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Triassic and Lower Jurassic radiolarian biostratigraphy in the siliceous claystone and bedded chert units of the southeastern Mino Terrane, Central Japan

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Abstract

The siliceous claystone and chert lithologic units of the Triassic-Jurassic chert-clastic sequence are well exposed in the Inuyama, Mt. Kinkazan and Hisuikyo areas of the southeastern Mino Terrane. Twenty-one continuous sections from those areas were investigated in order to establish comprehensive radiolarian biozones and clarify the successive lithologic changes through the Triassic and lowest Jurassic.

Twenty new radiolarian zones are established; the lowest two are assemblage zones and the others are defined by the first or last occurrence of index taxa. The definitions are as follows in chronological order: TR 0, *Follicucullus* Assemblage Zone (early Spathian or older); TR 1, *Parentactinia nakatsugawaensis* Assemblage Zone (late Spathian); TR 2A, *Eptingium nakasekoi* Lowest-occurrence Zone (early Anisian); TR 2B, *Triassocampe coronata* group Lowest-occurrence Zone (early Anisian); TR 2C, *Triassocampe deweveri* Lowest-occurrence Zone (late Anisian); TR 3A, Spine A2 (possiblly derived from *Oertlispongus inaequispinosus*) Lowest-occurrence Zone (late Anisian); TR 3B, *Yeharaia elegans group* Lowest-occurrence Zone (early Ladinian); TR 4A, *Muelleritortis cochleata* Lowest-occurrence Zone (late Ladinian); TR 4B, *Spongoserrula dehli* Lowest-occurrence Zone (late Ladinian to early Carnian); TR 5A, *Capnuchosphaera* Lowest-occurrence Zone (early Carnian); TR 5B, *Poulpus carcharus* sp. nov. Lowest-occurrence Zone (early to late Carnian); TR 6A, *Capnodoce-Trialatus* Concurrent-range Zone (late Carnian to early Norian), TR 6B, *Trialatus robustus-Lysemelas olbia* gen. *et* sp. nov. Partial-range Zone (early Norian); TR 7, *Lysemelas olbia* gen. *et* sp. nov. Lowest-occurrence Zone (early to late Norian); TR 8A: *Praemesosaturnalis multidentatus* group Lowest-occurrence Zone (late Norian); TR 8B: *Praemesosaturnalis pseudokahleri* sp. nov. Lowest-occurrence Zone (late Norian); TR 8C: Skirt F (possiblly derived from *Haeckelicyrtium takemurai*) Lowest-occurrence Zone (late Norian to early Rhaetian); TR 8D: *Haeckelicyrtium breviora* sp. nov. Taxon-range Zone (early to late Rhaetian); JR 0A: *Haeckelicyrtium breviora* sp. nov.-*Bipedis horiae* sp. nov. Partial-range Zone (Hettangian); and JR 0B: *Bipedis horiae* sp. nov. Lowest-occurrence Zone (Hettangian/Sinemurian). These zones are correlated to previousy established radiolarian assemblages and zones in Japan and other regions. Age assignment of the zones is also discussed on the basis of the correlation and other available chronological data.

The original stratigraphic succession of the Triassic in the studied area, which ranges in age from Early Triassic to Early Jurassic, is more than 100 m in thickness and can be reconstructed in detail. The succession is subdivided into seven units based on lithologic features. Each unit was probably accumulated under a particular sedimentary condition, thus successive changes of paleoceanographic environments during Triassic time can be traced continuously.

Nine new genera including *Ayrtonius, Blomella, Braginella, Bulbocampe, Enoplocampe, Lysemelas, Parvibrachiale, Spongoxystris* and *Veles*, and 47 new species are described herein. A comprehensive list of identified taxa is presented.

Key words: biostratigraphy, Central Japan, Mino Terrane, Radiolaria, Triassic.

Introduction

Since the 1970's studies of Upper Paleozoic to Mesozoic radiolarians in Japan have been perfomed by many workers in order to determine the age of pelagic sedimentary rocks such as chert and siliceous mudstone. Among them, Nakaseko and Nishimura (1979) first demonstrated that radiolarians are powerful for age determination of cherts distributed in Mesozoic complexes, the Mino and Chichibu Terranes. They also studied Cretaceous radiolarians from the Shimanto Terrane (Nakaseko and Nishimura, 1981). Yao *et al.* (1980), Yao (1982) and Yao *et al.* (1982) established a basis of Triassic-Jurassic radiolarian biostratigraphy. Subsequent workers have also been engaged in the Jurassic and Cretaceous radiolarian biostratigraphic work contributing towards the improvement of zonal accuracy and correlation (e.g., Matsuoka and Yao, 1986; Aita, 1987; Hori, 1990; Matsuoka, 1995).

However, Triassic radiolarian biostratigraphy remains not well reexamined: Kishida and Hisada (1986) and Sato *et al.* (1986) independently established radiolarian zonations for the Middle and Upper Triassic, but resolution has not been much improved since Yao (1982). Yoshida (1986) also proposed seven radiolarian zones, one of which is the lowest Jurassic and the others are the Upper Triassic, but the Middle Triassic is absent in his studied section. These discrepancies in Triassic radiolarian biostratigraphy may be due to complicated structures of strata, composed of hard bedded cherts and fissile siliceous claystone, and by faults and/or foldings, which prevent the precise reconstruction of continuous sections as a basis for biostratigraphic work. The incomplete preservation of radiolarians in cherts, which is generally far less than that in the Jurassic fine-grained clastic rocks, is also a factor hampering study.

Recently, many earth scientists have been interested sedimentary environments of siliceous claystone and chert units of chert-clastic sequences (Matsuoka and Yao, 1990; Matsuoka, 1992) since they seem to give long-termed, continuous paleoceanographic information, and some studies have already tried to solve such problems using geochemical or even mathematical approaches (e.g., Hori *et al.*, 1993; Musashino, 1993; Nakao and Isozaki, 1994; Sugiyama *et al.*, 1994; Kubo *et al.*, 1996). However, since biostratigraphic information for paleoceanographic study is not much improved, the accumulation of new knowledge henceforth may not be dramatically accelerated.

