20 µm

**Occurrence:** *S. transitus* Zone (upper Illyrian) of Slovenia.

**Remarks:** Because *Hexatortilisphaera bipolaris* n. sp. is a perfect transitional form between the genera *Pseudostylosphaera* and *Hexatortilisphaera* it is described herein despite of the fact that this species is not present in our material. Such transitional forms are often restricted to a very short interval and therefore difficult to find.

The other *Hexatortilisphaera* species have no more separation in polar spines and main spines of second order. Most similar is *Pseudostylosphaera goricanae* n. sp. that has only polar spines.

Family Parentactiniidae Kozur & Mostler, 1981

### Genus *Parentactinia* DUMITRICĂ, 1978b

Type species: *Parentactinia pugnax* DUMITRICĂ, 1978b

### *Parentactinia pugnax* DUMITRICĂ, 1978b
(Pl. 11, Fig. 8)

**Occurrence:** Upper Anisian and Lower Ladinian, world-wide.

Family Pentactinocarpidae DUMITRICĂ, 1978b

### Genus *Pentactinocapsa* DUMITRICĂ, 1978b

Type species: *Pentactinocapsa quadripes* DUMITRICĂ, 1978b

### *Pentactinocapsa awaensis*
(NAKASEKO & NISHIMURA, 1979)
(Text-Fig. 6 a; Pl. 5, Fig. 11; Pl. 9, Fig. 11)

1979  *Acanthosphaera awaensis* NAKASEKO and NISHIMURA, n. sp. – NAKASEKO & NISHIMURA, p. 67, Pl. 1, Figs. 1, 5, 6

1994  *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979) – KOZUR & MOSTLER, p. 46, Pl. 2, Figs. 10, 11

1995  *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979) – RAMOVŠ & GORIČAN, p. 188, Pl. 4, Fig. 9

**Occurrence:** Illyrian of Japan, Hungary, Slovenia and Austria.

**Remarks:** The continuation of the basal spines beyond the shell has a very variable angle against the shell axis.

There are only 4 round spines at the base of the pyramidal part of the shell that originate from short spinules of verticiles of the 4 basal spines. In the other *Pentactinocapsa* species at least 6–8 spines are present in that position.

### *Pentactinocapsa multispinosa* n. sp.
(Text-Figs. 5, 6 b; Pl. 5, Figs. 1–10, 12;
Pl. 9, Figs. 1, 2)

**Derivatio nominis:** According the high number of spines.

**Holotypus:** The specimen on Text-Fig. 6 b; rep.-no. 15-8-95/I-17.

**Material:** More than 100 specimens.

**Diagnosis:** *Pentactinocapsa* with 11–13 round spines, an apical spine, 4 basal spines and 6–8, mostly 7 spines at the end of two spinules from verticiles that branch off from the basal spines in the lower part of the apical half of the shell. Loose cortical shell with large pores.

**Description:** The loose cortical shell is in the apical part low pyramidal to subconical; between the lateral and basal spines it has the shape of an inverted cone frustum with very slowly diminishing diameter and below the basal spines the shell is hemilenticular to nearly flat. The pores have different size, but some very large pores are
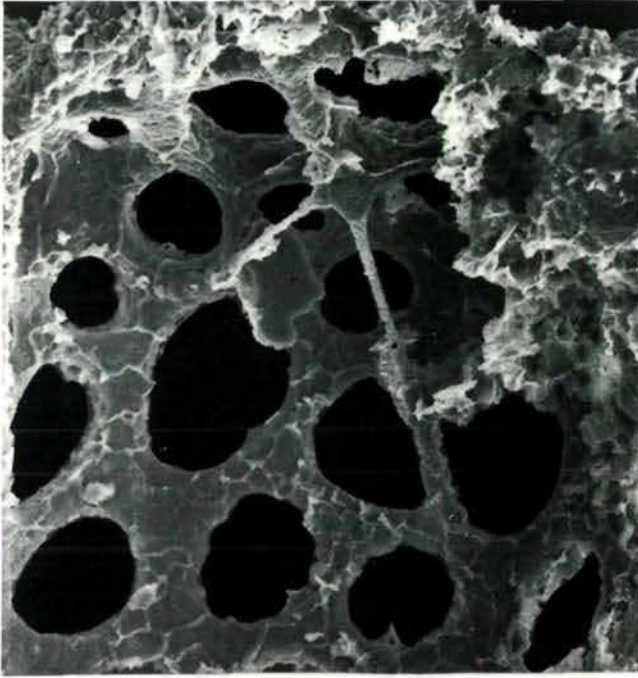
**Fig. 5:** *Pentctinocapsa multispinosa* n. sp.. verticile of the basal spines. Immediately below the verticile, the basal spine is a short distance free. Also the branching lateral spines of the verticile are free adjacent to the verticile. x 500, sample WW 3, rep. no. 15-8-95/1-27.

always present. The pore outline is variable, but always rounded (roundish, oval, rounded rectangular to rounded polygonal, rarely some rounded triangular pores are present). The pentactine spicular system is to its largest part inserted in the shell wall. The round, basally indistinctly rounded four-bladed apical spine is moderately large and free. The 4 basal spines are only distally free and form there outside the shell spines of the same size as the apical spine that are under different angle obliquely outward directed. In the middle part of the apical half of the shell a verticile with two needle-like spinules branch off every basal spine. Below the branching point the basal spine is a short distance free, then again inserted in the shell as above the branching point. The spinules are near the branching point also free, then inserted in the shell (see Text-Fig. 5). At their end a spine of the same length and shape as the apical spine and the basal spines ma be present. Consequently, maximally 8 such spines are present, but because some adjacent spinules may join, the number of the lateral spines varies from 6-8.
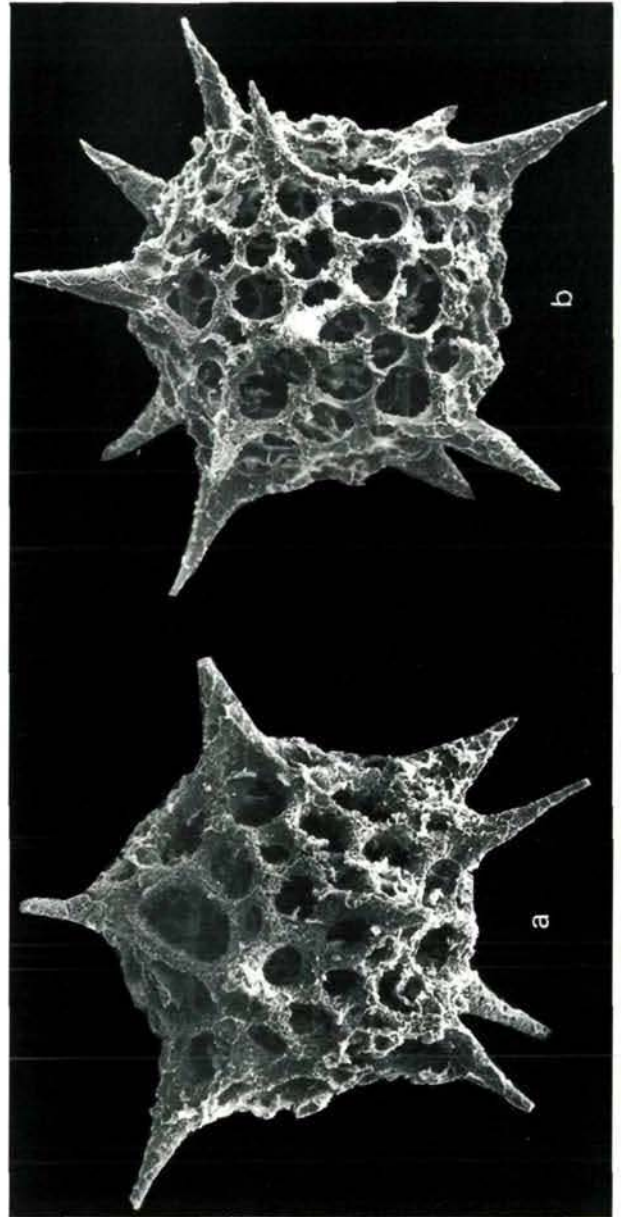


**Fig. 6:** Comparision of the lateral views of *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979) and *P. multispinosa* n. sp. a) *P. awaensis*, x 200, sample WW 12, rep.-no. 15-8-95/1-18. b) *P. multispinosa*, holotype, x 200, sample WW 7, rep.-no. 15-8-95/1-17.

These lateral spines are nearly perpendicular to the shell axis and only a little upward directed.

**Measurements:**

Axial diameter of heshell: 175–195 μm

Maximum shell diameter perpendicular to the shell axis: 175–235μm

Length of the spines: 60–82 μm

**Occurrence:** *Spongosilicarmiger transitus* Zone (uppermost Anisian) of Austria and Hungary.

**Remarks:** *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979) displays maximally 4 lateral spines that are obliquely upward directed.


## Genus *Pentactinorbis* DUMITRICĂ, 1978b

Type species: *Pentactinorbis kozuri* DUMITRICĂ, 1978b


### Pentactinorbis dumitricai
### KOZUR & MOSTLER, 1994
(Pl. 9, Figs. 3, 4 (?), 5, 6, 7–9 (?), 10, 14)

1994   *Pentactinorbis dumitricai* n. sp. – KOZUR & MOSTLER, p. 47-48, Pl. 3, Figs. 4-7

1995   *Pentactinorbis dumitricai* KOZUR & MOSTLER, 1994 – RAMOVŠ & GORIČAN, p. 188, Pl. 4, Figs. 10, 12

**Occurrence:** Illyrian of Austria, Hungary and Slovenia.

**Remarks:** The small spinules on the pentactine spicular system cannot be recognized in our material. However, this is surely preservation controlled, because the type material is of excellent preservation, the herein described material is only of moderate preservation. In the material figured by RAMOVŠ & GORIČAN (1995) these spinules are also not recognizable.In some specimens, the spines are distinctly longer (Pl. 9, Figs. 7–9); they are determined as *Pentactinorbis* cf. *dumitricai*. A similar form is figured by RAMOVŠ & GORIČAN (1995, Pl. 4, Fig. 12). This may be intraspecific variability. However, such forms are so far only known from the *S. transitus* Zone of the upper Illyrian and not form the immediately underlying *Tetraspinocyrtis laevis* Zone.


Family Sepasagonidae Kozur & Mostler, 1981


### Genus *Parasepsagon*
### DUMITRICĂ, KOZUR & MOSTLER, 1980

Type species: *Parasepsagon tetracanthus* DUMITRICĂ, KOZUR & MOSTLER, 1980


### *Parasepsagon variabilis*
### (NAKASEKO & NISHIMURA, 1979)
(Pl. 4, Figs. 2, 3, 7, 9)

1979   *Staurodoras variabilis* NAKASEKO and NISHIMURA, n. sp. – NAKASEKO & NISHIMURA, p. 71-72, Pl. 3, Figs. 5, 8

1989   *Parasepsagon variabilis* (NAKASEKO & NISHIMURA) – YEH, p. 63, Pl. 1, Figs. 16, 19

1991   *Staurolonche* ? *variabilis* (NAKASEKO & NISHIMURA) – BRAGIN, p. 86, Pl. 1, Fig. 16

1995   *Parasepsagon variabilis* (NAKASEKO & NISHIMURA, 1979) – RAMOVŠ & GORIČAN, p. 187, Pl. 3, Fig. 5

**Occurrence:** Upper Anisian of Japan, SE Siberia, Slovenia, Austria and western North America.

**Remarks:** Width and length of the spines is variable, but in general one spine is somewhat longer and broader than the other three ones. Characteristically, the three-bladed, untwisted spines are rather short (as long as the outer shell diameter or shorter) and broad. The outer pore frame has nodes at the vertices and enclose larger pores. The inner layer of the cortical shell displays small pores.

In all other known *Parasepsagon* species, the spines are distinctly longer than the shell diameter.


### Genus *Pseudosepsagon*
### KOZUR & MOSTLER, 1994

Type species: *Pseudosepsagon pentaspinosus* KOZUR & MOSTLER, 1994

RAMOVŠ & GORIČAN (1995) assigned species with 3 twisted main spines and those with additional one or two needle-like spines to *Pseudosepsagon*. Consequently, they included also *Sarla* ? *anisica* into *Pseudosapsagon*. However, *Pseudopsepsagon* is from the transitional field of four-rayed Sepsagonidae to three-rayed ones. In the Illyrian *P. trinodosus* ammonoid zone forms with additional spines (*P. pentaspinosus* KOZUR & MOSTLER, 1994 and *P. illyricus* KOZUR & MOSTLER, 1994) clearly dominate over three-rayed forms without additional spines. In the next younger uppermost Illyrian *Kellnerites fels-*

*oeoersensis* ammonoid zone forms with additional needle-like spines are already subordinate against forms with three twisted main spines and without additional spines. In Ladinian and younger deposits only forms with three twisted spines are present and forms with additional needle-like spines are missing. Rich Pelsonian faunas are not known. If in these and (or) older deposits only forms with three twisted main spines and additionally one or two needle-like spines are present, then *Pseudosepsagon* should be restricted to these forms. However, if also in this level forms with three twisted spines and with additional needle-like spines occur together, then they should be united in one genus. For the moment, *Sarla* ? *anisica* KOZUR & MOSTLER, 1994 is tentatively assigned to *Pseudosepsagon*.

*Pseudosepsagon* ? aff. *illyricus* KOZUR & MOSTLER, 1994 sensu RAMOVŠ & GORIČAN (1995) does neither belong to *P. illyricus* KOZUR & MOSTLER, 1994 nor to the genus *Pseudosepsagon*. *P. illyricus* is a three-rayed form with an additional needle-like spine. *Pseudosepsagon* ? *aff illyricus* RAMOVŠ & GORIČAN (1995) comprises typical *Pseudostylosphaera* KOZUR & MOSTLER with two twisted polar spines as well as similar forms with two polar spines that have additionally 4 cross-like arranged spines in the equatorial plane or irregularly arranged spines near the equatorial plane that probably do not belong to the same species (and perhaps even not to *Pseudostylosphaera*).

### Pseudosepsagon ? anisicus
### (KOZUR & MOSTLER, 1994)
(Pl. 4, Figs. 6?, 10)

1994    *Sarla* ? *anisica* n. sp. – KOZUR & MOST-LER, p. 77-78, Pl. 17, Figs. 7, 8
1995    *Pseudosepsagon pentaspinosus* KOZUR·& MOSTLER, 1994, pars – RAMOVŠ & GORIČAN, p. 189, Pl. 3, Figs. 9, 10, 11 (?)
**Occurrence:** Rare in the middle Illyrian, common in the upper Illyrian (Upper Anisian) of Hungary, Slovenia and Austria.
**Remarks:** *Pseudosepsagon* ? *anisicus* displays a latticed cortical shell as *Pseudosepsagon pentaspi-*

*nosus*, but the three main spines are considerably broader and additional needle-like spines are missing. Moreover, the vertices of the pore frames bear exclusively nodes, whereas the vertices of the pore frames in *P. pentaspinosus* bear spines and only some nodes. This latter sculpture of the vertices of the pore frames is present also in *Tripocyclia* sp. B NAKASEKO & NISHIMURA, 1979, *Sarla* sp. A CHENG, 1989, *Sarla* (?) sp. B YEH (1990) that were all assigned to *P. pentaspinosus* by RAMOVŠ & GORIČAN (1995). If these forms without additional needle-like spines belong to *Pseudosepsagon*, then they really do belong to *P. pentaspinosus* as assumed by RAMOVŠ & GORIČAN (1995). However, forms with stout twisted main spines and without additional needle-like spines that display exclusively nodes on the vertices of the pore frames belong to *P.* ? *anisica* as most of the figured material in RAMOVŠ & GORIČAN (1995). In *Pseudosepsagon* ? cf. *anisicus* (Pl. 4, Fig. 6, only one specimen is present) two of the three twisted stout main spines are situated near to each other. May be that this form displays an additional spine, but in its possible position the shell is encrusted with silica.

Family Thalassothamnidae Haecker, 1906

### Genus *Triassothamnus*
### KOZUR & MOSTLER, 1981

Type species: *Palacantholithus* ? *verticillatus* DU-MITRICĂ, 1978b
Synonym: *Archaeothamnulus* DUMITRICĂ, 1982a

### Triassothamnus verticillatus
### (DUMITRICĂ, 1978b)
(Pl. 11, Fig. 3)

1978b   *Palacantholithus* ? *verticillatus* n.sp. – DUMITRICĂ, p. 42, Pl. 1, Fig. 1; Pl. 2, Fig. 5
1981    *Triassothamnus verticillatus* (DUMITRICĂ, 1978) – KOZUR & MOSTLER, p. 5
1982a   *Archaeothamnulus verticillatus* (DUMI-TRICĂ) – DUMITRICĂ, p. 418, Pl. 5, Fig,. 3, 4; Pl. 7, Fig. 4

1990 *Triassothamnus verticillatus* (DUMITRI-CĂ), 1978 b – GORIČAN & BUSER, p. 160, Pl. 7, Fig. 3

**Occurrence:** *S. transitus* Zone (upper Illyrian) to Lower Ladinian.

Superfamily Hexastylacea HAECKEL, 1882
emend. PETRUSHEVSKAYA, 1979
Family Palhindeolithidae
KOZUR & MOSTLER, 1981

**Genus *Tandarnia* DUMITRICĂ, 1982a**

Type species: *Tandarnia recoaroense* DUMITRICĂ, 1982a

**Tandarnia recoaroense DUMITRICĂ, 1982a**
(Pl. 11, Figs. 1, 2, 4-7)

1982a *Tandarnia recoaroense* n. sp. – DUMITRI-CĂ, p. 415, Pl. 3, Figs. 6–10
1990 *Tandarnia recoaroense* DUMITRICĂ, 1982 – GORIČAN & BUSER, p. 159, Pl. 7, Fig. 4
1995 *Tandarnia recoaroense* DUMITRICĂ, 1982 – RAMOVŠ & GORIČAN, p. 191, Pl. 4, Fig. 11

**Occurrence:** *S. transitus* Zone (upper Illyrian) and Fassanian of Austria, Hungary and Italy.

Family Tiborellidae Kozur & Mostler, 1994

**Genus *Tiborella* DUMITRICĂ, KOZUR & MOSTLER, 1980 (in: DUMITRICĂ et al., 1980)**

Type species: *Tiborella magnidentata* DUMITRICĂ, KOZUR & MOSTLER, 1980

**Tiborella florida florida**
**(NAKASEKO & NISHIMURA, 1979)**
(Pl. 3, Figs. 5, 13–16)

1979 *Cecrops floridus* NAKASEKO and NISHIMU-RA, n. sp. – NAKASEKO & NISHIMURA, p. 69–70, Pl. 2, Figs. 5, 8

1991 *Staurolonche floridus* (NAKASEKO et NIS-HIMURA) – BRAGIN, p. 87, Pl. 10, Fig. 4
1994 *Tiborella florida* (NAKASEKO & NISHIMU-RA, 1979) – KOZUR & MOSTLER, p. 52
1995 *Tiborella florida* (NAKASEKO & NISHIMU-RA, 1979), pars – RAMOVŠ & GORIČAN, p. 191–192, Pl. 4, Figs. 1-4, non ! Fig. 5

**Occurrence:** *T. florida* Subzone of the *S. transitus* Zone (uppermost Anisian *Kellnerites felsoeoersensis* ammonoid zone) of Japan, southeastern Siberia, Slovenia and Austria.

**Remarks:** The knob-like end of the 4 spines is very characteristic for the nominate subspecies. The spines are untwisted or very slightly twisted. Forms with strongly twisted spines and pointed ends that were assigned to *T. florida* by RAMOVŠ & GORIČAN (1995, Pl. 4, Fig. 5) do not belong to this species, but represent a new species that is similar to *T. magnidentata* DUMITRICĂ, KOZUR & MOSTLER, 1980, but distinguished by its rectangular shell outline.

*Tiborella* sp. A CHENG, 1989 and *Tiborella* sp. A YEH, 1990, both assigned to *Tiborella florida* by RAMOVŠ & GORIČAN (1995) do not belong to the nominate subspecies (*Tiborella* sp. A CHENG, 1989) and not even to *T. florida* respectively (*Tiborella* sp. A YEH, 1990). *Tiborella* sp. A CHENG, 1989 with untwisted, terminally pointed to rounded spines (but without knob-like distal end) belong to *Tiborella florida austriaca* n. subsp., whereas *Tiborella* sp. A YEH, 1990 b with one twisted and 3 untwisted, terminally pointed spines is a *T. anisica* KOZUR & MOSTLER, 1994.

**Tiborella florida austriaca n. subsp.**
(Pl. 4, figs. 1, 5)

1989 *Tiborella* sp. A – CHENG, p. 147, Pl. 7, Fig. 18

**Derivatio nominis:** According to the occurrence in Austria.

**Holotypus:** The specimen on Pl. 4, Fig. 1; rep.-no. KKM 1995/I-1.

**Material:** 7 specimens.

**Diagnosis:** *Tiborella* with untwisted spines that are terminally pointed or round, but without knob-like distal thickening.

**Description:** Outer shell subrectangular to sub-globular. The pore frames are highly elevated. The pores are large. The 4 spines are three-bladed, very broad, moderately long. Their length differs slightly within one specimen; one spine may be broader than the others. The distal ends of the spines are rounded (especially in the broader spine) or pointed, but without knob-like thickening. Two ridges of the spines are connected with the ridges of adjacent spines to form a subrectangular frame that is partly overgrown by the pore frames of the shell. The 4 spines continue inside the cortical shell and join a rather small medullary shell with large pores. Internal structure inside the medullary shell not observable in the present material.

**Measurements:**

Diameter of shell: 130–145 μm

Length of spines: 65–110 μm

Maximum width of spines: 50–65 μm

**Occurrence:** *T. laevis* Zone and *T. florida* Subzone of the *S. transitus* Zone (Illyrian) of Austria and the Philippines.

**Remarks:** *Tiborella florida florida* (NAKASEKO & NISHIMURA, 1979) displays somewhat more slender spines with a knob-like distal thickening. The most specimens display a slight torsion of the spines.

*Tiborella agria* SUGIYAMA, 1992 from the Upper Olenekian of Japan has also untwisted spines, but they are slender and strongly pointed.

In *Tiborella anisica* KOZUR & MOSTLER, 1994, from the Illyrian *Paraceratites trinodosus* ammonoid zone, one spine is strongly twisted and distinctly longer than the other three, untwisted spines.

Family Triposphaeridae VINASSA DE REGNY, 1898 emend. KOZUR & MOSTLER, 1981

Synonym: Entactiniidae RIEDEL, 1967

### Genus *Helioentactinia* NAZAROV, 1975

Type species: *Entactinosphaera polyacantha* FOREMAN, 1963

Synonym: *Parentactinosphaera* KOZUR & MOSTLER, 1979

### *Helioentactinia oertlii*
### (KOZUR & MOSTLER, 1979)
### (Pl. 7, Fig. 9)

1979    *Parentactinosphaera oertlii* n. sp. – KOZUR & MOSTLER, p. 73–74, Pl. 2, Fig. 2

1981    *Helioentactinia oertlii* (KOZUR & MOSTLER, 1979) – KOZUR & MOSTLER, p. 17, Pl. 2, Figs. 2, 4, 6; Pl. 4, Figs. 1, 2, 7

1984    *Helioentactinia oertlii* (KOZUR & MOSTLER, 1979) – LAHM, p. 19, Pl. 2, Figs. 2, 3

**Occurrence:** Upper Anisian to Ladinian, ? Carnian of Austria, Hungary and Italy.

### Genus *Weverisphaera*
### KOZUR & MOSTLER, 1981

Type species: *Weverisphaera fassaensis* KOZUR & MOSTLER, 1981

Synonym: *Pseudoheptacladus* LAHM, 1984

### *Weverisphaera anisica* n. sp.
### (Pl. 8, Fig. 6)

**Derivatio nominis:** According to the occurrence in the Anisian.

**Holotypus:** The specimen on Pl. 8, Fig. 6; rep.-no. KKM 1995/I-8.

**Material:** 15 specimens.

**Diagnosis:** Cortical shell spherical, small, double-walled. The 7 long, slender, three-bladed main spines are in their proximal half parallel-sided, in the distal part tapering to their pointed distal end.

**Description:** The spherical, small shell is double-walled. The outer pore frames have moderately large pores, the inner pore frames have small pores. The vertices of the outer pore frames are only a little elevated. The seven equisized main spines are slender, in their proximal half parallel-sided, in their distal half tapering to the pointed distal end. The three blades are rather broad, the furrows between them are narrow and deep. The rounded, needle-like terminal part of the main spines without blades and furrows is very short. Medul-

lary shell present. The structure inside the medullary shell is unknown.

**Measurements:**

Diameter of cortical shell: 125–135 µm

Length of the main spines: 160–175 µm

Maximum width of the main spines: 25–30 µm

**Occurrence:** Illyrian of Austria and Hungary.

**Remarks:** The Lower Ladinian *Weverisphaera fassanica* KOZUR & MOSTLER, 1981, is larger and the distal needle-like round part of the main spines is 1/3 of the entire length of the main spines or longer.

Suborder Spumellaria EHRENBERg, 1875
Superfamily Actinommacea HAECKEL, 1862
emend. KOZUR & MOSTLER, 1979
Family Actinommidae HAECKEL, 1862 emend.
KOZUR & MOSTLER, 1979

## Genus *Acanthosphaera* EHRENBERG, 1858

Type species: *Acanthosphaera haliphormis* EHRENBERG, 1861

### *Acanthosphaera carterae* n. sp.
(Pl. 9, Figs. 15–18)

**Derivatio nominis:** In honour of Dr. Elizabeth S. CARTER, Veronia, for her outstanding contribution to the Upper Triassic an Jurassic radiolarian research.

**Holotypus:** The specimen on Pl. 9, Fig. 16; rep.-no. KKM 1995/I-12.

**Material:** 23 specimens.

**Diagnosis:** Single latticed shell with large, mostly hexagonal and pentagonal pores of different size. 7–10 small, three-bladed spines are present.

**Description:** The spherical, single latticed shell bears large pores of different size and shape; most of them are hexagonal and pentagonal, but few tetragonal or roundish pores may be also present. The vertices of the pore frames bear tiny spines. Sometimes the pore frames are verrucose. 7–10 small spines of different size are present. At their base they are rather broad and have

there three high blades separated by deep and wide furrows. The distal part of the largest spines among them is needle-like. Two spines, often in subpolar position, are often somewhat larger than the other ones. At least the largest spines continue at the inner side as fragile, needle-like spines.

**Measurements:**

Diameter of shell: 160–180 µm

Length of the spines: 12–40 µm

Width at the base of the spines: 14–20 µm

**Occurrence:** Illyrian of Austria, Hungary and Italy.

### *Acanthosphaera nicorae* n. sp.
(Pl. 8, Fig. 9)

**Derivatio nominis:** In honour of Prof. Dr. Alda NICORA, Milano, for her outstanding contributions to the Triassic micropaleontology and stratigraphy.

**Holotypus:** The specimen on Pl. 8, Fig. 9; rep.-no. KKM 1995/I-9.

**Material:** 7 specimens.

**Diagnosis:** Single spherical shell with large pentagonal and hexagonal pores and 7–8 tricarinate short main spines of equal size.

**Description:** The single spherical shell displays large pentagonal to hexagonal pores of somewhat variable size. The 7–8 tricarinate main spines are always distinctly shorter than the shell diameter. Their three narrow blades are separated by wide and deep furrows and reach until the distal end. The base of the main spines is rather broad, their width decreases continuously.

**Measurements:**

Diameter of shell: 113–130 µm

Length of main spines: 65–74 µm

Maximum width of main spines: 17–22 µm

**Occurrence:** Illyrian of Austria and Hungary.

**Remarks:** The Middle Carnian *Acanthosphaera mocki* KOZUR & MOSTLER, 1979, has more and shorter spines. It may be the successor of *A. nicorae*. All other known Triassic *Acanthosphaera* species have needle-like, to their largest part round main spines.

## Genus Hexalonche HAECKEL, 1882

Type species: *Hexalonche phaenaxonia* HAECKEL, 1887

### Hexalonche simplex LAHM, 1984
(Pl. 8, Figs. 1, 4)

1984 *Hexalonche simplex* n. sp. – LAHM, p. 79, Pl. 14, Figs. 2, 3
**Occurrence:** Upper Anisian – Lower Ladinian.

### Hexalonche bragini n. sp.
(Pl. 8, Fig. 5)

**Derivatio nominis:** In honour of N. Ju. BRAGIN for his important contributions to the knowledge of the Mesozoic radiolarians.
**Holotypus:** The specimen on Pl. 8, Fig. 5; rep.-no. KKM 1995/I-11.
**Material:** 3 specimens.
**Diagnosis:** Small shell with moderately large triangular or tetragonal pores and six very large main spines that become continuously narrower from their broad base towards the pointed distal end.
**Description:** The shell is small, subspherical, a little elevated below the spines. The pores are moderately large, trigonal or tetragonal, the pore frames are narrow and low. The six spines are relatively to the shell very large. They are situated in three axes that are perpendicular to each other. Their base is broad and they become continuously narrower towards the pointed distal end. The spines are tricarinate with wide and deep furrows. Near their distal end they become needle-like with round cross section. Inner structure unknown.
**Measurements:**
Diameter of shell: 93–107 µm
Length of the main spines: 179–235 µm
Width of the main spines at their base: 35–42 µm
**Occurrence:** So far only known from the *T. florida* Subzone of the *S. transitus* Zone (upper Illyrian) at the locality Weiße Wand.

## Genus *Triassospongosphaera* KOZUR & MOSTLER, 1981

Type species: *Spongechinus triassicus* KOZUR & MOSTLER, 1979

### Triassospongosphaera multispinosa (KOZUR & MOSTLER, 1979)
(Pl. 8, Figs. 8, 12)

1979 *Acanthosphaera* ? *multispinosa* n. sp. KOZUR & MOSTLER, p. 50, Pl. 20, Fig. 3
1981 *Triassospongosphaera multispinosa* (KOZUR & MOSTLER, 1979) – KOZUR & MOSTLER, p. 67, Pl. 58, Fig. 3
1984 *Triassospongosphaera multispinosa* (KOZUR & MOSTLER, 1979) – LAHM, p. 66–67, Pl. 11, Fig. 10
**Occurrence:** Upper Anisian – Middle Carnian.

Family Ethmopshaeridae HAECKEL, 1862

## Genus *Cenosphaera* EHRENBERG, 1854

Type species: *Cenosphaera plutonis* EHRENBERG, 1854

### Cenosphaera parvispinosa n. sp.
(Pl. 9, figs. 12, 13)

**Derivatio nominis:** According to the tiny, needle-like spines at the vertices of the pore frames.
**Holotypus:** The specimen on Pl. 9, Fig. 13; rep.-no. KKM 1995/I-2.
**Material:** 31 specimens.
**Diagnosis:** Latticed shell with tiny spines at the vertices of the pore frames. Pores large, hexagonal and pentagonal.
**Description:** The spherical shell has large, hexagonal (dominant) and pentagonal pores. The pore frames are high and bear tiny, needle-like spines at the vertices. Few of these spines may be somewhat longer, but they are also very small and needle-like. There are no inner continuations of the spines.

**Measurements:**

Diameter of the shell: 210–239 μm

Length of the spines at the vertices: In general up to 5 μm, single spines up to 17 μm

Width of the spines at the vertices: In general up to 2 μm, rarely up to 5 μm

**Occurrence:** Upper Anisian and Lower Ladinian of Austria, Hungary and Italy.

**Remarks:** The presence of tiny spines in *Cenosphaera* is exceptional, but they are only sculptures on the vertices of the pore frames and have no inner continuations.

Superfamily Centrocubacea
HOLLANDE & ENJUMET, 1960

## Family Heptacladidae
## DUMITRICĂ, KOZUR & MOSTLER, 1980

**Remarks:** The polygonal to cubic microsphere of *Heptacladus* consists of 2 opposite pentagonal frames and 5 quadratic frames between them. It is therefore near related to the Centrocubidae as already stated by DUMITRICĂ (1983). Centrocubidae HOLLANDE & ENJUMET, 1960 and Heptacladidae DUMITRICĂ, KOZUR & MOSTLER, 1980 are united in the superfamily Centrocubacea. It is not clear, whether this microsphere is a modified entactinarian spicular system, like in *Lithocubus* HAECKEL, 1882 for the Nassellaria or a special spumellarian medullary shell. For the moment, they are assigned to the Spumellaria. However, a separate superfamily is necessary. The Centrocubidae are restricted to the Neogene Centrocubacea, in which branching verticile spines form a spongy meshwork. In the Heptacladidae, the verticile spines are unbranched and join directly the adjacent spines that originate from the corners of the microsphere. Several other, mostly undescribed families may belong to this superfamily.

## Genus *Heptacladus* DUMITRICĂ,
## KOZUR & MOSTLER, 1980

Type species: *Heptacladus crassispinus* DUMITRICĂ, KOZUR & MOSTLER, 1980

## *Heptacladus crassispinus* DUMITRICĂ,
## KOZUR & MOSTLER, 1980
(Pl. 7, Fig. 12)

**Occurrence:** Upper Anisian to Lower Ladinian from Austria, Hungary and Italy.

## *Heptacladus* ? *anisicus* n. sp.
(Text-Fig. 7; Pl. 7, Figs. 10, 11, 13, 14)

**Derivatio nominis:** According to the occurrence in the Anisian.

**Holotypus:** The specimen on Pl. 7, Fig. 10; rep.-no. KKM 1995/I-5.

**Material:** 31 specimens.

**Diagnosis:** The subspherical shell bears needle-like short spines at the vertices. The 4 round, needle-like main spines are very long and very slender, a round medullary shell is present.

**Description:** The pores of the very large subspherical shell are very large, but of irregular size and shape. The vertices of the pore frames bear small, needle-like spines that may branch at their distal end. The four main spines are not situated in one plane, but are not situated much outside the equatorial plane. They are very long, very slender, needle like. A spherical medullary shell is present that is connected by 6–8 spines with the cortical shell. Four of these spines continue outside the cortical shell as the main spines. Structure inside the medullary shell unknown.

**Measurements:**

Diameter of the cortical shell: 133–181 μm

Diameter of the medullary shell: 64–69 μm

Length of the main spines: 245–363 μm

Maximum width of the main spines: 17–29

Length of the by-spines at the vertices: 7–29 μm

**Occurrence:** *S. transitus* Zone (upper Illyrian) at Weiße Wand.

**Remarks:** Because the structure inside the medullary shell is not known, the assignment to *Heptacladus* is tentative. *Heptacladus crassispinus* DUMITRICĂ, KOZUR & MOSTLER, 1980 is distinguished by the presence of 7 spines and by the absence of a medullary shell.
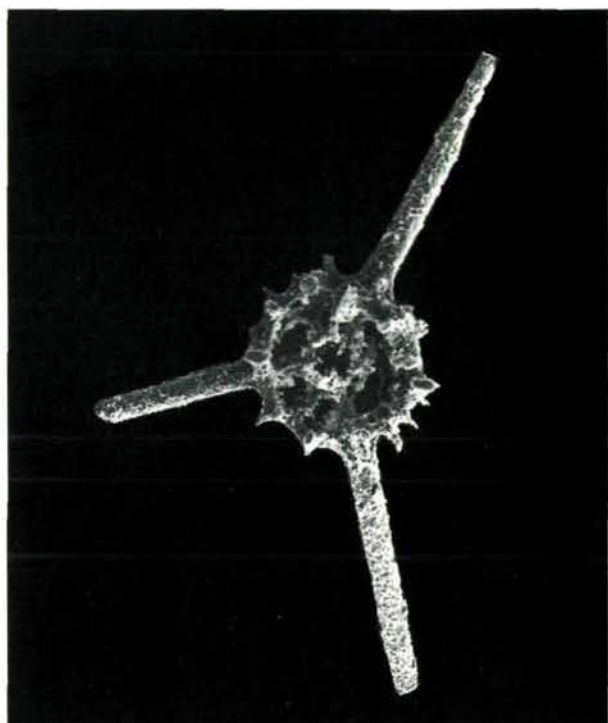
Fig. 7: *Heptacladus anisicus* n. sp., opened specimen with visible medullary shell. x 150. sample WW 4. rep.-no. 15-8-95/I-11.

## Genus *Komoella* LAHM, 1984

Type species: *Komoella symmetrica* LAHM, 1984

### *Komoella symmetrica* LAHM, 1984
(Pl. 8, Fig. 2)

1984    *Komoella symmetrica* n. sp. – LAHM, p. 32–33, Pl. 4, Figs. 5, 6

**Occurrence:** Upper Anisian and Lower Ladinian of Austria, Hungary and Italy.

**Remarks:** Our material displays beside tiny by-spines at the vertices of the pore frames also few somewhat longer by-spines. Because also in *Heptacladus* the length of the by-spines is very variable, this difference is regarded as intraspecific variability.

## Genus *Livinallongella* LAHM, 1984

Type species: *Livinallongella hauseri* LAHM, 1984

**Remarks:** LAHM (1984) reported the same inner structure as for *Heptacladus* DUMITRICĂ, KOZUR & MOSTLER, 1980, but did not figured this structure. We have opened several specimens of *L. hauseri*, but because of the recrystallisation of our material we could neither confirm nor reject the observations by LAHM (1984). In the assignment of *Livinallongella* to the Heptacladidae we follow LAHM (1984), but this assignment is tentative so long the inner structure cannot be documented.