I have been engaged in Triassic radiolarian biostratigraphic work in the Inuyama, Mt. Kinkazan and Hisuikyo areas for seven years. These areas are underlain by the Mino Terrane (Mizutani, 1990) belonging to the Complex 3 of Otsuka (1988) and the Kamiaso Unit of Wakita (1988) (Fig. 1). A total of 21 sections were examined for radiolarian biostratigraphy and 20 continuous biozones are established. In this paper I define those radiolarian zones with descriptions of new taxa. During field investigations, I intended to trace lithologic change in detail. As a result, a fundamental trend of lithologic changes through the Triassic became clear with the detailed chronologic information. Therefore, I also show and discuss one possible scenario for the successive change of Triassic marine environments.

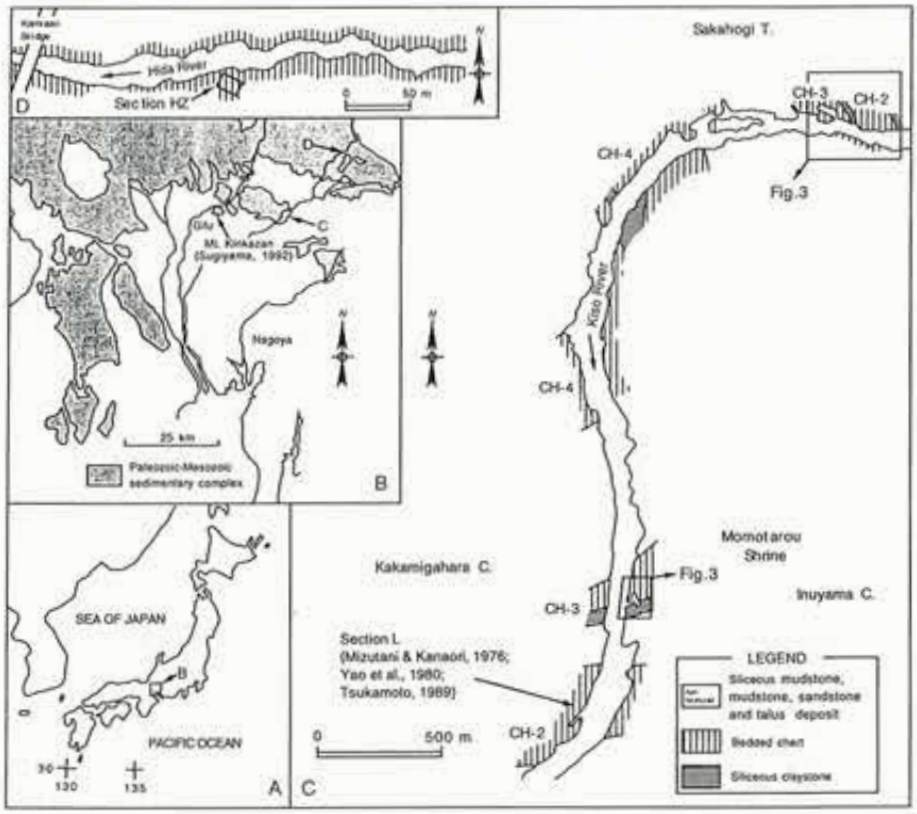


Fig. 1. Index map showing the location of studied setions. C: Simplified map showing the location of the sections in Inuyama and Kakamigahara Cities and Sakahogi Town, modified from Kimura and Hori (1993). D: Location of the section in the Hisuikyo area.

Siliceous rock terms and types of bedded chert

Before discussing detailed descriptions of the geologic settings of the studied areas, it is necessary to define some terms used in this study. As mentioned above, the object of field investigation is siliceous claystone and chert lithologic units which occupy the lower part of the Triassic to Jurassic chert-clastic sequence. The former unit is usually in fault contact with the latter unit, or grades into the latter unit in some cases.

The siliceous claystone unit is composed of thick gray siliceous claystone associated with carbonaceous, black claystone beds and nodules or nodular insertions of dolostone especially in the lower part. There is some confusion about the usage of terms for this siliceous claystone strata among investigators such as siliceous claystone (Otsuka, 1988), siliceous mudstone (Yamakita, 1988), "Toishi-type" shale (Imoto, 1984a), "Toishi-type" siliceous mudstone (Kuwahara *et al.*, 1991) and so on. In this study, I exclusively use the term siliceous claystone for this type of siliceous fine-grained rock although the definition follows that of "Toishi-type" shale by Imoto (1984a). The siliceous claystone also intercalates with thin beds of chert, whose frequency and thickness gradually increase stratigraphically upward, and finally grades into the chert unit.

It is apparent that bedded cherts are composed of rhythmical alternations of chert and siliceous claystone beds. For convenience I regard strata consisting of more than 50 % chert beds in the proportion of thickness as bedded chert, and siliceous claystone beds are simply described as "claystone beds" below. Bedded cherts can exhibit various lithologic aspects resulting from the proportion of chert and claystone beds, sedimentary structures, color of chert beds and so on. According to my observation, bedded cherts are subdivisible into two types based mainly on the rough character of the chert beds; one has rather argillaceous chert beds and very rich in siliceous organic remains under the microscope, and the other possesses highly silicified chert beds with very rare











Fig. 2. Photographs of bedded cherts. 1: B-type, Section H. 2: F-type, Section B. 3: F-type, Section N. 4: A-type, Section H. 5: A-type, Section K.