### *Livinallongella lahmi* n. sp.
(Pl. 7. Figs. 1, 2, 3 [cf.] 4, 5, 6 [cf.], 7, 8 [aff.])

**Derivation of name:** In honour of Dr. B. LAHM who recovered the genus *Livinallongella*.

**Holotypus:** The specimen on Pl. 7, Fig. 2, rep.-no. KKM 1995/I-6.

**Material:** More than 100 specimens.

**Diagnosis:** A *Livinallongella*, in which the 7 main spines have after the vertices an oval, rarely triangular cross section, but without furrows. Vertices are present in or after the midlength of the main spines, rarely also before the midlenght.

**Description:** The cortical shell is spherical to subspherical and often overgrowths a little the base of the 7 main spines. The proximal part of the main spine is three-bladed with three deep furrows. The distal part of the main spines after the vertices is needle-like and has an oval cross section. In transitional forms to *Livinallongella hauseri* LAHM (*Livinallongella* cf. *lahmi*, Pl. 7, Figs. 3, 6) their cross section is triangular, but without furrows. This distal part of the main spines is in general as long as the proximal part, but in some specimens longer. The vertices are situated in or behind the midlength of the main spines, but in some specimens before the midlength. They bear three, needle-like denticles of different length. Often they are as long as or even longer than the distal part of the main spines after the vertices, exceptionally they are very short. The

main spines continue inside the cortical shell and have in the inner part vertices. A medullary shell could not be observed, but the innermost part was always recrystallized.

**Measurements:**
Diameter of shell: 100–136 µm
Length of the main spines: 133–169 µm
Maximum width of the main spines: 23–31 µm
Length of the distal part of the main spines after the vertices: 35–127 µm
Length of the side-spines at the vertices: 33–154 µm, rarely only 18 µm (*Livinallonga* aff. *lahmi*)

**Occurrence:** Very common in the *S. transitus* Zone (upper Illyrian) of the Weiße Wand Member of the Weiße Wand section, but surprisingly not yet found outside the type locality.

**Remarks:** In *Livinallongella hauseri* LAHM, 1984, the distal part of the spines is more than twice as long as the proximal part and it has the same cross section as the proximal part; only its distal end is needle-like with roundish cross section. The spines at the vertices are always considerably shorter (4–5 times) than the distal part of the main spine after the vertices.

*Livinallongella lahmi* is used in a very broad sense and may include several species. However, the investigated stratigraphic interval (part of a radiolarian subzone is too short to decide whether the observed differences demonstrate very high intraspecific variability or different taxa.

Moreover, rich *Livinallongella* associations occur only in samples WW 12 and WW 13. Thus, possible differences in the range of the rather different morphotypes cannot be estimated.

### Genus *Paraheptacladus* KOZUR & MOSTLER, 1981

Type species: *Paraheptacladus symmetricus* KOZUR & MOSTLER, 1981
**Remarks:** This genus probably does not belong to the Heptacladidae, but to the entactinarian Triposphaeridae. However, the internal structure is not yet well known.

### *Paraheptacladus symmetricus* KOZUR & MOSTLER, 1981
(Pl. 8, Fig. 3)

1981 *Paraheptacladus symmetricus* n. sp. – KOZUR & MOSTLER, p. 27-28, Pl. 69, Fig. 1
**Occurrence:** Upper Anisian and Lower Ladinian of Austria, Hungary and Italy.

### Genus *Welirella* DUMITRICĂ, KOZUR & MOSTLER, 1980

Type species: *Welirella weveri* DUMITRICĂ, KOZUR & MOSTLER, 1980
**Remarks:** The assignment of *Welirella* to the Heptacladidae is tentative. The inner continuations of the main spines have (in their outer part) verticiles with three spines, like the Heptacladidae. However, the structure of the central part of the unit is unknown. Therefore we do not know, whether it has there an entactinarian spicular system or a microsphere.

### *Welirella fleuryi* (DE WEVER, 1979, in DE WEVER et al., 1979)
(Pl. 8, Fig. 10)

1979 *Conosphaera* (?) *fleuryi* DE WEVER, n. sp. – DE WEVER, SAN FILIPPO, RIEDEL & GRUBER, p. 78-79, Pl. 1, Figs. 5–7
**Occurrence:** Upper Anisian to Middle Carnian of the Tethys.
**Remarks:** *Welirella fleuryi* (DE WEVER, 1979) has 12 main spines with very broad base. In the holotype very big pores are present at the base of the main spines between their blades. However, these big pores may be closed by pore frames with smaller pores as in the paratype and in the present material.

### *Welirella mesotriassica* n. sp.
(Pl. 8, Fig. 13)

1984 *Astrocentrus pulcher* KOZUR & MOSTLER, 1979 – LAHM, p. 20, Pl. 2. Fig. 5

**Derivatio nominis:** According the occurrence in the Middle Triassic

**Holotypus:** The specimen on Pl. 8, Fig. 13; rep.-no. KKM 1995/I-13.

**Material:** More than 100 specimens.

**Diagnosis:** *Welirella* with 14-15 main spines with broad blades and narrow deep furrows between them. Pores at the base of the spines moderately large.

**Description:** The spherical shell is double-walled. The outer pore frames surround large irregular pores and have nodes or short broad spines at the vertices. The inner pore frames enclose small oval or roundish pores. The 14-15 main spines have in their proximal part three high and broad blades that are separated by deep and narrow furrows. At their base, the blades have a median furrow. The pores at the base of the main spines are moderately large. The inner continuation of the main spines has vertices with three side spines.

**Measurements:**

Diameter of shell: 167–227

Length of main spines: 109–120

Width at the base of the main spines: 36–41

**Occurrence:** Illyrian to Ladinian of Austria, Hungary and Italy.

**Remarks:** LAHM (1984) assigned forms with double-layered shells to *Astrocentrus pulcher* KOZUR & MOSTLER, 1979, that has a spongy shell. According to his opinion the spongy character is caused by recrystallization. However, the Middle Carnian material from Göstling is excellently preserved and not recrystallized. It shows in all specimens of *Astrocentrus pulcher* a spongy shell. On the other hand, our material from the Weiße Wand Member is only moderately preserved and recrystallized but it shows clearly the double-layered character of the shell in *Welirella fleuryi* and *W. mesotriassica* with large outer pore frames and small inner pore frames.

*Welirella fleuryi* (DE WEVER, 1979) has only 12 main spines. Their blades are narrow and the furrows between them are broad. Therefore large pores are developed at the base of the spines at the place of the furrow between the blades. These large pore may be closed by the inner pore frames with small pores.

*Welirella weveri* DUMITRICĂ, KOZUR & MOSTLER, 1980 emend., has only 9 spines with a very broad base and very big pores at the base of the spines.

Family Pantanelliidae PESSAGNO, 1977

### Genus *Pessagnollum* n. gen.

Type species: *Pessagnollum multispinosum* n. gen. n. sp.

**Derivatio nominis:** In honour of E.A. PESSAGNO, Dallas, for his outstanding contributions to the Mesozoic radiolarian research.

**Diagnosis:** The spherical shell has very large hexagonal and pentagonal pores and high pore frames. Two short, broad, pyramidal tricarinate polar spines and several smaller by-spines of similar shape are present that are concentrated to the equatorial plane.

**Occurrence:** Upper Illyrian of western Tethys.

**Assigned species:** *Pessagnollum multispinosum* n. gen. n. sp.

**Remarks:** The pore frames are typical for the Pantanelliidae. Very short polar spines are occasionally also present in *Ellipsoxiphus* DUNIKOWSKI, 1882 (junior synonyms: *Druppatractylus* HAECKEL, 1887, and *Pantanellium* PESSAGNO, 1977), e.g. in *Ellipsoxiphus* sp. aff. *P. haidaense* (PESSAGNO & BLOME, 1980), but this genus has no additional spines almost of the same size as the polar spines.

### *Pessagnollum multispinosum* n. gen. n. sp.
(Pl. 8, Fig. 11)

**Derivatio nominis:** According to the numerous spines for the family Pantanelliidae.

**Holotypus:** The specimen on Pl. 8, Fig. 11; rep.-no. KKM 1995/I-10.

**Material:** 11 specimens.

**Diagnosis:** As for the genus.

**Description:** The spherical shell has the typical Pantanelliidae pore frames with very large hexagonal and pentagonal pores. The two polar spines are very short, broad, of pyramidal shape. They have

three high blades and very broad and deep furrows. Few vertices of the pore frames have short spines, but near the equatorial plane 6-8 short, broad, pyramidal spines are present that have about half of the size of the polar spines or are somewhat larger. The interior of all specimens is sediment filled preventing the observation of the inner structure, but a medullary shell is probably present.

**Measurements:**

Diameter of shell: 163–174 µm

Length of polar spines: 39–48 µm

Basal width of polar spines: 35-39 µm

Length of spines near the equatorial plane: 17–27 µm

**Occurrence:** *S. transitus* Zone (upper Illyrian) of Austria and Hungary.

**Remarks:** Pantanelliidae appear for the first time in the upper Olenekian, but are nearly absent in the Middle Triassic and become again common in the Norian. No species, similar to *P. multispinosum* is known.

Family Stylosphaeridae HAECKEL, 1882

### Genus *Spongostylus* HAECKEL, 1882

Type species: *Spongostylus hastatus* HAECKEL, 1887

### *Spongostylus nakasekoi* n. sp.
(Pl. 6, Fig. 18)

**Derivatio nominis:** In honour of Prof. KOJIRO NAKASEKO, Osaka, for his outstanding contributions to the radiolarian research in Japan.

Holotypus: The specimen on Pl. 6, Fig. 18; rep.-no. KKM 1995/I-15.

Material: 7 specimens, all with more or less corroded spongy shell.

Diagnosis: *Spongostylus* with very large, slightly twisted polar spines that are widest at the beginning of the distal third.

Description: The spherical spongy shell is badly fossilized. It consists of several densely spaced concentric spongy layers. The two polar spines are very large and slightly twisted. They are three-bladed with wide and deep furrows. Their width increases slowly and continuously until the beginning of the distal third, where they are widest and decrease from there to the pointed distal end.

Measurements:

Diameter of shell: 115-140 µm

Length of polar spines: 257-285 µm

Maximum width of polar spines: 46-54 µm

Occurrence: Illyrian of Austria and Hungary.

Remarks: *Spongostylus nakasekoi* n. sp. is the forerunner of the Lower Ladinian *Spongostylus koppi* (LAHM, 1984). This species displays also slightly twisted large polar spines, but they become continuously narrower from their base to the pointed distal end.

### *Spongostylus tricostatus* n. sp.
(Pl. 6, Fig. 16)

1990    *Spongopallium* cf. *koppi* (LAHM) – GORIČAN & BUSER, p. 157, Pl. 4, Figs. 2–4

1995    *Spongopallium* ? sp. RAMOVŠ & GORIČAN, Pl. 1, Figs. 6, 7

**Derivatio nominis:** According to the three-bladed polar spines.

**Holotypus:** The specimen on Pl. 6, Fig. 16; rep.-no. KKM 1995/I-7.

**Material:** 12 specimens.

**Diagnosis:** The spherical spongy shell has very big, three-bladed polar spines.

**Description:** The spherical shell is relatively small, spongy, consisting of numerous densely spaced spongy shells around a microsphere. The polar spines are long and very broad. They have three high blades, separated by deep, wide, V-shaped furrows. The proximal part of the polar spines is parallel sided or a slight widening occurs after the midlength. The distal narrowing to the pointed end occurs over a short distance.

Occurrence: *S. transitus* Zone (upper Illyrian) and Lower Ladinian of Austria and Slovenia.

**Measurements:**

Diameter of shell: 120–150 µm

Length of polar spines: 170–300 µm

Maximum width of the polar spines: 50–70 µm

**Remarks:** The Lower Ladinian *Spongostylus koppi* (LAHM, 1984) displays slender polar spines that become continuously narrower from their base to the pointed distal end. Specimens with slightly twisted slender polar spines occur also in our material, but in contrast to *S. koppi,* they are widest after their midlength. They may fit into the intraspecific variability of the new species, but it cannot be excluded that they are an independent taxon. They are assigned to *S.* cf. *tricarinata.*

GORIČAN & BUSER (1990) figured under *Spongopallium* ? cf. *koppi* forms that belong to the new species. The inner structure consisting of numerous densely spaced spongy shells around a tiny microsphere is well documented in this material. This is the typical structure of the Triassic *Spongostylus,* distinctly different from *Spongopallium* (see under Spongopalliidae).

*Spongostylus* ? *tetrapterus* (RAMOVŠ & GORIČAN, 1995) from the *S. transitus* Zone of Slovenia displays four-bladed polar spines. Its inner structure is unknown, but because of the similarity with *Spongostylus tricostatus* n. sp. it is rather a *Spongostylus* than a *Spongopallium.*

### Genus *Staurolonche* HAECKEL, 1882

Type species: *Staurolonche robusta* RÜST, 1885

### *Staurolonche trispinosum trilobum* (NAKASEKO & NISHIMURA, 1979) (Pl. 10, Fig. 16)

1979 *Staurosphaera triloba* NAKASEKO and NISHIMURA, n. sp. – NAKASEKO & NISHIMURA, p. 72, Pl. 5, Figs. 1, 2

1980 *Stauracontium* ? *trispinosum ladinicum* n. sp. – DUMITRICĂ, KOZUR & MOSTLER, p. 17, Pl. 1, Fig. 5 (?); Pl. 2, Fig. 4; Pl. 3; Figs. 6, 7; Pl. 5; Fig. 4; Pl. 14, Fig. 45

1990 *Stauracontium* ? *trispinosum* (KOZUR & MOSTLER), 1979 – GORIČAN & BUSER, p. 158, Pl. 1, Fig. 2

1990 *Stauracontium* ? *trispinosum ladinicum* DUMITRICĂ, KOZUR and MOSTLER – YEH, p. 20, Pl. 6, Fig. 17

**Occurrence:** Upper Anisian and Lower Ladinian of Japan, Philippines, Austria, Hungary, Italy, Slovenia.

**Remarks:** KOZUR & MOSTLER (1979) established *Staurosphaera trispinosa* for Middle Carnian forms, in which the lateral spines at the verticiles are as long as or longer than the proximal part of the main spines before the verticile. DUMITRICĂ, KOZUR & MOSTLER (1980) separated Ladinian forms, in which the lateral spines at the verticiles are distinctly shorter than the proximal part of the main spines before the verticile. For the same forms, NAKASEKO & NISHIMURA (1979) had established few month earlier *Staurolonche triloba.* Consequently, *S. trispinosum ladinicum* is a junior synonym of *S. triloba.* LAHM (1984) regarded *S. trispinosum ladinicum* as inseparable from *S. trispinosum trispinosum,* because transitional forms are present. GORIČAN & BUSER (1990) followed LAHM (1984), but they recognized the synonymy with *Staurosphaera triloba* (NAKASEKO & NISHIMURA, 1979).

Our studies have shown that in the Anisian only forms with short spines at the verticiles occur. In the Lower Ladinian these forms clearly dominate, but exceptionally already forms occur, in which the lateral spines at the verticiles are at least as long as the proximal part of the main spines before the verticile. In the Carnian only the latter forms are present. Therefore, a subdivision in subspecies level is furthermore possible.

One medullary shell is present. Consequently, the forms belong to *Staurolonche,* HAECKEL, 1882.

### *Staurolonche praegranulosa* n. sp. (Pl. 10, Fig. 11)

**Derivatio nominis:** According to the assumed ancestral position to *Staurolonche granulosa* (DUMITRICĂ, KOZUR & MOSTLER).

**Holotypus:** The specimen on Pl. 10, Fig. 11; rep.-no. KKM 1995/I-14.

**Material:** 7 specimens.

**Diagnosis:** The cortical shell has small trigonal to hexagonal pores. The four large main spines are slightly twisted and become continuously narrower from the base towards the pointed distal end.

**Description:** The spherical cortical shell displays pores of different size and shape. Triangular to hexagonal pores occur at one specimen. The four main spines are long, but differ somewhat in their length in one specimen. They are slightly twisted and tricarinate, in their distal part needle-like and round without blades and furrows. The furrows of the proximal part are deep and rather narrow. The main spines become continuously narrower from their relative broad base towards the pointed distal end.

**Measurements:**

Diameter of shell: 160–190 µm

Length of the main·spines: 230–330 µm

Width of the main spines at their base: 50–70 µm

**Occurrence:** Illyrian of Austria and Hungary.

**Remarks:** In *Staurolonche granulosa* (DUMITRICĂ, KOZUR & MOSTLER, 1980) the proximal part is parallel-sided and nearly untwisted and the main spines are broadest at the beginning of the twisted distal part.

## Family Spongopalliidae n. fam.

**Diagnosis**: Shell with two polar spines originating in an elongated inner medullary shell inside an elongated latticed shell (outer medullary shell) that is surrounded by a spongy mantle of various thickness.

**Occurrence:** Ladinian of western Tethys.

**Assigned genus:** *Spongopallium* DUMITRICĂ, KOZUR & MOSTLER, 1980.

**Remarks:** The Stylosphaeridae HAECKEL 1882, have no spongy mantle around a latticed medullary shell. If they have a spongy shell, like *Spongostylus* HACKEL, 1882, no latticed medullary shell is present surrounding the microsphere.

## Genus *Spongopallium* DUMITRICĂ, KOZUR & MOSTLER, 1980

Type species: *Spongopallium contortum* DUMITRICĂ, KOZUR & MOSTLER, 1980

### *Spongopallium* ? *tubulispina* n. sp.

1982    Spumellaria gen, et spec. indet. with tubular spines – DUMITRICĂ & MELLO, Pl. 2, Fig. 13

1990    *Spongopallium* ? sp. B – GORIČAN & BUSER, p. 158, Pl. 4, Fig. 6

**Derivatio nominis:** According to the tubular polar spines.

**Holotypus:** The specimen figured by GORIČAN & BUSER (1990, Pl. 4, Fig. 6); rep.-no. 87/220/7.

**Locus typicus:** Bohinj (northwestern Slovenia).

**Stratum typicum:** Limestone intercalation in tuffs and tuffites, sample 19726/5, middle part of Lower Ladinian (for locality and sample data see GORIČAN & BUSER (1990).

**Diagnosis:** *Spongopallium* (?) with tubular polar spines that are only distally carinate.

**Description:** The subspherical shell is spongy. The two polar spines have at their base several ridges and short, narrow furrows or pores between them. Then follows a tubular part and the distal part has sharp high blades separated by deep furrows that are connected with the hollow tube. The spines are widest at the beginning of the carinate distal part. Inner structure unknown.

**Occurrence:** Middle and Upper Fassanian of Italy, Slovakia and Slovenia.

**Remarks:** Our two present specimens were unsuccessfully broken for studying the inner structure. Therefore the well preserved specimen figured by GORIČAN & BUSER (1990, Pl. 4, Fig. 6) was chosen as holotype. The pore-bearing part at the base of the polar spines probably corresponds to the outer medullary shell and this part is not covered by the spongy mantle. By the tubular polar spine this species is well recognizable and easily separable from other *Spongopallium* species.

Superfamily Sponguracea HAECKEL, 1862
emend. KOZUR & MOSTLER, 1981
Family Oertlispongidae KOZUR & MOSTLER
(in: DUMITRICĂ et al., 1980)

### Genus *Paroertlispongus*
KOZUR & MOSTLER, 1981

Type species: *Paroertlispongus multispinosus* KO-
ZUR & MOSTLER, 1981

### *Paroertlispongus multispinosus*
KOZUR & MOSTLER, 1981
(Pl. 11, Fig. 12)

1981 *Paroertlispongus multispinosus* n. gen. n.
sp. – KOZUR & MOSTLER, p. 48, Pl. 44,
Fig. 2; Pl. 45, Fig. 1

1984 *Paroertlispongus multispinosus* KOZUR &
MOSTLER, 1981 – LAHM, p. 45-46, Pl. 7,
figs. 5, 6

1992 *Palaeoeucyrtis elongata* n. sp. – FENG,
QINGLAI, Pl. 2, Fig. 13

1993 *Palaeoeucyrtis elongata* FENG, pars -
FENG, QINGLAI & LIU, BENPEI, p. 548,
Pl. 2, Figs. 1-3

1994 *Paroertlispongus multispinosus* KOZUR &
MOSTLER, 1981 – KOZUR & MOSTLER,
p. 69, Pl. 12, Fig. 10; Pl. 13, Figs. 4, 11

**Occurrence:** *T. florida* Subzone of the *S. transi-
tus* Zone (upper Illyrian, uppermost Anisian) to
Lower Ladinian of Austria, Hungary, Italy,
China.

**Remarks:** *Paroertlispongus multispinosus* has a
long main spine that become wider distalwards
and is widest distinctly behind its midlength.
Oertlispongidae are mostly preserved as isolated
main spines. Most of the taxa can be determined
by these spines and several taxa were established
by isolated spines before the shell was known
DUMITRICĂ (1982b). The shell is obviously not
very resistant against dissolving in HF.

FENG, QINGLAI (1992) introduced the genus
*Palaeoeucyrtis* FENG for such isolated spines of
*Paroertlispongus* and for the isolated shorter spi-
nes of different Intermediellidae LAHM, 1994.

Family Intermediellidae LAHM, 1984

### Genus *Paurinella* KOZUR & MOSTLER, 1981

Type species: *Paurinella curvata* KOZUR & MOST-
LER, 1981

Synonym: *Yichunella* FENG, 1992

### *Paurinella fusina* (FENG, 1992)
(Pl. 11, Fig. 10)

1992 *Palaeoeucyrtis fusina* n. sp. – FENG,
QINGLAI, Pl. 2, Figs. 15, 16

1993 *Palaeoeucyrtis fusina* FENG – FENG,
QINGLAI & LIU, BENPEI, p. 548–549, Pl. 2,
Figs. 5–8

**Occurrence:** *S. transitus* Zone (upper Illyrian) of
China, Austria and Hungary.

**Remarks:** FENG, QINGLAI (1992) and FENG,
QINGLAI & LIU, BENPEI (1993) described isola-
ted main spines of *Paroertlispongus* as well as
of *Paurinella* and other Intermediellidae as
*Palaeoeucyrtis*. The spindle-shaped isolated
spines correspond in the form to the spines of an
Upper Illyrian *Paurinella* species. FENG,
QINGLAI (1992) and FENG, QINGLAI & LIU, BEN-
PEI (1993) described also a *Paurinella* species,
*P. sinensis*, that has partly the same spine type.
The proximal tapering part of these spines is in
general enclosed by the shell and cannot be ob-
served in forms with preserved shell except, if
the shell is corroded, as in our specimen on
Pl. 11, Fig. 10.

Superfamily Trematodiscacea HAECKEL, 1862
emend. KOZUR & MOSTLER, 1979
Family Relindellidae KOZUR & MOSTLER, 1980
(in: DUMITRICĂ et al., 1980)

### Genus *Pentaspongodiscus*
KOZUR & MOSTLER, 1979

Type species: *Pentaspongodiscus tortilis* KOZUR
& MOSTLER, 1979

### *Pentaspongodiscus mesotriassicus*
DUMITRICĂ, KOZUR & MOSTLER, 1980
(Pl. 4, Fig. 14)

1980   *Pentaspongodiscus mesotriassicus* n. sp. DUMITRICĂ, KOZUR & MOSTLER, p. 10, Pl. 8, Fig. 7

1984   *Pentaspongodiscus mesotriassicus* DUMITRICĂ, KOZUR & MOSTLER 1980 – LAHM, p. 56, Pl. 9, Fig. 11

1990   *Pentaspongodiscus mesotriassicus* DUMITRICĂ, KOZUR & MOSTLER, 1980 – GORIČAN & BUSER, p. 151, Pl. 2, Figs. 1, 2

**Occurrence:** *S. transitus* Zone (upper Illyrian) and Lower Ladinian of Austria, Hungary, Italy and Slovenia.

**Remarks:** *Pentaspongodiscus mesotriassicus* belongs to the most common species in the uppermost Anisian and above all in the Lower Ladinian of the western Tethys, but only in limestones samples. So far, this species was not discovered in radiolarites of the same age. Apparently, some radiolarian species cannot be well dissolved by HF from radiolarites.


### *Pentaspongodiscus steigeri* LAHM, 1984
(Pl. 4, Fig. 15)

1984   *Pentaspongodiscus steigeri* n. sp. – LAHM, p. 56-57, Pl. 9, Fig. 12

**Occurrence:** *S. transitus* Zone (upper Illyrian) and Lower Ladinian of Austria, Hungary and Italy..


Suborder Nassellaria EHRENBERG, 1875
Family Sanfilippoellidae
KOZUR & MOSTLER, 1979

Synonym: Poulpinae DE WEVER, 1981

### Genus *Neopylentonema* KOZUR, 1984

Type species: *Neopylentonema mesotriassica* KOZUR, 1984

### *Neopylentonema mesotriassica* KOZUR, 1984
(Pl. 4, Fig. 11)

1984   *Neopylentonema mesotriassica* n. sp. – KOZUR, p. 71, Pl. 4, Fig. 5; Pl. 5, Fig. 1; Pl. 6, Fig. 1

1990   *Neopylentonema mesotriassica* KOZUR, 1984 – GORIČAN & BUSER, p. 148, Pl. 6, Fig. 11

**Occurrence:** Upper Anisian and Lower Ladinian of the western Tethys.


### Genus *Poulpus* DE WEVER, 1979

Type species: *Poulpus piabyx* DE WEVER, 1979


### *Poulpus illyricus*
KOZUR & MOSTLER, 1994
(Pl. 11, Fig. 9)

1994   *Poulpus illyricus* n. sp. KOZUR & MOSTLER, p. 117, Pl. 29, Figs. 8–10; Pl. 32, Figs. 1, 2, 4

**Occurrence:** Middle and upper Illyrian of Austria and Hungary.


### Genus *Hozmadia*
DUMITRICĂ, KOZUR & MOSTLER, 1980

Type species: *Hozmadia reticulata* DUMITRICĂ, KOZUR & MOSTLER, 1980


### *Hozmadia rotunda*
(NAKASEKO & NISHIMURA, 1979)
(Pl. 3, Figs. 3, 4, 6, 7, 8 [cf.], 10 [aff.], 11)

1979   *Tripilidium rotundum* NAKASEKO and NISHIMURA, n. sp. – NAKASEKO & NISHIMURA, p. 81–82, Pl. 8, Figs. 1-3

1982   *Hozmadia* (?) sp. A – YAO, Pl. 1, Fig. 15

1991   *Hozmadia* cf. *reticulata* DUMITRICĂ, KOZUR & MOSTLER, 1980 – BRAGIN, p. 97–98, Pl. 1, Fig. 7

1993    *Hozmadia rotunda* (Nakaseko & Nishi-
        mura) - Sashida, Nishimura, Igo, Kaza-
        ma & Kamata, p. 84, Fig. 6-10
1994    *Hozmadia rotunda* (Nakaseko & Nishi-
        mura, 1979) - Kozur & Mostler, p. 116,
        Pl. 29, figs. 3, 4, 7
1995    *Hozmadia rotunda* (Nakaseko & Nishi-
        mura, 1979) – Ramovš & Goričan,
        p. 186, Pl. 7, Figs. 5-6

**Occurrence:** Middle and above all Upper Anisian of Austria, Hungary, Italy and Slovenia.

**Remarks:** The subspherical cephalis with large pentagonal pores, the curved feet that ends in a needle-like prolongation and the stout, pointed apical horn are characteristic features of *Hozmadia rotunda*. The form of the apical horn is variable. Partly it becomes continuously narrower towards the pointed distal end, partly the apical part is nearly parallel-sided or there is even a slight widening after the midlength and the distal part becomes rapidly narrower. In one specimen (Pl. 3, Fig. 10), the distal end of the apical spine is rounded. It may be a transition form to *Hozmadia rotundispina*. It is herein determined as *H*. aff. *rotunda*. Distinct nodes are in general present at the vertices of the pore frames, but few specimens (Pl. 3, Fig. 8) have a rather smooth surface. This may be preservation controlled. This form is determined as *H*. cf. *rotunda*.

*Hozmadia latispinosa* n. sp.
(Pl. 3, Figs. 1, 2)

**Derivatio nominis:** According to the very large apical horn.
**Holotypus:** The specimen on Pl. 3, Fig. 1; rep.-no. KKM 1995/I-16.
**Material:** 12 specimens.
**Diagnosis:** Cephalis spherical, with large pores. Apical horn very large, especially broad. Feet curved, rather broad, terminally without needle-like part.
**Description:** The cephalis is spherical and has a large aperture that is surrounded by a smooth brim. The pores are large, hexagonal or pentagonal and have high pore frames with nodes at the vertices.

The apical horn is very large, especially broad and in its largest part of the same width. It is widest a little behind the midlength and its width decreases only in the distal third. The distal end of the apical horn is pointed or slightly rounded and has no needle-like end. The three blades are very high, narrow and separated by very wide ad deep furrows. The three feet in prolongation of 2 L and D are slightly curved and have three high, narrow blades that reach until the pointed distal end that has no needle-like prolongation.
**Measurements:**
Length of the cephalis: 140–152 µm
Width of the cephalis: 140–155 µm
Lengths of the apical horn: 125–130 µm
Width at the midlenght of the apical horn: 56–60 µm
Length of the feet: 90–125 µm
Maximum width of the feet: 35 µm
**Occurrence:** *T. florida* Subzone of the *S. transitus* Zone (upper Illyrian) of the Weiße Wand Member (Loibl Formation), Austria.
**Remarks:** *Hozmadia rotunda* (Nakaseko & Nishimura, 1979) has not so stout apical horn and the feet have a distal needle-like prolongation.

In *Hozmadia rotundispina* both the apical horn and the feet have round distal ends.

*Hozmadia reticulocostata* n. sp.
(Pl. 3, Fig. 9)

**Derivatio nominis.** According to the reticulate and costate surface of the cephalis.
Holotypus: The specimen on Pl. 3, Fig. 9; rep.-no. KKM 1995/I-17.
**Material:** 4 specimens.
**Diagnosis:** *Hozmadia* with large pores and costae that originate in the feet.
Description: The cephalis is spherical and has a large aperture that is surrounded by a narrow, smooth ring. The pores of the cephalis are large and have mainly pentagonal and tetragonal outline. Small nodes are present at the vertices of the pore frames. From the blades of the 2 feet L narrow costae run obliquely upward. The apical horn is large, tricarinate with high, narrow blades and

deep and wide furrows between them. The proximal part of the apical horn is nearly parallel-sided, the distal part tapers towards the pointed distal end. The three feet in prolongation of 2 L and D are curved, tricarinate and have a needle-like round distal portion.

**Measurements:**
Length of the cephalis: 120–130 µm
Width of the cephalis: 127–134 µm
Length of the apical horn: 105–116 µm
Width of the apical horn: 32–35 µm
Length of the feet: 70–85 µm
Width of the feet: 25–30 µm

**Occurrence**: *T. florida* Subzone of the *S. transitus* Zone (upper Illyrian) of the Weiße Wand Member (Loibl Formation), Austria.

**Remarks:** The similar *Hozmadia rotunda* (NAKASEKO & NISHIMURA, 1979) has no costae on the cephalis.

### *Hozmadia rotundispina* n. sp.
(Pl. 2, Figs. 9-11; Pl. 3, Fig. 12)

**Derivatio nominis:** According to the rounded distal ends of the apical spine and feet.

**Holotypus:** The specimen on Pl. 3, Fig. 12; rep.-no. KKM 1995/I-18.

**Material:** 21 specimens.

**Diagnosis:** *Hozmadia* with large pores and broad apical spines and feet that have all a rounded distal end.

**Description:** The spherical cephalic has a large aperture surrounded by a smooth brim. The pores are large, mostly pentagonal and tetragonal. The large apical horn is broad, in the apical half parallel-sided, in the distal half slightly tapering towards the rounded distal end. The three blades are broad and have often in their basal part a median furrow. The furrows between the blades are deep and mostly narrow. The three feet in prolongation of 2 L and D are also broad, slightly curved to nearly straight. Their blades reach until the rounded distal end and often somewhat on the shell. They are sometimes broad and in this case the deep furrows are narrow, sometimes they are narrow and the deep furrows are broad.

**Measurements:**
Length of the cephalis: 127–150 µm
Width of the cephalis: 145–167 µm
Length of the apical horn: 107–130 µm
Width of the apical horn: 53–64 µm
Length of the feet: 100–130 µm
Width of the feet: 33–52 µm

**Occurrence:** *T. florida* Subzone of the *S. transitus* Zone (upper Illyrian) of the Weiße Wand Member (Loibl Formation), Austria.

**Remarks:** Most similar is *Hozmadia latispinosa* n. sp. that has, however, pointed distal ends of the apical spine and of the feet. Perhaps both forms are the end forms of a wide intraspecific variability.

Family Silicarmigeridae KOZUR & MOSTLER, 1980 (in: DUMITRICĂ et al., 1980)

### Genus *Spongosilicarmiger* KOZUR, 1984

Type species: *Spongosilicarmiger italicus* KOZUR, 1984

### *Spongosilicarmiger nakasekoi* YEH, 1990
(Pl. 1, Figs. 1-2, 6–10; Pl. 2, Figs. 1–3 [cf.])

1979    *Stichopterium* (?) sp. B – NAKASEKO & NISHIMURA, p. 80-81, Pl. 11, Figs. 2, 5

1990    *Spongosilicarmiger nakasekoi* YEH, n. sp. – YEH, p. 25, Pl. 5, Figs. 3, 16; Pl. 8, Figs. 4, 5; Pl. 9, Figs. 7, 8, 14; Pl. 11, Fig. 20

1995    *Spongosilicarmiger scabiturritus* SUGIYAMA, 1992 – RAMOVŠ & GORIČAN, 191, Pl. 6, Figs. 1-4

**Occurrence:** Upper Illyrian *S. transitus* Zone of Japan, Philippines, Austria, Hungary, Italy.

**Remarks:** The cephalis is covered by microgranular silica and therefore the pores are closed and also the pore frames are covered, but Sometimes the pores are open in the distal part of the cephalis. The smooth surface of the cephalis is the only difference to *Spongosilicarmiger scabiturritus* SUGIYAMA, 1992, with open pores and rugged surface as correctly mentioned by SUGIYAMA (1992). So-

metimes also in this species the pores are closed by recrystallization or an basal closure of microgranular silica. But also in such specimens the pore frames are visible and cause the rugged surface of the cephalis in S. *scabiturritus* . Consequently, the specimens with smooth cephalis surface that were assigned to S. *scabiturritus* by RAMOVŠ & GORI-ČAN (1995), belong to S. *nakasekoi*.

In *Spongosilicarmiger priscus* KOZUR & MOST-LER, 1994, the pores and pore frames of the cephalis are also closed by microgranular silica as in S. *nakasekoi*, but the surface of the cephalis is covered by distinct nodes and not smooth as in S. *nakasekoi*.

## *Spongosilicarmiger transitus laevis* n. subsp.
(Pl. 1, Figs. 3, 4, 5, 11–13; Pl. 2, Figs. 5–7)

**Derivatio nominis:** According to the smooth cephalis.
**Holotypus:** The specimen on Pl. 1, Figs. 5, 11, 12; rep.-no. KKM 1995/I-19.
**Material:** 14 specimens.
**Diagnosis:** Cephalis smooth, poreless. Cephalic tube with coarse pore frames. Only a few pores are open the others are closed by microgranular silica. At least one foot strongly sidewards directed.
**Description:** The cephalis is moderately large, subspherical and poreless. It consists of dense, microgranular silica. Its surface is smooth and has few indistinct ribs. In the cephalic tube few roundish pores are open, but the pore frames are also visible around closed pores. The frustum-like postcephalic part has 5–6 narrow segments separated by narrow circumferential rings. The pores between the rings are roundish or irregular, but mostly closed. The aperture is large, open. The thorax feet are needle-like and in their upper part inserted in the shell, where they are visible as narrow ridges. They are strongly outward directed and connected by wing-like shell material except their distal part.
**Measurements:**
Length of the cephalic tube: 75–110 μm
Maximum width of the cephalic tube: 45–50 μm
Length of the cephalis: 55–75 μm

Width of the cephalis: 80–85 μm
Length of the postcephalic part of the test: 110–160 μm
Width of the postcephalic part of the test (without wings): 105–120 μm
Length of the feet: 140–180 μm
**Occurrence:** T. *florida* Subzone of S. *transitus* Zone (upper Illyrian) of Austria.
**Remarks:** *Spongosilicarmiger nakasekoi* YEH, 1990, is distinguished by the fewer outward direction of the feet.

In *Spongosilicarmiger transitus transitus* KO-ZUR & MOSTLER, 1994 from the upper T. *florida* Subzone and Y. annulata Subzone of the S. *transitus* Zone (upper Illyrian) the cephalis is covered by distinct nodes.

## *Spongosilicarmiger terebrus* n. sp.
(Pl. 2, Figs. 4, 8, 12)

**Derivatio nominis:** According to the shape of the cephalotube.
**Holotypus:** The specimen on Pl. 2, Figs. 4, 8, 12; rep.-no. KKM 1995/I-20.
**Material:** 3 specimens.
**Diagnosis:** *Spongosilicarmiger* with blunt ending cephalotube that has at the distal end four short, cross-like arranged ribs and one or two intercalated ribs.
**Description:** Cephalis subspherical, covered with a layer of microgranular silica with a slightly uneven surface, but without open pores. Cephalic tube cylindrical with a blunt distal end that has 4 short cross-like arranged, high, narrow ribs and one or two intercalated ribs. These ribs cover only the blunt distal end that looks like a drill head. The remaining cephalotube has crater-like pore frames, but only few roundish pores are open. The frustum-like large postcephalic part of the test has five segments. The narrow and low circumferential rings are inserted in the shell and outside not well visible. The outer pore frames are well developed, but only some pores are open, mainly at both sides of the feet. The three feet in prolongation of D and 2 L are needle like and in the proximal part inserted in the shell, where they are visible as

narrow ridges. The distal, moderately outward directed part is free. The aperture is large, open.