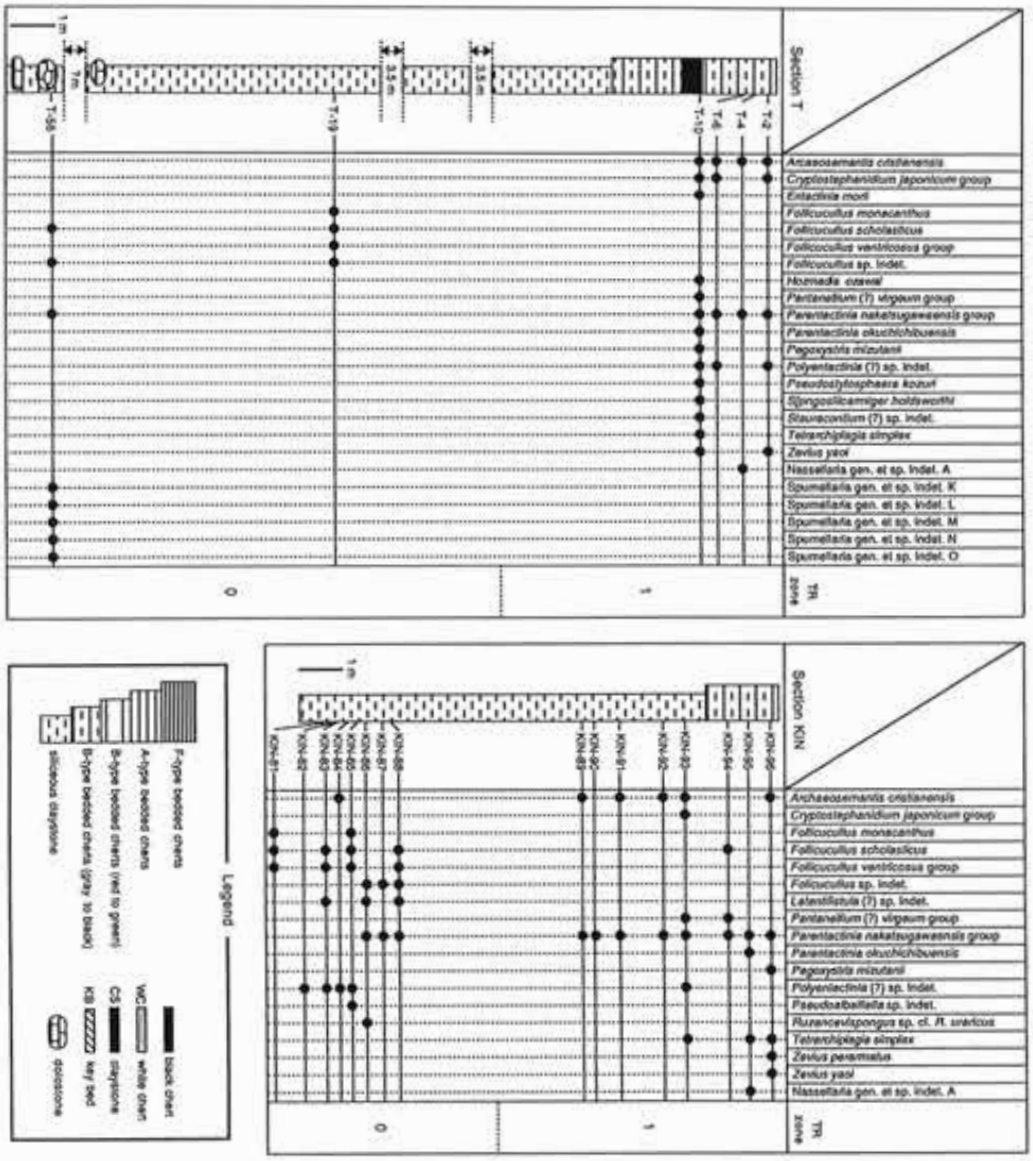


Fig. 3. Map showing the location of sections in Inuyama City and Sakahogi Town.

organic remains well-preserved in a fine-grained siliceous matrix. The former and latter correspond to B- and F-types of Imoto's (1984b) bedded chert classification, respectively (Sugiyama *et al.*, 1994). These types of bedded cherts seem to have close relationships with layered types of chert beds, and are easily recognizable in outcrop; namely, the B-type is predominated by single-layered chert beds and generally forms concave topography on outcrops, whereas the F-type by various degrees of multi-layered chert beds (triple-layered, striped and laminar types of Kakuwa, 1991) and convex topography. Here, one notices that there are obviously two types of triple-layered chert beds in previous reports. One truly has three heterogeneous layers (relatively argillaceous two layers and highly siliceous layer) that are often recognizable by different colors in a single bed. The other also has seemingly three colors in a single bed, but no heterogeneity is observed under the microscope. The latter beds probably resulted from secondary decoloration, and belong to single-layered chert beds.

In this study, I use two notation B and F not only for distinction of types of chert beds but also for bedded cherts according to Sugiyama *et al.* (1994). The terms "B-type bedded chert" and "F-type bedded