**Measurements:**
Length of the cephalic tube: 80–90 μm
Maximum width of the cephalic tube: 40–44 μm
Length of the cephalis: 50–54 μm
Width of the cephalis: 76–85 μm
Length of the postcephalic part of the test: 105–125 μm
Width of the postcephalic part of the test: 100–110 μm
Length of the feet: Up to 200 μm

**Occurrence:** *T. florida* Subzone of *S. transitus* Zone (upper Illyrian) of Austria.

**Remarks:** The drill-head like, blunt, costate distal end of the cephalotube distinguishes this species from all other *Spongosilicarmiger* species.

## 7. Stratigraphic evaluation of the radiolarian fauna (see table 1)

KOZUR & MOSTLER (1994) recognized the very big differences between the radiolarian faunas of the Illyrian (Upper Anisian) *Paraceratites trinodosus* ammonoid Zone (*T. laevis* radiolarian zone) and the Fassanian *Reitziites reitzi* ammonoid Zone (*S. italicus* radiolarian zone). These differences were so strong that many guide forms of the S. italicus Zone are not directly related to ancestors in the *T. laevis* Zone. This very sharp change between the Upper Anisian and Lower Ladinian radiolarian fauna in a short stratigraphic interval had the disadvantage that many Ladinian forms appeared without ancestor in the next older radiolarian zone. Moreover, it was to expect that still a radiolarian fauna between the *T. laevis* and *S. italicus* zones was present. This fauna was now contemporaneously found in Slovenia (RAMOVŠ & GORIČAN, 1995) and in the southern Karawanken (present paper). It represents the *T. florida* Subzone of the *S. transitus* Zone (Kozur, 1995) between the *T. laevis* and *S. italicus* Zone. Not so rich assemblages of this fauna were known since NAKASEKO & NISHIMURA (1979), but except KOZUR & MOSTLER (1994) and RAMOVŠ & GORIČAN (1995)

these faunas were either incorrectly or not exactly dated. One of these faunas is the *Tiborella florida* fauna of Japan that was dated by NAKASEKO & NISHIMURA (1979) as Upper Triassic. This dating again was used to date taxa similar to species of this assemblage as possible Carnian (YEH, 1990, p. 25). Both KOZUR & MOSTLER (1994) and RAMOVŠ & GORIČAN (1995) dated this fauna as latest Anisian near the Anisian-Ladinian boundary (defined with the base of the *Reitziites reitzi* ammonoid zone s.str.).

The similar, but at least partly a subzone younger *Busuanga chengi* assemblage (*Y. annulata* Subzone of the *S. transitus* Zone sensu KOZUR, 1995) of latest Anisian age was assigned to the Ladinian by YEH (1990).

A part of the radiolarian faunas described by MARTINI et al. (1989) and DE WEVER et al. (1990) belongs also to the *S. transitus* Zone. Another part of these radiolarian faunas with *Tetraspinocyrtis laevis* belongs to the Upper Anisian *T. laevis* Zone and parts of these faunas with *Oertlispongus inaequispinosus* belongs to the Lower Ladinian. Thus, the summarizing assignment of these faunas as Anisian-Ladinian was correct, but not precise.

FENG, QINGLAI (1992) and FENG, QINGLAI & LIU BENPEI (1993) assigned the *"Shengia yini"* assemblage to the lowermost Scythian and the *"Pseudoeucyrtis liui"* assemblage to the Upper Scythian. Both are typical radiolarian faunas of the *S. transitus* Zone and belong because of the occurrence of *Triassocampe scalaris* DUMITRICĂ, KOZUR & MOSTLER, 1980 (= *Triassocampe soror* FENG & LIU, 1993 and *Shengia nanpanensis* FENG, 1992) to their largest part to the upper subzone (*Y. annulata* Subzone) of the *S. transitus* Zone. *Pseudoeucyrtis liui* FENG 1992 is an *Archaeospongoprunum mesotriassicum* KOZUR & MOSTLER, 1981 that is a typical upper Anisian guideform. Its co-occurrence with *Triassocampe deweveri* (NAKASEKO & NISHIMURA) (= *Shengia solida* FENG) and *T. scalaris* indicates the latest Anisian upper subzone (*Y. annulata* Subzone) of the *S. transitus* Zone for the "*Pseudoeucyrtis liui* assemblage". The same age is indicated for the upper "*Shengia yini* assemblage", in which *T. scalaris* is already common, but also in the lower

part of this assemblage *T. soror* (= *T. scalaris*) is rarely present. There also *T. deweveri* (= *Shengia solida*) is rarely present and *Paurinella fusina* (FENG) is common that occurs also in the *T. florida* Subzone of the *S. transitus* Zone of Austria. Thus, apparently the lower part of the "*Shengia yini* assemblage" belong to the *T. florida* Subzone or to the lower part of the *Y. annulata* Subzone of the *S. transitus* Zone.

Our rich fauna makes it now easier to recognize the *T. florida* Subzone (and the *S. transitus* Zone in general) also in faunas, in which *T. florida* is absent. Characteristic for the *T. florida* Subzone (and the *S. transitus* Zone in general) is the dominance of Anisian elements that range up from the *T. laevis* Zone together with the first Ladinian elements and some forms that are restricted to the *S. transitus* Zone or the *T. florida* Subzone. Important and common species that ranges up from the *T. laevis* Zone (or older zones) and do no more occur in the *S. italicus* Zone are: *Eptingium manfredi japonicum*, *E. nakasekoi*, *E. ramovsi*, *Hindeosphaera spinulosa*, *Hozmadia costata*, *Parasepsagon variabilis*, *Parentactinia lata*, *Pentactinocapsa awaensis*, *Pentactinorbis dumitricai*, *Pseudosepsagon ? anisicus*, *Pseudosepsagon pentaspinosus*, *P. compacta*, *P. japonica*, *Silicarmiger costatus anisicus*, *Spongostephanidium japonicum*, *S. longispinosum*, *Tiborella florida austriaca*, *Weverisphaera anisica*, *Acanthosphaera carterae*, *Acanthosphaera nicorae*, *Hozmadia rotunda* and *Poulpus illyricus*. With exception of the last 4 species (Spumellaria and Nassellaria) these are all Entactinaria, the dominant element of the Anisian faunas.

Species, restricted to the *S. transitus* Zone (S.t.), *T. florida* Subzone (T.f.) or to the *Yeharaia annulata* Subzone (Y.a.) are: *Hexatortilisphaera aequispinosa* (S.t.), *Hexatortilisphaera bipolaris* (S.t.), *Pentactinocapsa multispinosa* (S.t.), *Pseudostylosphaera goricanae* (S.t.), *Tiborella florida florida* (T.f.), *Triassistephanidium anisicum* (T.f.), *Heptacladus ? anisicus* (S.t.), *Livinallongella lahmi* (S.t.), *Paurinella fusina*, (S.t.), *Paurinella sinenesis* (S.t.), *Pessagnollum multispinosum* (T.f.), *Pseudoertlispongus angulata* (Y.a.), *Spongostylus tricostatus* (S.t.), *Spongostylus nakasekoi* (S.t.), *Spongostylus tetrapterus* (S.t.), *Staurolonche praegranulosa* (S.t.), *Hozmadia latispinosa* (S.t.), *H. reticulocostata* (S.t.), *H. rotundispina* (S.t.), *Spongosilicarmiger nakasekoi* (S.t.), *Spongosilicarmiger transitus laevis* (T.f.), *Spongosilicarmiger terebrus* (T.f.) and *Triassocampe scalaris baloghi* (Y.a.). Several of these forms are rare and may have a longer range beyond the *S. transitus* Zone. Especially an occurrence in older zones cannot be excluded for several of these species because they begin without known ancestral form. On the other hand, several of these species have their successors in the following Lower Ladinian *S. italicus* Zone. Consequently, most of the species of this group have at least their uppermost occurrence in the *T. transitus* Zone. However, *Paurinella fusina*, *P. sinensis* and *Pseudoertlispongus angulata* are species of typical Lower Ladinian genera that began in the *S. transita* Zone, and *T. scalaris baloghi* is a subspecies of a typical Lower Ladinian species.

A third stratigraphically important group are taxa that begin at the base or within the *S. transitus* Zone, but ranges at least into the following Lower Ladinian *S. italicus* Zone. These species are: *Eptingium manfredi manfredi*, *Pseudoertlispongus mostleri* (begins in the *Y. annulata* Subzone), *Triassocampe deweveri*, *T. scalaris scalaris* (begins in the *Y. annulata* Subzone), *Triassospongocyrtis longispinosa*, *Yeharaia annulata* (begins in the *Y. annulata* Subzone).

All other species of the *S. transitus* Zone are long-ranging forms or extraordinary rare forms with unknown range.

From the above list is clearly recognizable that in the *S. transitus* Zone the Anisian forms clearly dominate. These forms disappeared at the base of the overlying *S. italicus* Zone. Many characteristic Ladinian forms, such as Oertlispongidae with recurved or otherwise differentiated main spine that are very characteristic for the overlying *S. italicus* and younger Ladinian zones, are totally missing. Few taxa are restricted to the *T. florida* Subzone. The *Y. annulata* Subzone is distinguished from the *T. florida* Subzone by the appearance of a few further Ladinian species, *Pseudoertlispongus mostleri*, *Triassocampe scalaris* and *Yeharaia annulata*..

**Table 1:** Comparison of the ammonoid, conodont, and radiolarian zonation by KRAINER & MOSTLER (1992), KOZUR & MOSTLER (1994) with that by KOZUR (1995) and present paper.

| Krainer & Mostler (1992) and Kozur & Mostler (1994) | | | | | | Kozur (1995) and present paper) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stage | Substage | Ammonoid Zone/Subzone | Conodont Zone | Radiolarian Zone | Rad. Subzone | Stage | Substage | Ammonoid Zone/Subzone | Conodont Zone | Radiolarian Zone | Rad. Subzone |
| Ladinian | Fassanian | *Eoprotrachyceras curionii* | *B. truempyi* | unnamed | unnamed | Ladinian | Fassanian | *Eoprotrachyceras curionii* | *B. truempyi* | unnamed | unnamed |
| | | *Nevadites* fauna | *Neogondolella transita* | *Ladinocampe multiperforata* | *Ladinocampe vicentinensis* | | | *Nevadites secedensis* | *P. ? trammeri – Neogondolella transita* | *Ladinocampe multiperforata* | *Ladinocampe vicentinensis* |
| | | | | | *Ladinocampe annuloperforata* | | | | | | *Ladinocampe annuloperforata* |
| | | *"Xenoprotrachyceras" reitzi* — *Halilucites costosus* | *Neogondolella mesotriassica – Paragondolella ? trammeri praetrammeri* | *Spongosilicarmiger italicus* | *O. inaequispinosus* | | | *Reitziites reitzi* — *Halilucites costosus* | *Paragondolella alpina – Paragondolella ? trammeri* | *Spongosilicarmiger italicus* | *O. inaequispinosus* |
| | | *Reitziites reitzi* | | | *Oertilispongus primitivus* | | | *Reitziites reitzi* | | | *Oertilispongus primitivus* |
| | | *Kellnerites felsoeoers.* | | | *Spongosilicarmiger transitus* | Anisian | Illyrian | *Kellnerites felsoe-oersensis* — *Kellnerites felsoeoers.* | *Neogondolella mesotriassica* | *Spongosilicarmiger transitus* | *Yeharaia annulata* |
| | | | | | | | | *Lardaroceras pseudohung.* | | | *Tiborella florida* |
| Anisian | Illyrian | not investigated | not investigated | not investigated | not investigated | | | *Paraceratites trinodosus* | *Neogondolella constricta* | *Tetraspinocyrtis laevis* | |
| | | *Paraceratites trinodosus* | *Neogondolella constricta* | *Tetraspinocyrtis laevis* | | | | | | | |

Some Anisian forms become very rare or disappeared, such as *Parentactinia lata*, *Pentactinocapsa awaensis* and *Spongosilicarmiger nakasekoi*. Despite the fact that also in the *Y. annulata* Subzone the species dominance of the Anisian forms continued, the few Ladinian forms become already rich in specimens. By this, the *Y. annulata* Subzone has transitional character between Upper Anisian and Lower Ladinian radiolarian faunas, but forms of Anisian character are still dominant.

At the base of the *S. italicus* Zone (base of the *Reitziites reitzi* ammonoid zone) the Ladinian forms dominate both in the number of taxa and in specimens. This is caused both by disappearance of Anisian forms and above all by appearance of numerous Ladinian species and genera. For this reason, the radiolarians favours the priority Ladinian base at the base of the *R. reitzi* Zone s.str. (= base of the *S. italicus* Zone).

## Acknowledgements

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## Explanation of Plates

All figured specimens are from the Weiße Wand Member (Loibl Formation) of the locality Weiße Wand in the Southern Karawanken, Austria (see Text-Figs. 1, 3). They all belong to the *Tiborella florida* Subzone of the *Spongosilicarmiger transitus* Zone (upper Illyrian, uppermost Anisian)

## Plate 1

Figs. 1, 2, 6–10:  *Spongosilicarmiger nakasekoi* YEH, 1990, sample WW 7; Figs. 1, 2, 6, 7, 9: different views and magnifications of one specimen, rep.-no. KKM 1995/I-88, Figs. 1, 2: x 200, different views, Fig. 6: x 129, Figs. 7, 9: different view of proximal part, x 500; Figs. 8, 10: different magnifications of a distally broken specimen, rep.-no. KKM 1995/I-35, Fig. 8: x 155, Fig. 10: x 200.

Figs. 3–5, 11–13:  *Spongosilicarmiger transitus laevis* n. subsp., sample WW 12, Figs. 3, 4: different views of the same specimen, various degree of outward direction of the feet well recognizable, x 200, rep.-no. KKM 1995/I-33; Figs. 5, 11, 12: holotype, rep.-no. KKM 1995/I-19, Fig. 5: detail of proximal part, x 500, Figs. 11, 12: different views of the entire specimen, x 200; Fig. 13, x 200, rep.-no. KKM 1995/I-34.

## Plate 2

## Plate 3

Figs. 1, 2:        *Hozmadia latispinosa* n. sp., sample WW 9, x 200; Fig. 1: holotype, rep.-no. KKM 1995/I-16; Fig. 2; rep.-no. KKM 1995/I-24.

Figs. 3, 4, 6, 7, 11: *Hozmadia rotunda* (NAKASEKO & NISHIMURA, 1979), sample WW 8, rep.-no. KKM 1995/I-25; Figs. 3, 4: x 200; Fig. 6: x 145; Fig. 7. x 160; Fig. 11: x 140.

Figs. 5, 13-16:  *Tiborella florida florida* (NAKASEKO & NISHIMURA, 1979), x 200; Fig. 5: sample WW 6, KKM 1995/I-26; Fig. 13: sample WW 8, rep.-no. KKM 1995/I-27 ; Fig. 14: sample WW 9, rep.-no. KKM 1995/I-28: Fig. 15: sample WW 12, rep.-no. KKM 1995/I-29; Fig. 16. sample WW 13, rep.-no. KKM 1995/I-30.

Fig. 8:          *Hozmadia* cf. *rotunda* (NAKASEKO & NISHIMURA, 1979), x 145, sample WW 9, rep.-no. KKM 1995/I-36.

Fig. 9:          *Hozmadia reticulocostata* n. sp., holotype, x 200, sample WW 13, rep.-no. KKM 1995/I-17

Fig. 10:        *Hozmadia* aff. *rotunda* (NAKASEKO & NISHIMURA, 1979), x 145, sample WW 9, rep.-no. KKM 1995/I-37.

Fig. 12:        *Hozmadia rotundispina* n. sp., holotype, x 125, rep.-no. KKM 1995/I-18.
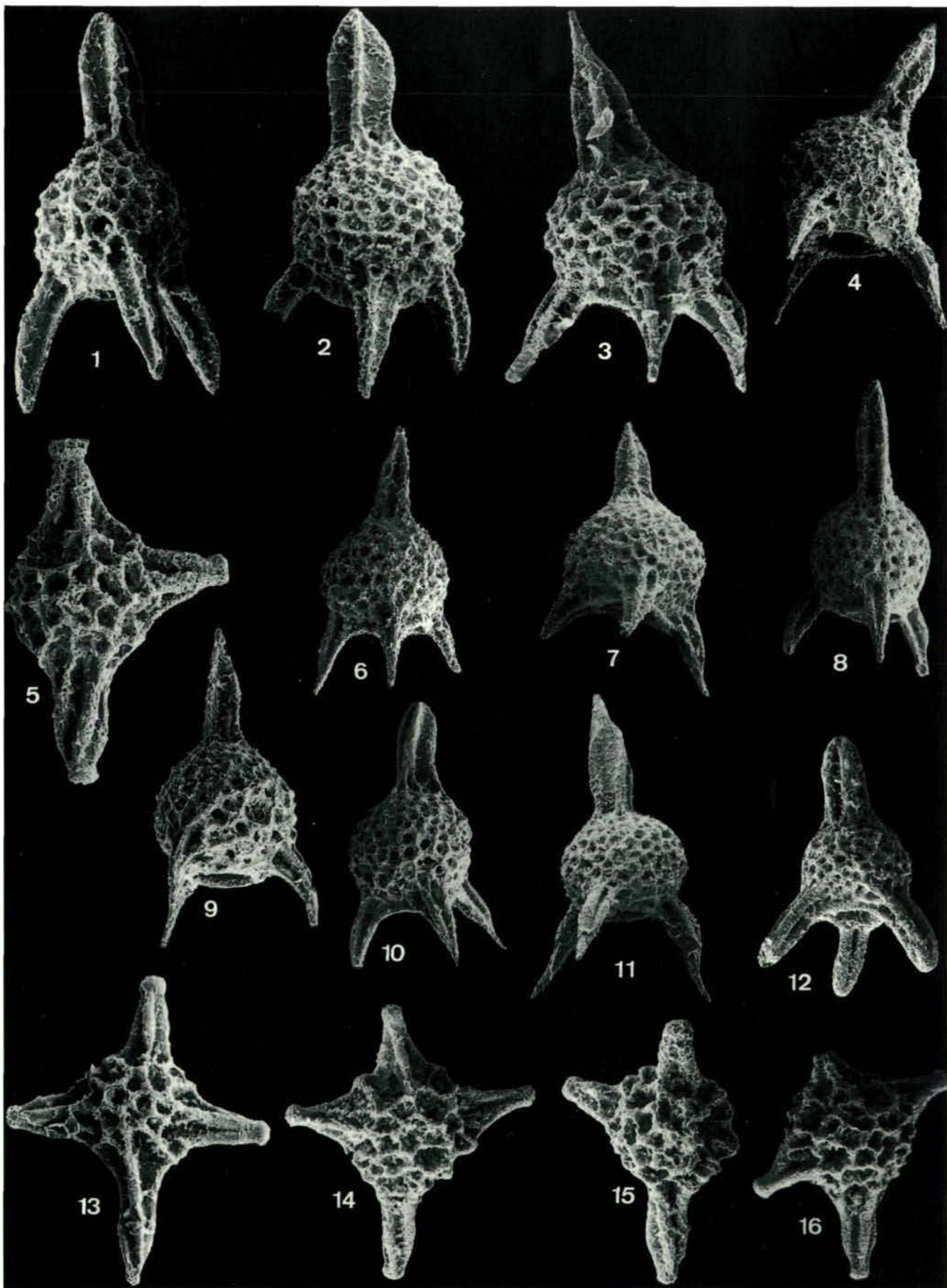
## Plate 4

Figs. 1, 5:  *Tiborella florida austriaca* n. sp., x 200, sample WW 6; Fig. 1: holotype, rep.-no. KKM 1995/I-1; Fig. 5: rep.-no. KKM 1995/I-38.