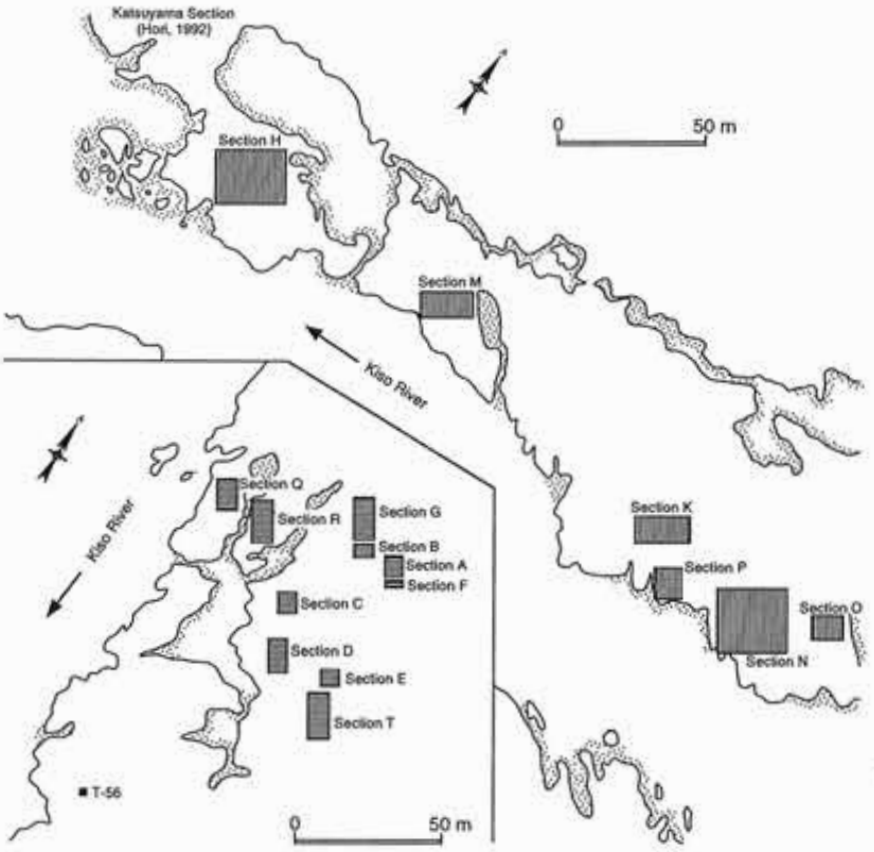


Fig. 4. Geologic column of Sections T and KIN and list of radiolarians.

chert" mean siliceous strata consisting only of or predominated by B-type chert beds or F-type chert beds, respectively. The B- and F-type bedded cherts stratigraphically alternate with one another in the entire chert unit. The alternations are sometimes quite abrupt, other times gradual. It is certain that both the types are indicative of a paticular sedimentary environment and/or diagenetic condition. Another type of bedded chert is discriminated as A-type (abbreviation of "alternating") for descriptional convenience (Fig. 2). This type is characterized by alternating occurrences of B-type and F-type bedded cherts within a short interval, and it is herein defined that the thickness of B- and F-type bedded cherts is approximately less than one meter. In the A-type bedded cherts, B-type chert beds are commonly thinner than F-type ones. The presence of A-type bedded cherts indicates that cyclic changes of sedimentary environments and/or diagenetic conditions took place during a short period.

Geological description of studied sections

1. Mt. Kinkazan area

Mt. Kinkazan located approximately 15 km east of the Inuyama area (Fig. 1) is composed of bedded cherts associated with sandstone, mudstone, siliceous mudstone and siliceous claystone. Radiolarians have been reported by Ando (1987), Ando *et al.* (1991) and Sugiyama (1990, 1991, 1992). According to Ando *et al.* (1991), Lower and Middle Triassic strata are distributed in four localities in Mt. Kinkazan; namely Loc. 1 (=route B of Sugiyama, 1992), Locs. 2 and 3 (=route A of Sugiyama, 1992) and Loc. 4 (=route C of Sugiyama, 1992). This study reexamined the litho- and biostratigraphy of Loc. 1 which seems to be the best preserved section of siliceous claystone to chert unit in the Mt. Kinkazan area.

The route map is given by Ando *et al.* (1991, fig. 2a). As shown in Fig. 3, 12 samples designated by the prefix KIN are examined. The basal horizon KIN 77

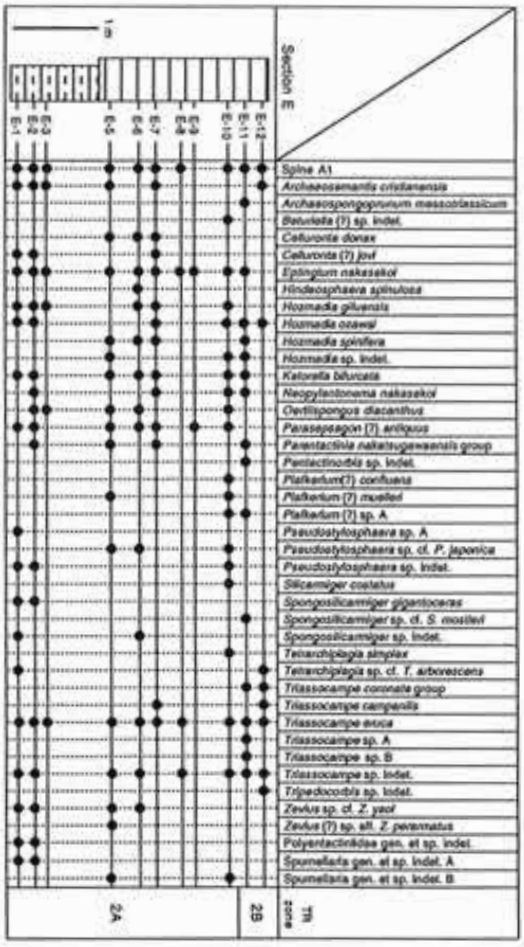


Fig. 5. Geologic column of Section E and list of radiolarians. Legend shown in Fig. 4.

nearly corresponds to JMP 1344 of Ando *et al.* (1991), and strata become younger northwest as mentioned by Ando *et al.* (1991), although some minor faults and foldings exist. Below the horizon KIN-93, the lithology is represented by gray siliceous claystone intercalating with black, carbonaceous claystone beds and gray chert beds. Beyond KIN-93 it grades into bedded chert consisting of black, dark gray or gray B-type chert beds 1-5 cm thick.