Figs. 2, 3, 7, 9:  *Parasepsagon variabilis* (NAKASEKO & NISHIMURA, 1979), x 200; Fig. 2: sample WW 6, rep.-no. KKM 1995/I-38; Fig. 3: sample WW 8, rep.-no. KKM 1995/I-39; Fig. 7: sample WW 9, rep.-no. KKM 1995/I-40; Fig. 9: sample WW 12, rep.-no. KKM 1995/I-41.

Figs. 4, 8:  *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA, 1979); Fig. 4: x 170, sample WW 7, rep.-no. KKM 1995/I-42; Fig. 8: x 180, sample WW 12, rep.-no. KKM 1995/I-42.

Fig. 6, 10:  *Pseudosepsagon* ? *anisicus* (KOZUR & MOSTLER, 1994), x 200; Fig. 6: doubtful specimen with atypical position of the spines, sample WW 8, rep.-no. KKM 1995/I-43; Fig. 10: sample WW 6, rep.-no. KKM 1995/I-44.

Fig. 11:  *Neopylentonema mesotriassica* KOZUR, 1984, x 230, sample WW 13, rep.-no. KKM 1995/I-45.

Fig. 12:  Broken, indeterminable, probably four-spined entactinarian or spumellarian Radiolaria, x 200, sample WW 12, rep.-no. KKM 1995/I-46.

Fig. 13:  *Eptingium ramovsi* n. sp., x 200, sample WW 7, rep.-no. KKM 1995/I-47.

Fig. 14:  *Pentaspongodiscus mesotriassicus* DUMITRICĂ, KOZUR & MOSTLER, 1980, x 100, sample WW 6, rep.-no. KKM 1995/I-48.

Fig. 15:  *Pentaspongodiscus steigeri* LAHM, 1984, x 100, sample WW 12, rep.-no. KKM 1995/I-49.
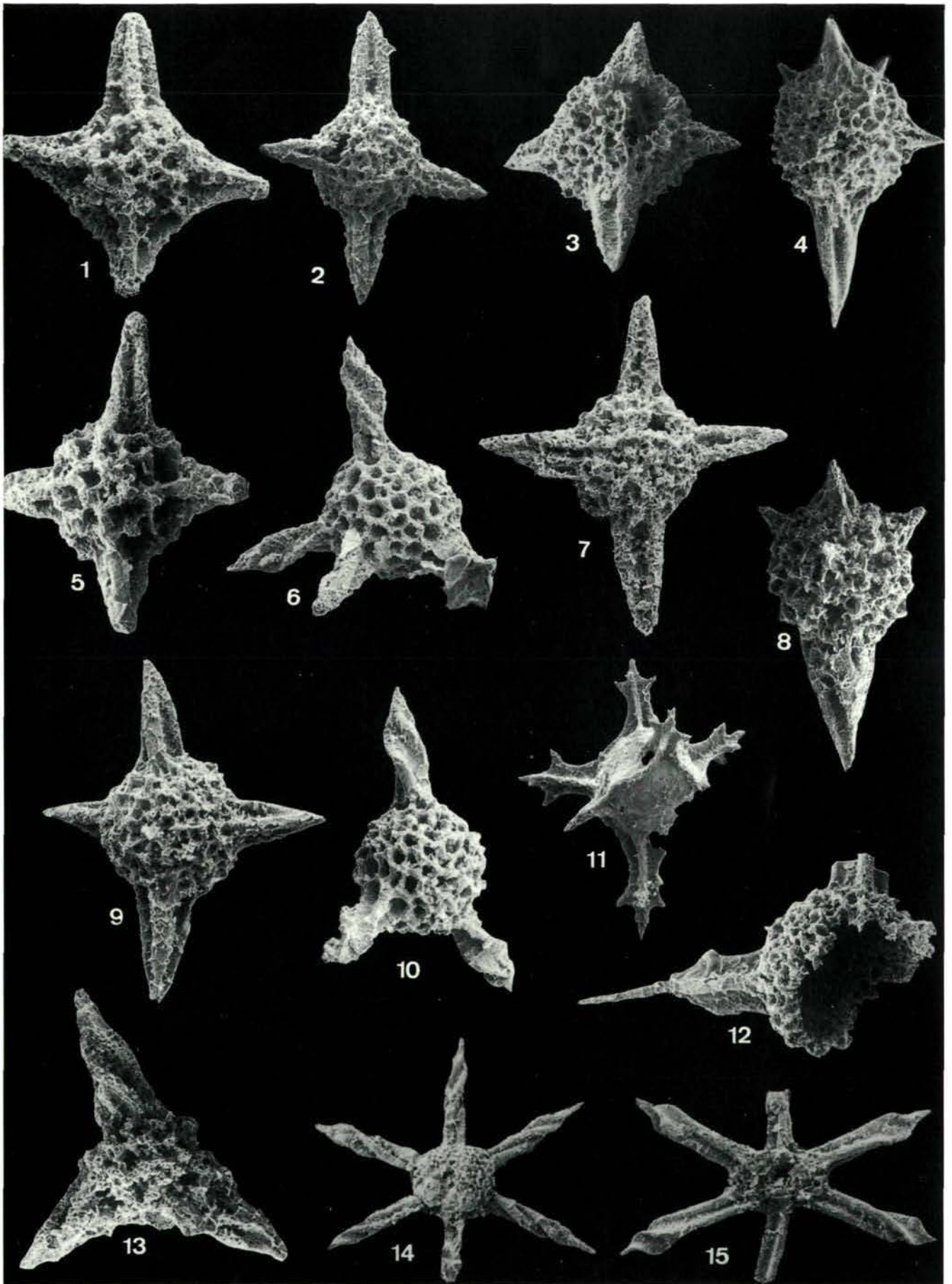
## Plate 5

Figs. 1–10, 12: *Pentactinocapsa multispinosa* n. sp., x 200; Fig 1: lateral view, sample WW 3, rep.-no. KKM 1995/I-50; Fig. 2: oblique lateral-upper view, sample WW 1, rep.-no. KKM 1995/I-51; Fig. 3: lateral view, sample WW 4, rep.-no. KKM 1995/I-52; Fig. 4: lateral view, sample WW 6, rep.-no. KKM 1995/I-53; Fig. 5: somewhat oblique lateral view, sample WW 7, rep.-no. KKM 1995/I-54; Fig. 6: upper view, sample WW 7, rep.-no. KKM 1995/I-55; Fig. 7: lateral view, sample WW 8, rep.-no. KKM 1995/I-56; Fig. 8: upper view, sample WW 9, rep.-no. KKM 1995/I-57; Fig. 9: upper view, sample WW 9, rep.-no. KKM 1995/I-58; Fig. 10: somewhat oblique upper view, sample WW 12, rep.-no. KKM 1995/I-59; Fig. 12: oblique lateral-upper view, sample WW 13, rep.-no. KKM 1995/I-60.

Fig. 11: *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979), somewhat oblique lateral(-lower) view, x 140, rep.-no. KKM 1995/I-61.
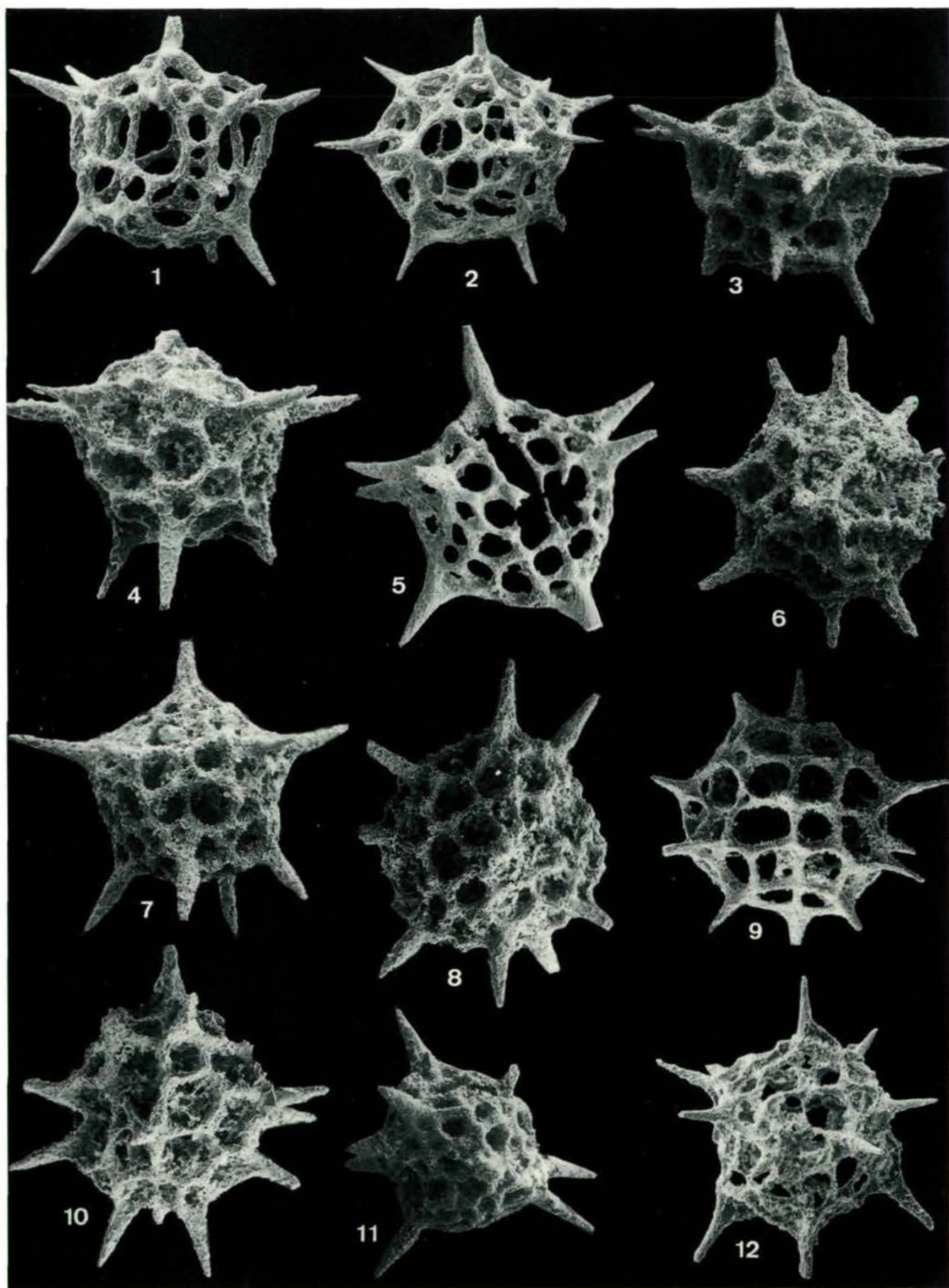
# Plate 6

Figs. 1–3:     *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA, 1979), Fig. 1: x 180, sample WW 4, rep.-no. KKM 1995/I-62; Fig. 2: x 200, sample WW 8, rep.-no. KKM 1995/I-63; Fig. 3: x 200, sample WW 6, rep.-no. KKM 1995/I-64.

Figs. 4, 5, 6 ?,     *Spongistephanidium longispinosum* SASHIDA, 1991; Fig. 4: x 220, sample WW 3, rep.-no. KKM
8 ?, 11 ?: 5:     1995/I-65; Fig. 5 x 230, sample WW 6, rep.-no. KKM 1995/I-66; Fig. 6: x 200, sample WW 9, rep.-no. KKM 1995/I-67; Fig. 8: somewhat oblique lateral-equatorial view of a specimen with basally unusually broad spines that is only tentatively assigned to *S. longispinosum*, x 240, rep.-no. KKM 1995/I-68; Fig. 11: specimen with unusual asymmetric spine position, x 230, sample WW 7, rep.-no. KKM 1995/I-69.

Figs. 7, 9:     *Spongostephanidium austriacum* n. sp., Fig. 7: x 250, sample WW 8, rep.-no. KKM 1995/I-70; Fig. 9: holotype, x 230, sample WW 7, rep.-no. KKM 1995/I-4.

Fig. 10:     Eptingiidae DUMITRICĂ, 1978, n. gen. n. sp., x 240, sample WW 12, rep.-no. KKM 1995/I-71.

Figs. 12-14:     *Pseudostylosphaera coccostyla acrior* (BRAGIN, 1986); Fig. 12: x 145, sample WW 4, rep.-no. KKM 1995/I-72; Fig. 13: x 140, sample WW 3, rep.-no. KKM 1995/I-73; Fig. 14: x 145, sample WW 12, rep.-no. KKM 1995/I-74.

Fig. 15:     *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA, 1979), x 200, sample WW 9, rep.-no. KKM 1995/I-76.

Fig. 16:     *Spongostylus tricostatus* n. sp., holotype, x 170, sample WW 3, rep.-no. KKM 1995/I-7.

Fig. 17:     *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA, 1979) emend., x 110, sample WW 8, rep.-no. KKM 1995/I-75.

Fig. 18:     *Spongostylus nakasekoi* n. sp., holotype, x 130, sample WW 9, rep.-no. KKM 1995/I-15.
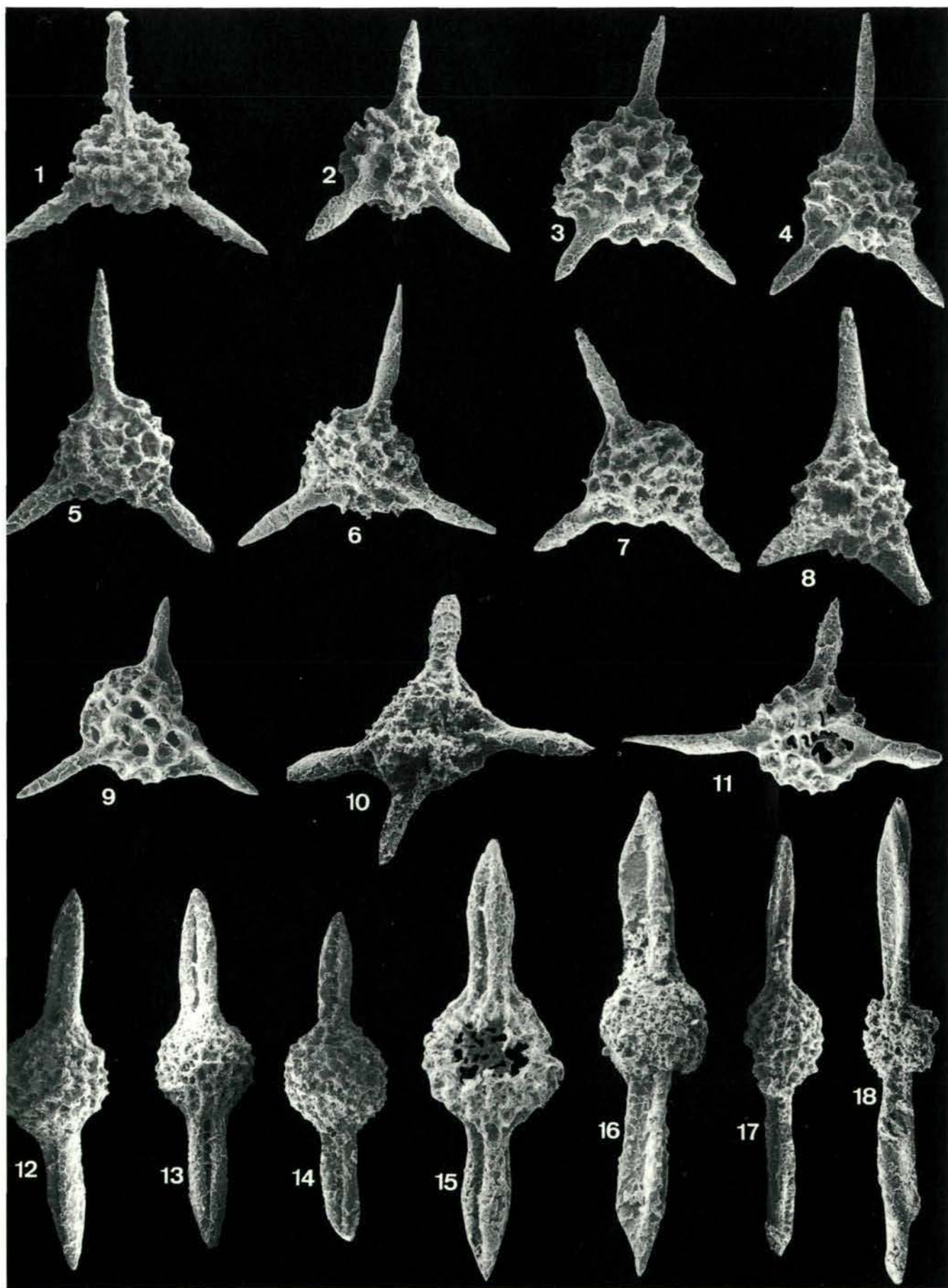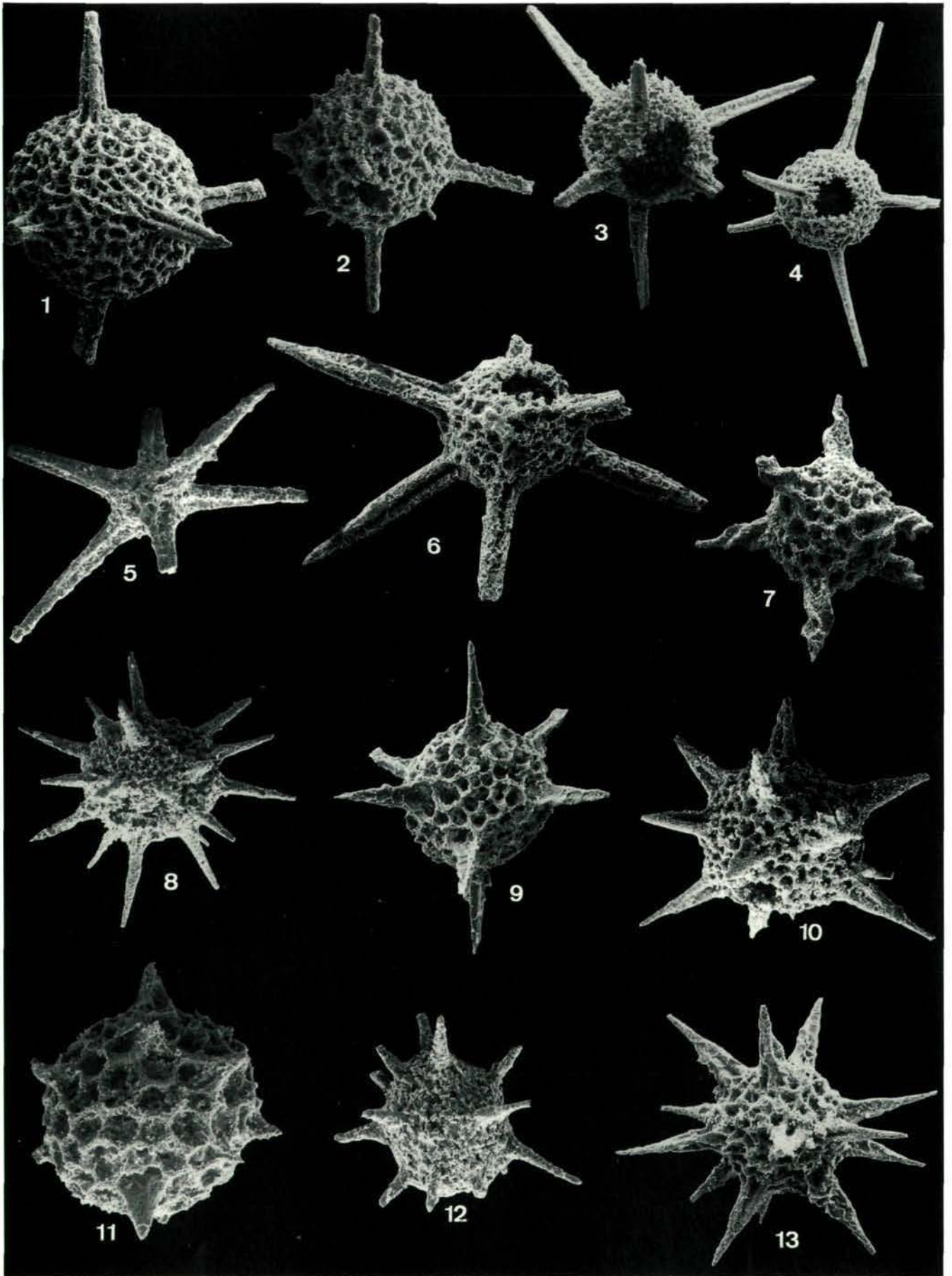
# Plate 7