2. Inuyama area

The stratigraphic sequence in the Inuyama area, extending over Aichi and Gifu Prefectures, is composed of six, stacked thrust sheets (Kimura and Hori, 1993). Many excellent biostratigraphic studies have been done in this area (e.g., Yao, 1982; Hori, 1992), and the general geology is recently presented in Kimura and Hori (1993) and Matsuoka *et al.* (1994). The following description is subdivided into three parts.

(1) Inuyama City

Ten sections were investigated in Inuyama City near the Momotarou Shrine (Fig. 4), which are located on CH-3 of Yao *et al.* (1980). The following descriptions of the investigated sections are ordered from south to north, which means stratigraphically older to younger because the sections are located on the southwest flank of the Sakahogi Synform (Mizutani, 1964) and it is known that the strata become younger northward (Kimura and Hori, 1993).

Section T

Section T represents the lowest part of the chert-clastic sequence. This section is not a complete succession in the strict sense since it is covered in some parts with soil and bush and it is difficult to check repetitions of strata by faults and foldings. It is however certain that the strata generally become younger northward. Six samples listed in Fig. 3 were examined from a 25 m interval.

In the lower part, the strata are composed of thick, gray siliceous claystone intercalating with black, carbonaceous claystone beds and rare gray to black chert beds 1-3 cm thick. The sample T-19 is one of the intercalated chert beds. The siliceous claystone contains nodules of dolostone below the horizon of T-19, and some dolostone nodules contain blocks of chert. Sample T-56 is a chert block in the dolostone. Beyond the hiatus in the middle part, chert beds rapidly increase in number and thickness, and the lithology changes into grayish to blackish bedded chert. Black chert beds are conspicuous around sample T-10. The other four samples were collected from the lowest part of the chert unit where the chert beds are 5-10 cm in thickness. All chert beds belong to B-type, but the main constituents are not radiolarian tests but sponge spicules.

Section E

The bottom of Section E is approximately 5 m north of the top of Section T beyond a covered area.

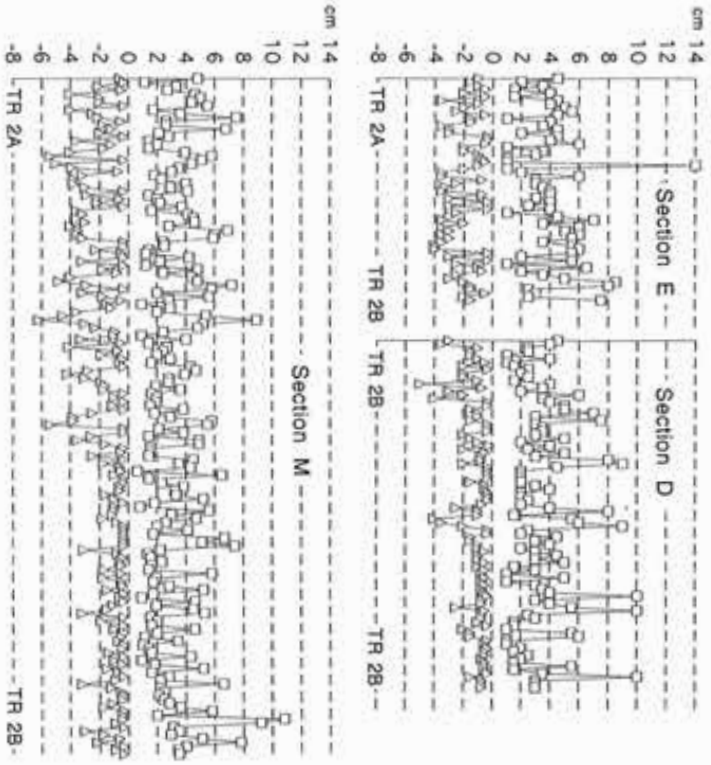


Fig. 6. Graph showing changes in bed thickness in Sections E, D and M. Squares (above x axis) and triangles (below x axis) represent chert and claystone thickess, respectively (each claystone thickness is shown in minus quantity). These are plotted stratigraphically upward from left to right.

This section is a 3 m interval of continuous B-type bedded chert from which 11 samples were examined (Fig. 5).

In this section chert beds are generally thicker than the claystone beds (Fig. 6). Below the horizon E-5, the chert beds are gray, greenish gray, or blackish gray, whereas they are purplish red above E-5. The purplish red color changes laterally into green to greenish gray. Above the horizon E-12, strata are folded and partly covered by bush and a pool of water, thus reconstruction of a continuous sequence is impossible.

Section D

Section D is apparently located nearly parallel to Section E. This section is a continuous interval of B-type bedded chert approximately 4.5 m between two fold axes; 15 samples were examined here (Fig. 7).

Below the horizon D-5 chert beds are relatively thin, whereas claystone beds are thick and attain a maximum thickness of 5 cm (Fig. 6). Above D-5 the former beds rapidly increase in thickness and, in contrast, the latter ones gradually decrease. Except for the uppermost part showing purplish red, the chert beds in this section are gray to black. One conspicuous black chert bed lies just above horizon D-16.

Section C

The bottom of Section C is more than 10 m north of the top of Section D, but the precise distance between them is not known since there are intense folds. This section represents a continuous B-type bedded chert interval of approximately 6 m between two fold axes; 21 samples were examined (Fig. 8).

As shown in Fig. 9, chert beds are considerably thicker than claystone beds. In fact, the mean thickness of the chert beds is greater in this section than in other sections. The chert beds below the horizon C-1 are gray, greenish gray or blackish gray. Below horizon C-21 at least two, conspicuous black chert beds are present but the precise horizons are uncertain owing to a strong fold defining the base of this section. A yellow chert bed is observed just beneath the C-1 horizon. Between horizons C-1 and C-5, the color of the chert beds is purplish to brick red but changes laterally into greenish gray to green. Above the

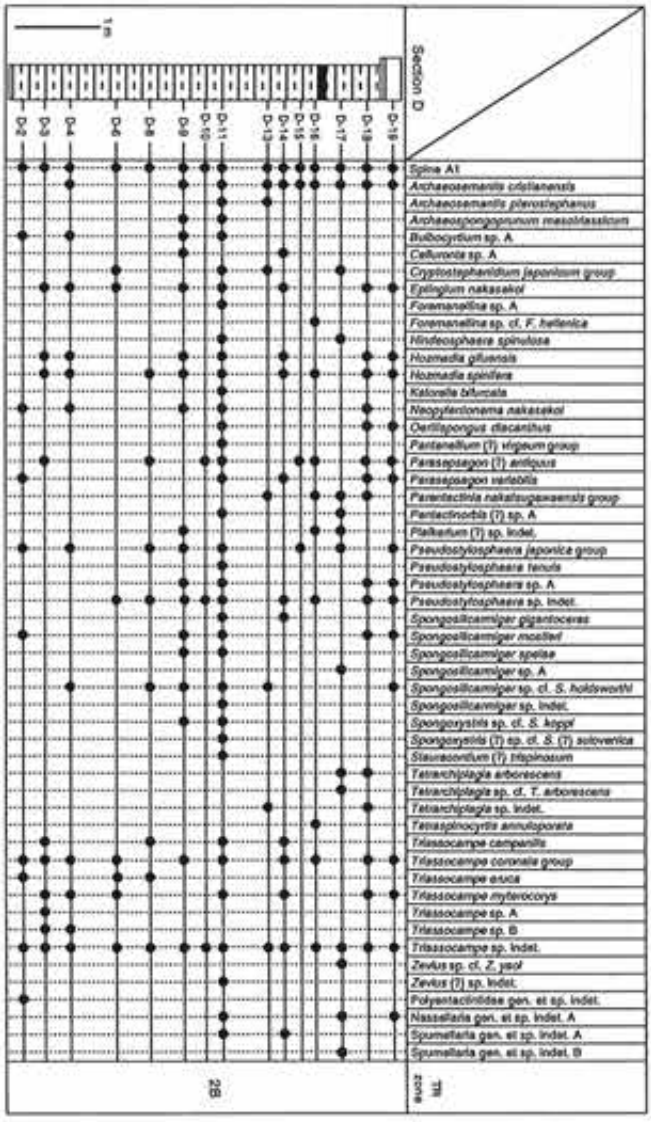


Fig. 7. Geologic column of Section D and list of radiolarians. Legend shown in Fig. 4.

horizon C-5 all chert beds are brick red.

Section F

The bottom of Section F probably lies stratigraphically a few meters above the top of Section C, but the details are not known because of foldings and lacking of available key beds between them. This section is a continuous B-type bedded chert interval of approximately 2.2 m between the bush and a small pool; nine samples were examined as shown in Fig. 10.

The chert beds are all brick red as observed in the upper part of Section C, but they are thin. The thickness of the claystone beds is nearly constant as in Section C; most are approximately 0.5 cm or less.

Section A

The bottom of Section A is approximately 2 m north of the top of Section F. This section is a completely continuous B-type bedded chert interval of approximately 4.8 m between a pool and a massive white chert named WC-1; 17 samples were examined in this section (Fig. 11).

All the chert beds are brick red in color except for three white chert beds; of the latter WC-1 is a very good key bed that is laterally traceable.

Section B

Section B is located on the left side of Section A beyond a small pool; the base corresponds to WC-1. It is a continuous bedded chert interval of approximately 4.5 m between WC-1 and the end of outcrop; 23 samples were examined from the section (Fig. 12).

Between horizons B-9 and B-10 there is another white chert bed (WC-2) which is also a useful key bed. Below WC-2 the chert beds are brick red, and form B-type bedded chert with relatively thin chert beds similar to the underlying Section A (Fig. 9). However, above the WC-2, the lithology rapidly changes into F-type bedded chert of lighten color, vermilion to reddish orange.

Section G

The bottom of Section G is approximately 1.5 m north of the top of Section B. This section represents a continuous bedded chert interval of approximately 9 m between a covered interval and strong folding; 58 samples were examined from this section (Fig. 13).

Between horizons G-57 and G-1 there is a thick claystone bed (CS-1) that is widely traceable as a concave horizon. Here the bedded chert is quite different above and below CS-1; below is somewhat recrystallized F-type bedded chert, whose chert beds are white, blackish gray, gray, dark brown or dark crimson in color, and above is brick red, well-stratified B-type bedded chert. The B-type chert beds again change gradually into F-type around horizon G-15. Above G-15, thin B-type chert beds are sometimes