Figs. 1, 2, 4, 5, 7:    *Livinallongella lahmi* n. sp.; Fig. 1: x 130, sample WW 12, rep.-no. KKM 1995/I-81; Fig. 2: holotype, x 140, sample WW 12, rep.-no. KKM 1995/I-6; Fig. 4: x 150, sample WW 13, rep.-no. KKM 1995/I-82; Fig. 5: x 150, sample WW 12, rep.-no. KKM 1995/I-83; Fig. 7: x 170, sample WW 12, rep.-no. KKM 1995/I-84.

Fig. 3, 6:    *Livinallongella* cf. *lahmi* n. sp.; Fig. 3: x 140, sample WW 12, rep.-no. KKM 1995/I-86; Fig. 6: x 150, sample WW 13, rep.-no. KKM 1995/I-87.

Fig. 8:    *Livinallongella* aff. *lahmi* n. sp., x 125, sample WW 12, rep.-no. KKM 1995/I-85.

Fig. 9:    *Helioentactinia oertlii* (KOZUR & MOSTLER, 1979), x 80, sample WW 3, rep.-no. KKM 1995/I-76.

Figs. 10, 11,    *Heptacladus* ? *anisicus* n. sp.; Fig. 10: holotype, x 120, sample WW 6, rep.-no. KKM 1995/I-5; Fig. 11: x 110,

13, 14:    sample WW 8, rep.-no. KKM 1995/I-78; Fig. 13: x 150, sample WW 7, rep.-no. KKM 1995/I-79; Fig. 14: x 150, sample WW 12, rep.-no. KKM 1995/I-80.

Fig. 12:    *Heptacladus crassispinus* DUMITRICĂ, Kozur & MOSTLER, 1980, x 120, sample WW 7, rep.-no. KKM 1995/I-77.
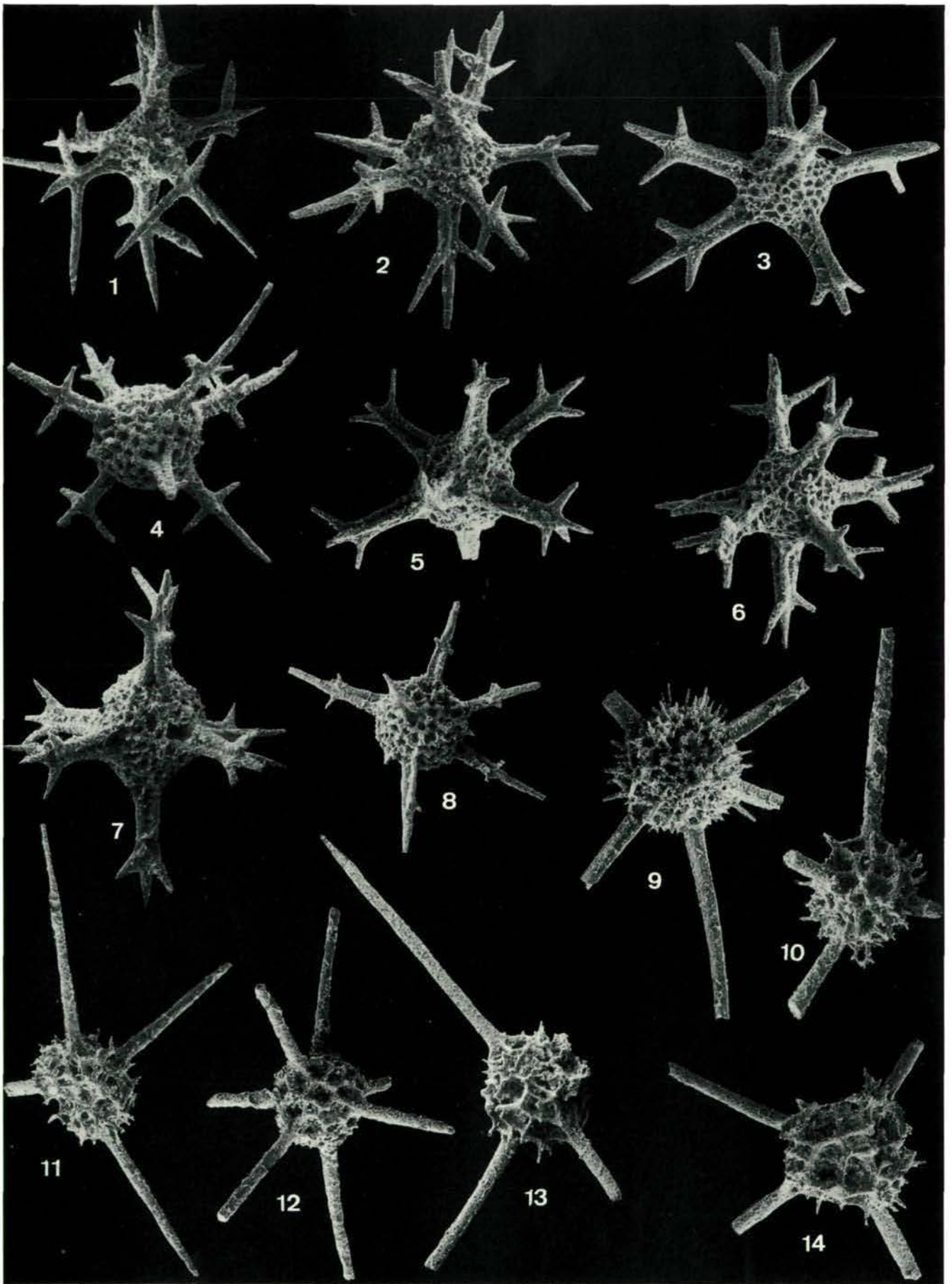
# Plate 8

Fig. 1, 4: *Hexalonche simplex* LAHM, 1984; Fig. 1: x 120, sample WW 7, rep.-no. KKM 1995/I-89; Fig. 4: x 70, sample WW 3, rep.-no. KKM 1995/I-90.

Fig. 2: *Komoella symmetrica* LAHM, 1984, x 200, sample WW 12, rep.-no. KKM 1995/I-91.

Fig. 3: *Paraheptacladus symmetricus* KOZUR & MOSTLER, 1981, x 90, sample WW 3, rep.-no. KKM 1995/I-92.

Fig. 5: *Hexalonche bragini* n. sp., holotype, x 140, sample WW 9, rep.-no. KKM 1995/I-11.

Fig. 6: *Weverisphaera anisica* n. sp., x 200, sample WW 7, rep.-no. KKM 1995/I-8.

Fig. 7: *Hexatortilisphaera aequispinosa* n. gen. n.sp., holotype, x 200, rep.-no. KKM 1995/I-21.

Figs. 8, 12: *Triassospongosphaera multispinosa* (KOZUR & MOSTLER, 1979); Fig. 8: x 150, sample WW 7, rep.-no. KKM 1995/I-93; Fig. 12: x 200, sample WW 4, rep.-no. KKM 1995/I-94.

Fig. 9: *Acanthosphaera nicorae* n. sp., holotype, x 230, sample WW 8, rep.-no. KKM 1995/I-9.

Fig. 10: *Welirella fleuryi* (DE WEVER, 1979), x 140, sample WW 13, rep.-no. KKM 1995/I-95.

Fig. 11: *Pessagnollum multispinosum* n. gen. n. sp., x 230, sample WW 12, rep.-no. KKM 1995/I-10.

Fig. 13: *Welirella mesotriassica* n. sp., holotype, x 150, sample WW 8, rep.-no. KKM 1995/I-13.

# Plate 9

Figs. 1, 2: *Pentactinocapsa multispinosa* n. sp., x 170, sample WW 7, rep.-no. KKM 1995/I-106, Fig. 1: lateral view, Fig. 2: oblique lateral-upper view.

Figs. 3, 4 ?, 5, 6, *Pentactinorbis dumitricai* KOZUR & MOSTLER, 1994; Fig. 3. x 200, sample WW 3, rep.-no. KKM 1995/I-96;
7–9 ?, 10, 14: Fig. 4: x 200, sample WW 12, rep.-no. KKM 1995/I-97; Fig. 5: x 220, sample WW 12, rep.-no. KKM 1995/I-98; Fig. 6: x 200, sample WW 6, rep.-no. KKM 1995/I-99; Fig. 7: x 150, sample WW 7, rep.-no. KKM 1995/I-100, Fig. 8: x 160, sample WW 8, rep.-no. KKM 1995/I-101; Fig. 9: x 150, sample WW 12, rep.-no. KKM 1995/I-102; Fig. 10: x 160, sample WW 3, rep.-no. KKM 1995/I-103, Fig. 14: x 160, sample WW 8, rep.-no. KKM 1995/I-104.

Fig. 11: *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA, 1979), x 160, sample WW 3, rep.-no. KKM 1995/I-105.

Figs. 12, 13: *Cenosphaera parvispinosa* n. sp.; Fig. 12: x 200, sample WW 7, rep.-no. KKM 1995/I-107; Fig. 13, holotype, x 180, sample WW 6, rep.-no. KKM 1995/I-2.

Figs. 15-18: *Acanthosphaera carterae* n. sp.; Fig. 15: x 200, sample WW 12, rep.-no. KKM 1995/I-108; Fig. 16; holotype, x 175, sample WW 9, rep.-no. KKM 1995/I-12; Fig. 17: x 200, sample WW 6, rep.-no. KKM 1995/I-109; Fig. 18: x 250, sample WW 3, rep.-no. KKM 1995/I-110.
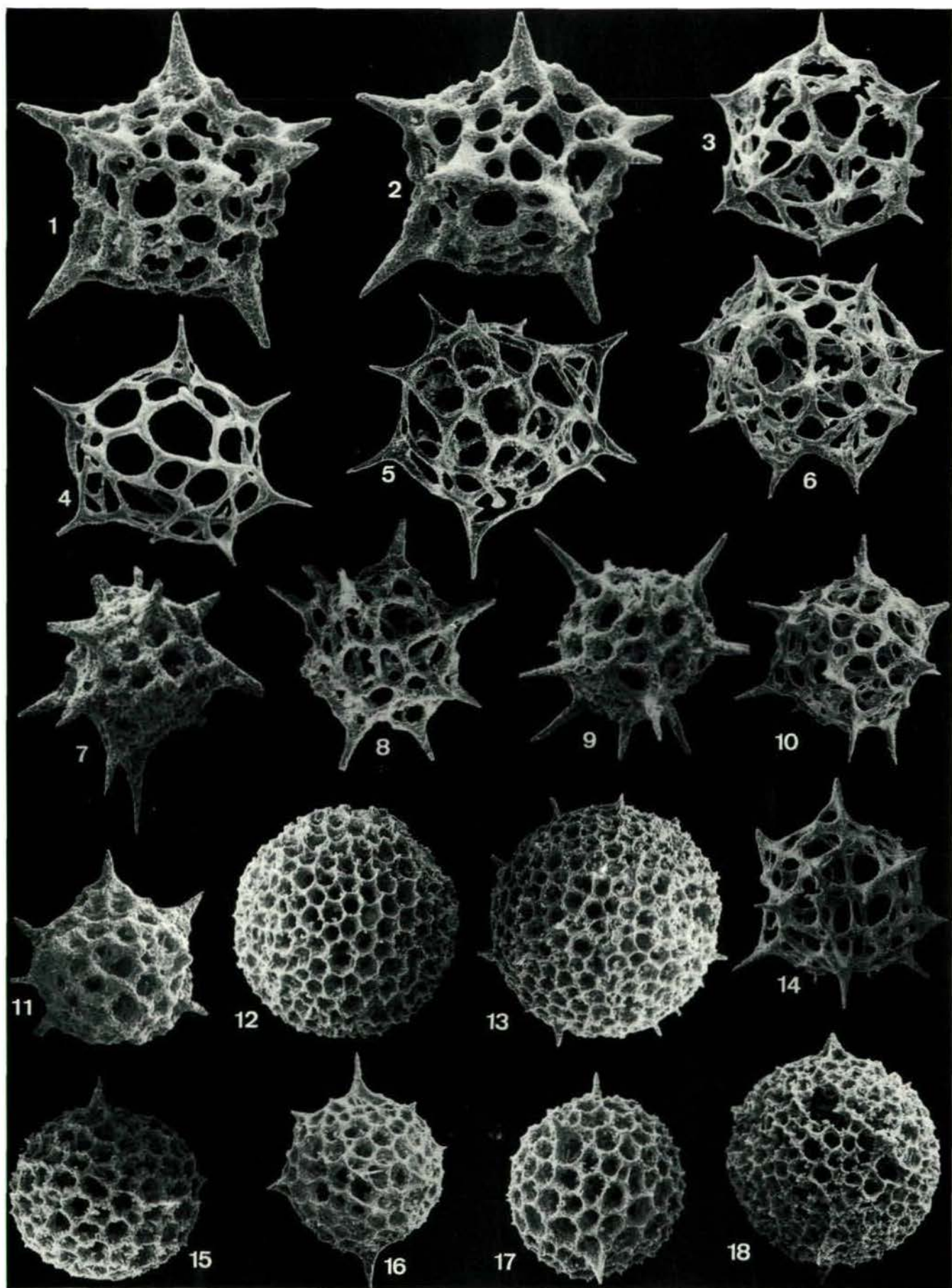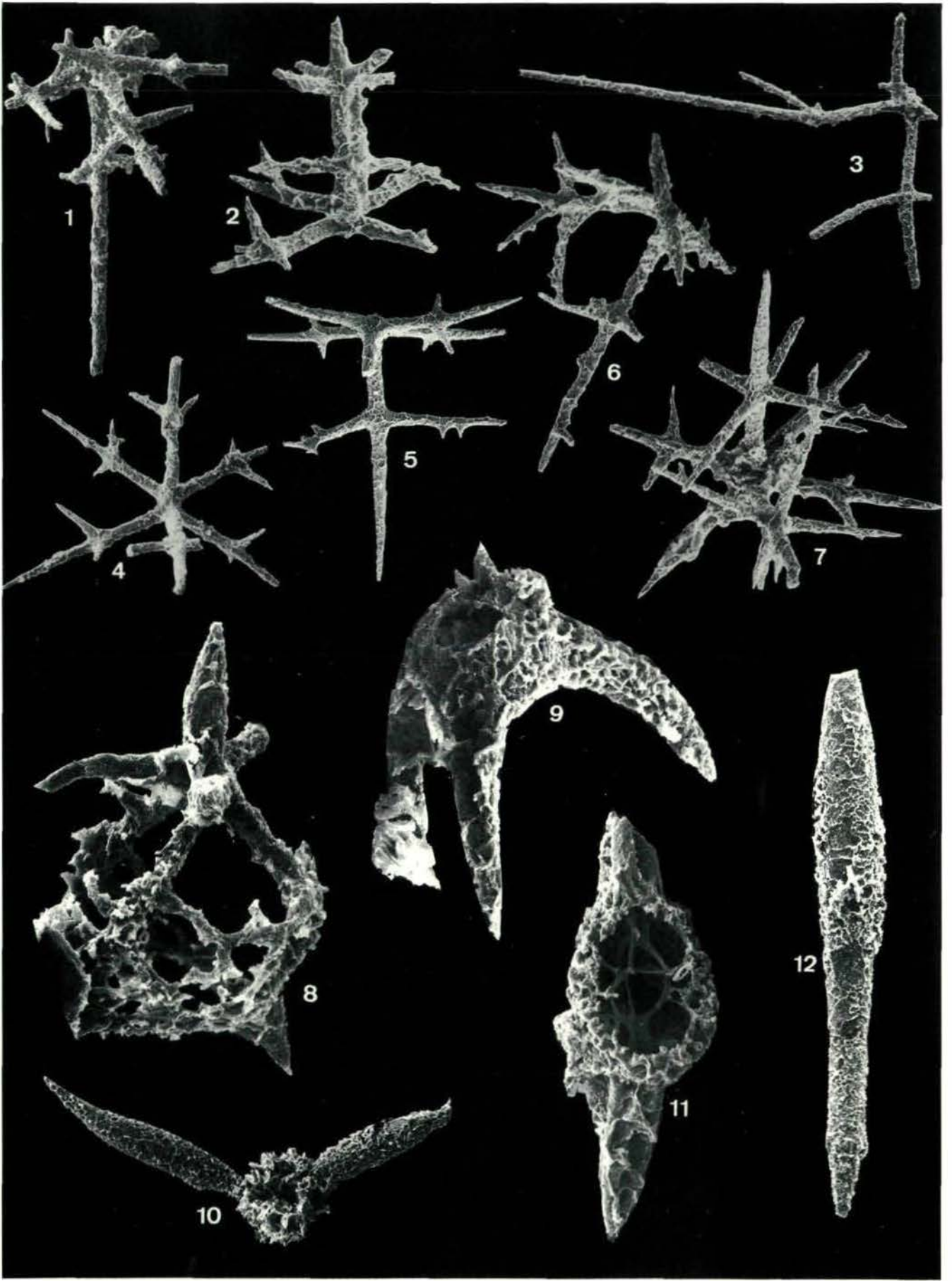
# Plate 10

Figs. 1–4, 6, 10 ?:  *Eptingium manfredi manfredi* DUMITRICĂ, 1978a; Fig. 1: x 200, sample WW 12, rep.-no. KKM 1995/I-111; Fig. 2: x 170, sample WW 12, rep.-no. KKM 1995/I-112; Fig. 3: x 130, sample WW 13, rep.-no. KKM 1995/I-113; Fig. 4: x 200, sample WW 9, rep.-no. KKM 1995/I-114; Fig. 6: x 170, sample WW 8, rep.-no. KKM 1995/I-115; Fig. 10: x 200, sample WW 6, rep.-no. KKM 1995/I-116.