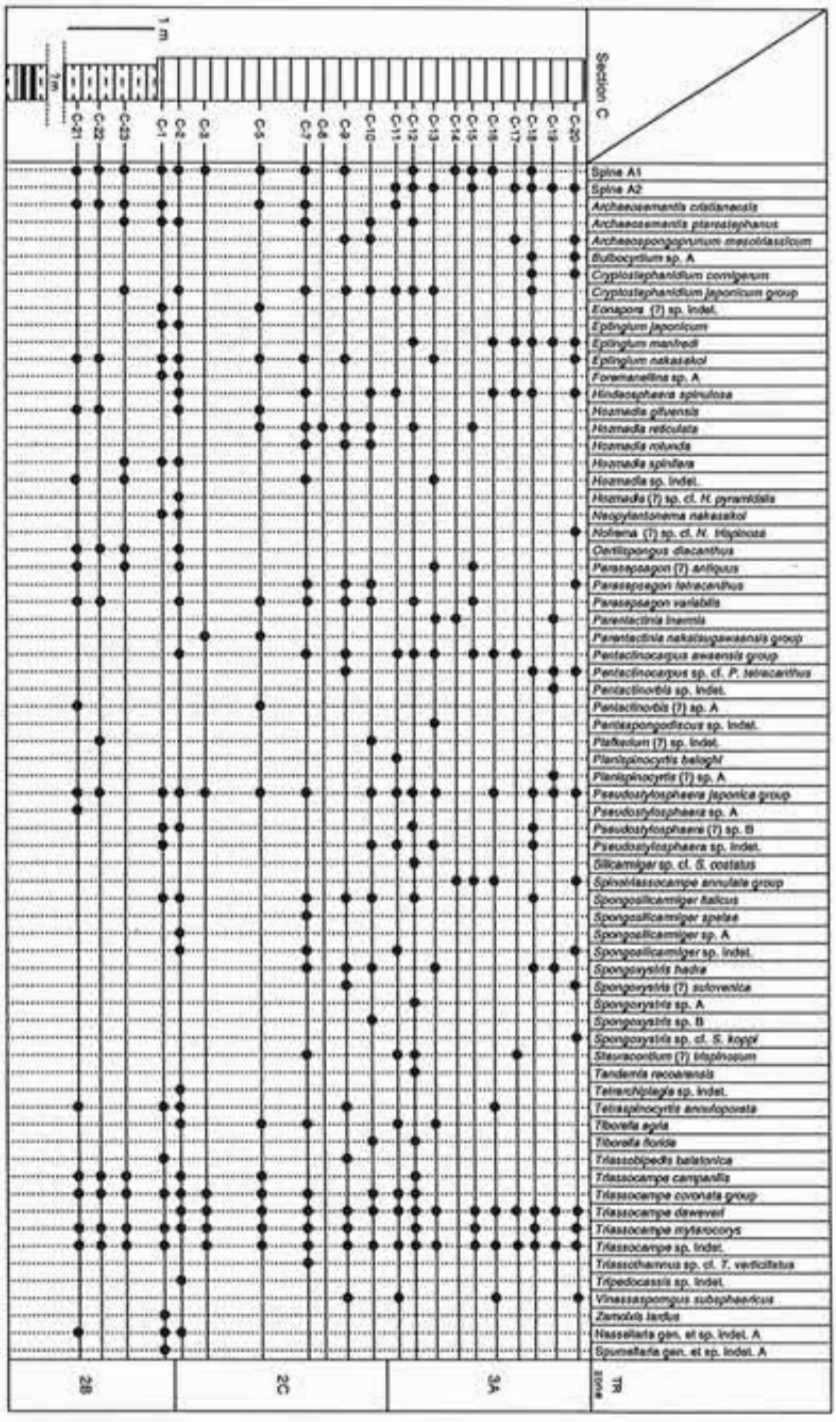


Fig. 8. Geologic column of Section C and list of radiolarians. Legend shown in Fig. 4.

intercalated between F-type chert beds, which is also recognized as a concave horizon. Those between horizons G-21 and G-22 show conspicuous concave topography.

Section R

Section R, located on the left side of Sections B and G beyond a pool, is a continuous bedded chert interval of approximately 20 m; 30 samples were examined from this section (Fig. 14). Below and above this section it is difficult to reconstruct continuous sequences owing to foldings. This section intercalates three key beds WC-1, WC-2 and CS-1 mentioned above.

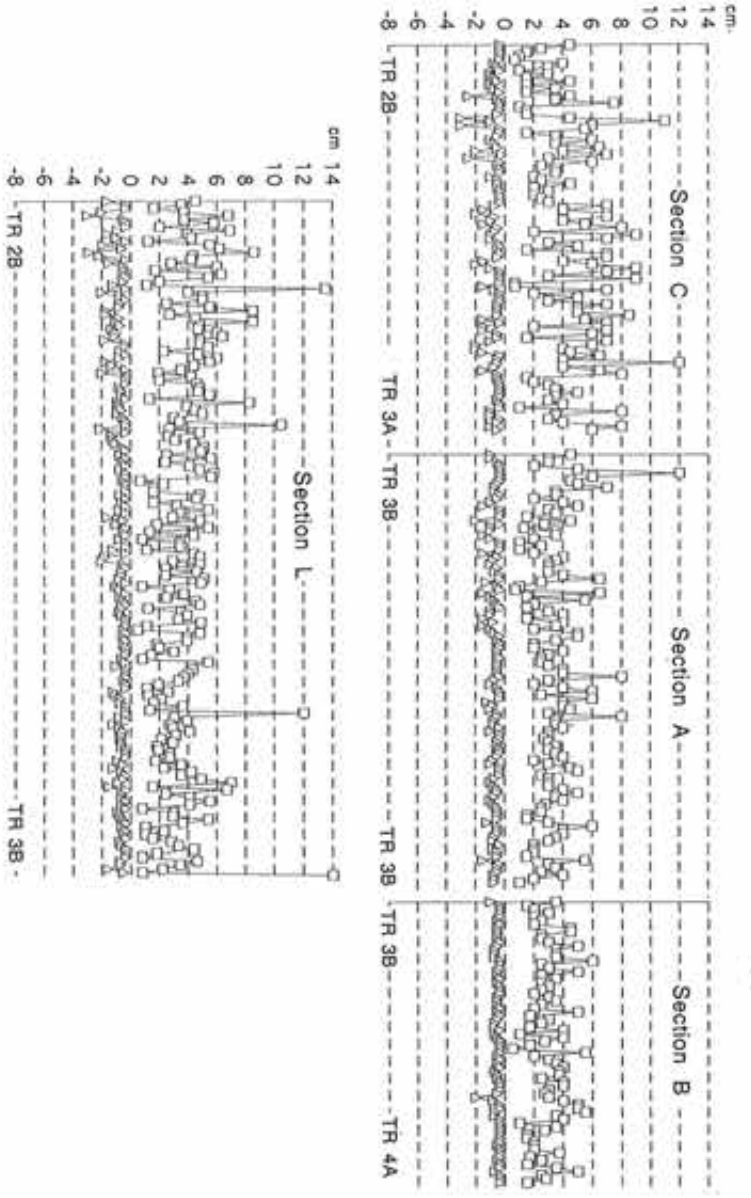


Fig. 9. Graph showing vicissitudes of bed thickness in Sections C, A, B and L. Squares (above x axis) and triangles (below x axis) represent chert and claystone thickess, respectively (each claystone thickness is shown in minus quantity). These are plotted stratigraphically upward from left to right.