Fig. 5:  *Eptingium* sp., x 140, sample WW 9, rep.-no. KKM 1995/I-117.

Fig. 7:  *Eptingium manfredi japonicum* NAKASEKO & NISHIMURA, 1979, x 140, sample WW 3, rep.-no. KKM 1995/I-118.

Fig. 8:  *Eptingium ramovsi* n. sp., x 200, sample WW 6, rep.-no. KKM 1995/I-119.

Figs. 9, 13, 14, 15 ?:  *Triassistephanidium anisicum* n. sp., x 200; Fig. 9: holotype, sample WW 7, rep.-no. KKM 1995/I-3; Fig. 13: sample WW 12, rep.-no. KKM 1995/I-120; Fig. 14: sample WW 6, rep.-no. KKM 1995/I-121; Fig. 15: sample WW 9, rep.-no. KKM 1995/I-122.

Fig. 11:  *Staurolonche praegranulosa* n. sp., holotype, x 100, sample WW 9, rep.-no. KKM 1995/I-14.

Fig. 12:  *Cryptostephanidium cornigerum* DUMITRICĂ, 1978a, x 200, sample WW 12, rep.-no. KKM 1995/I-123.

Fig. 16:  *Staurolonche trispinosum trilobum* (NAKASEKO & NISHIMURA, 1979), x 140, sample WW 4, rep.-no. KKM 1995/I-124.
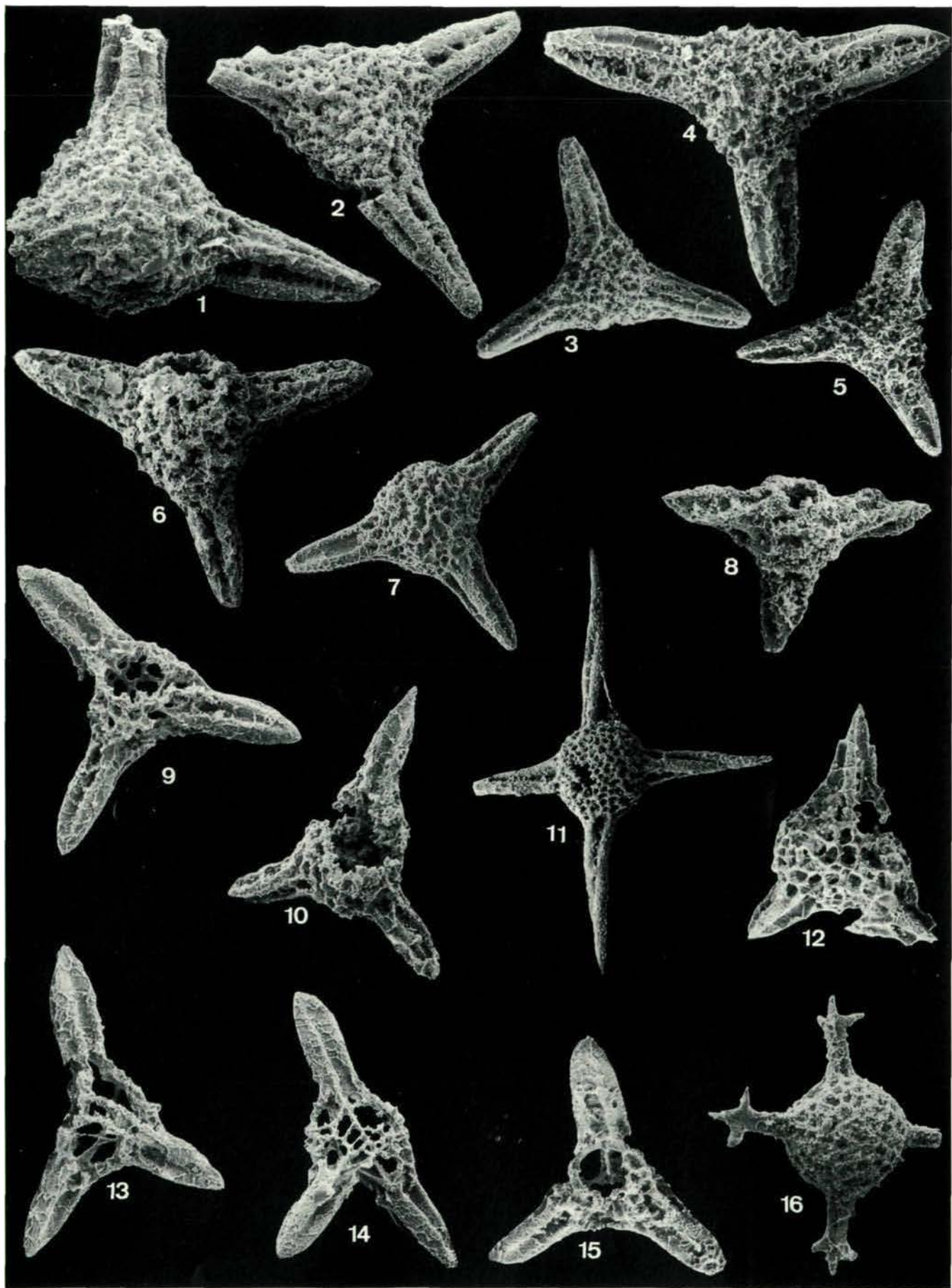
## Plate 11

Figs. 1, 2, 4–7: *Tandarnia recoaroense* DUMITRICĂ, 1983; Fig. 1: x 280, sample WW 3, rep.-no. KKM 1995/I-125; Fig. 2: x 280, sample WW 4, rep.-no. KKM 1995/I-126; Fig. 4: x 200, sample WW 6, rep.-no. KKM 1995/I-127; Fig. 5: x 200, sample WW 7, rep.-no. KKM 1995/I-128; Fig: 6: x 220, sample WW 8, rep.-no. KKM 1995/I-129; Fig. 7: x 250, sample WW 12, rep.-no. KKM 1995/I-130.

Fig. 3: *Triassothamnus verticillatus* (DUMITRICĂ, 1978b), x 170, sample WW 9, rep.-no. KKM 1995/I-131.

Fig. 8: *Parentactinia pugnax* DUMITRICĂ, 1978b, x 500, sample WW 7, rep.-no. 15-8-95/I-16.

Fig. 9: *Poulpus illyricus* KOZUR & MOSTLER, 1994, x 500, sample WW 7, rep.-no. 15-8-95/I-15.

Fig. 10: *Paurinella fusina* (FENG, 1992), x 150, sample WW 8, rep.-no. 15-8-95/I-29.

Fig. 11: *Eptingium nakasekoi* KOZUR & MOSTLER, 1994, entactinarian spicular system well visible, x 200, sample WW 7, rep.-no. 15-8-95/I-14.

Fig. 12: *Paroertlispongus multispinosus* KOZUR & MOSTLER, 1981, isolated main spine, typical preservation for Oertlispongidae, x 200, rep.-no. 15-8-95/I-7.
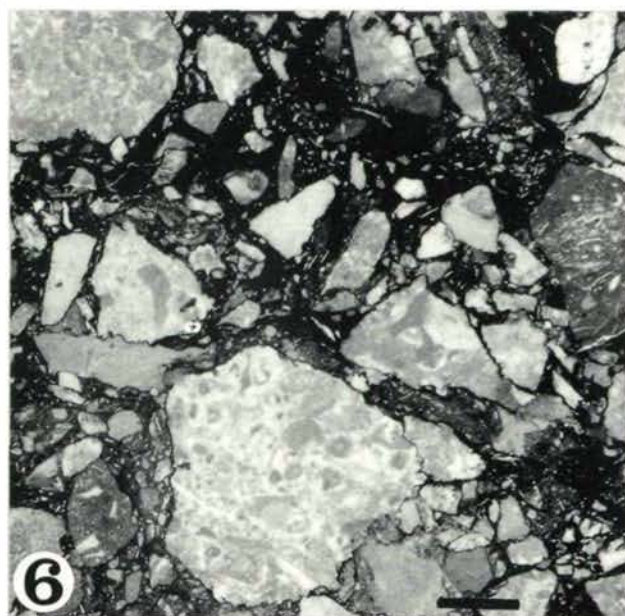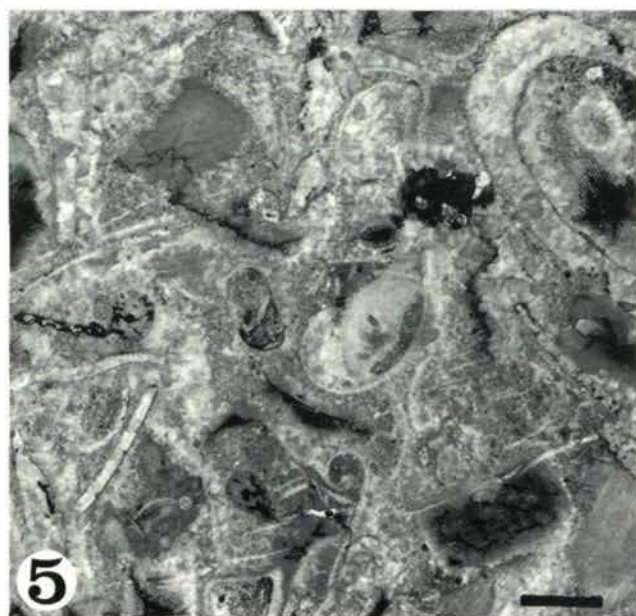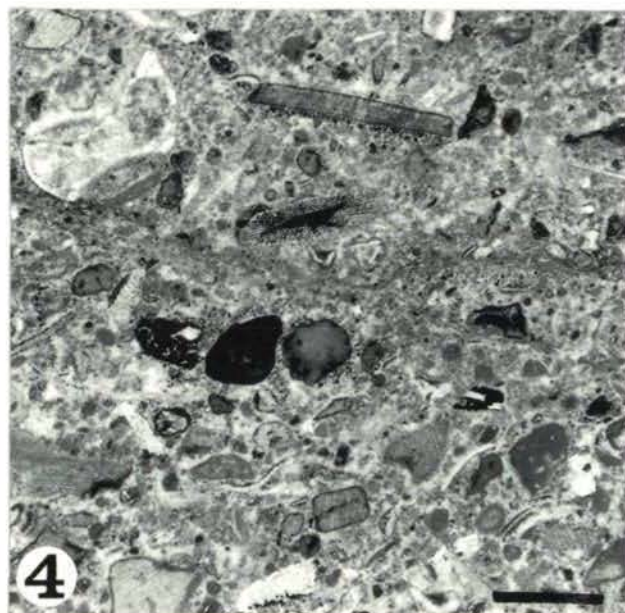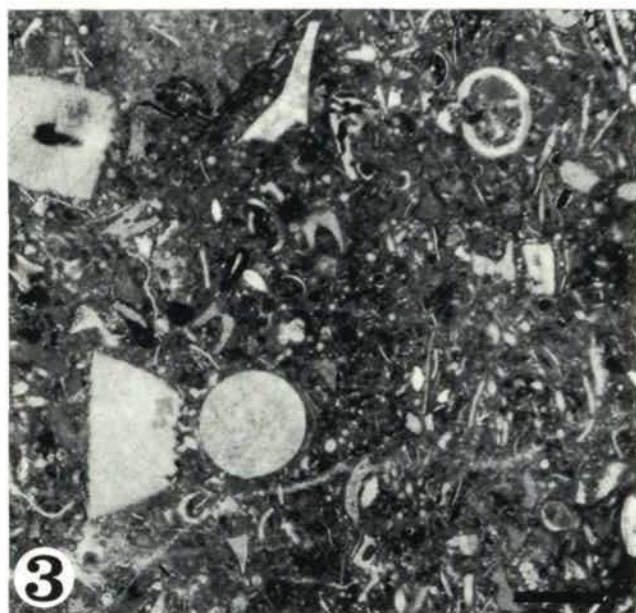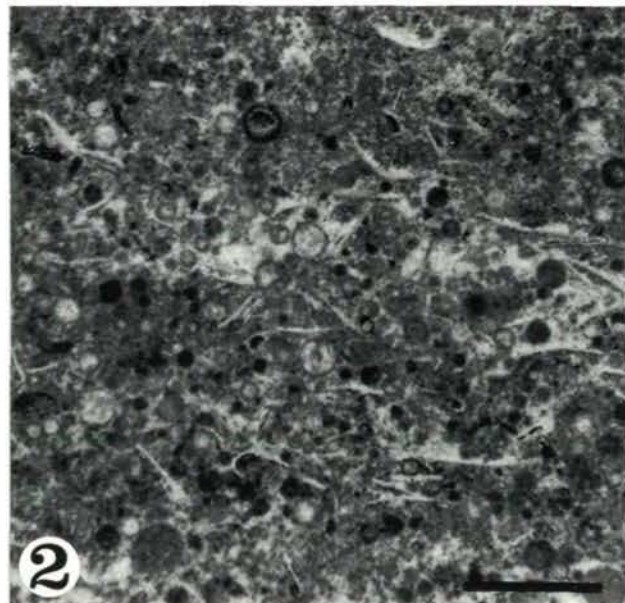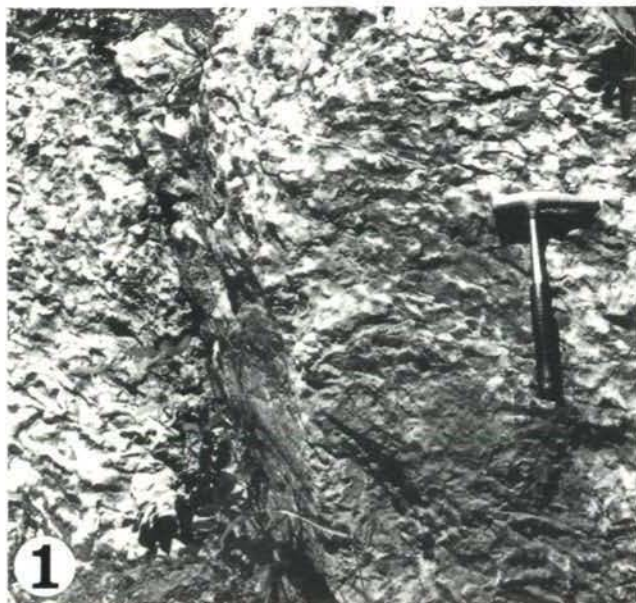
## Plate 12

Facies and thin section photomicrographs showing microfacies types of the Loibl Formation (Figs. 1, 3–6: Selenischniak Member, Fig. 2: Weiße Wand Member). Scale bar 1 mm.

Fig. 1:    Red nodular limestones exposed along the Selenitza forest road.

Fig. 2:    Bioclastic wackestone rich in radiolarians and filaments, with pelmicritic matrix and some calcite cement. Weiße Wand, sample RJ 2.

Fig. 3:    Bioclastic wackestone containing abundant echinoderm and shell fragments, a few other bioclasts and a micritic matrix. Selenitza forest road, sample ZE 5.

Fig. 4:    Bioclastic wackestone/packstone, abundant echinoderm fragments and some other bioclasts, micritic intraclasts and a few altered volcanic rock fragments. The matrix consists of micrite, locally of calcite cements. Selenitza forest road, sample ZE 3a.

Fig. 5:    Bioclastic grainstone/packstone with abundant echinoderm and shell fragments, cemented by calcite spar. Selenitza forest road, sample ZE 4.

Fig. 6:    Poorly sorted carbonate breccia (debris flow) composed of angular and subangular clasts. The clasts represent different types of carbonate rocks derived from shallow-water carbonates as well as from the Loibl Formation (containing radiolarians). Selenitza forest road, sample ZE 8.

# Plate 13

Thin section photomicrographs showing microfacies types of the Selenischniak Member of the Loibl Formation (Figs. 1–3, 5, 6) and of the Contrin Formation (Fig. 4). Scale bar = 1 mm.

Fig. 1: Filament packstone consisting of densely packed, thin shell fragments (filaments), some pelmicritic matrix and calcite spar. Selenischniak, sample LB 5.

Fig. 2: Bioclastic wackestone/packstone containing a large fragment of a hexactinellid sponge. Selenischniak, sample LB 11.

Fig. 3: Bioclastic wackestone containing a large fragment of a hexactinellid sponge. Selenischniak, sample LB 12.

Fig. 4: Algae-Tubiphytes bindstone from the uppermost Contrin Formation at the Zeller Prapotnik. Pore space is filled with calcite spar and subordinately with pelmicritic matrix. Zeller Prapotnik, sample PR 2.

Fig. 5: Bioclastic wackestone/packstone with abundant radiolarians and some shell fragments and other bioclasts. The matrix consists of micrite. Zeller Prapotnik, sample PR 5.

Fig. 6: Bioclastic wackestone containing abundant filaments and angular carbonate lithoclasts, mostly derived from shallow-water carbonates (Contrin Formation). Loibl Formation, Zeller Prapotnik, sample PR 15.