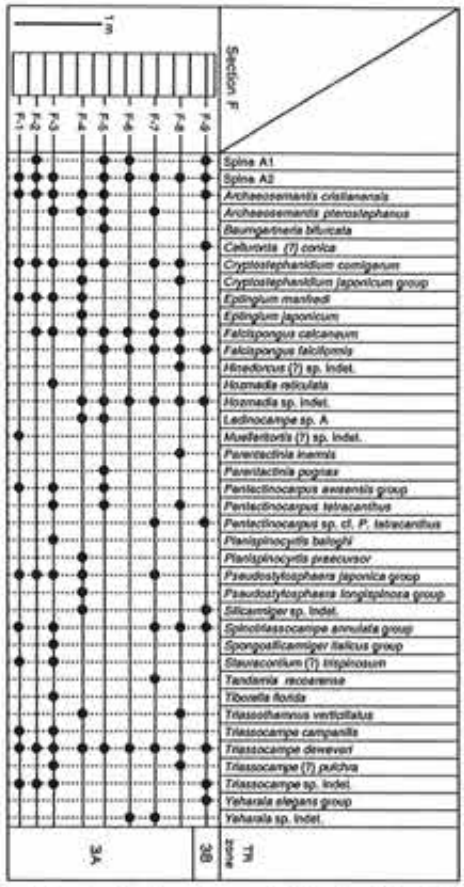


Fig. 10. Geologic column of Section F and list of radiolarians. Legend shown in Fig. 4.

Below WC-2 bedded chert is typical B-type, but it abruptly changes into F-type above WC-2 as observed in Seciton B. F-type chert beds between WC-2 and CS-1 are subdivisible into two based on their color: a vermilion to reddish orange lower part, and a gray to dark crimson upper part; these beds are separated by a sharp boundary between horizons R-17 and R-36. The lower F-type bedded chert undoubtedly corresponds to the upper part of Section B, and the upper F-type bedded chert to the lower part of the Section G, respectively. Sample R-38 corresponds to CS-2. From horizons R-39 to R-21 the bedded chert is B-type and is brick red color. Finally the B-type bedded cherts gradually change into F-type again above the horizon R-21.

Section Q

Section Q, located on the left of Section R beyond a pool, is a continuous bedded chert interval of approximately 11 m; 27 samples were examined from this section (Fig. 15). The bottom of this section is defined by CS-1, and above the uppermost horizon Q-27 it is impossible to trace a continuous sequence owing intense folding.

As in Section R, B-type chert beds are distributed below horizon Q-4, above which F-type bedded cherts

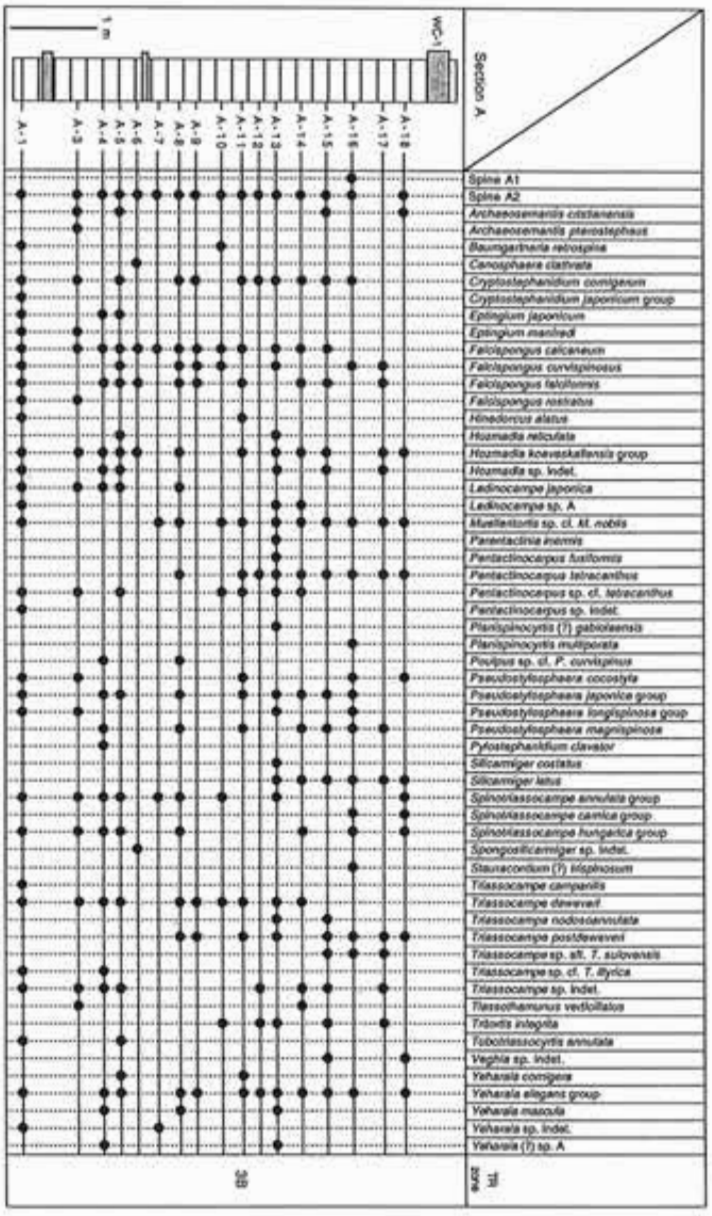


Fig. 11. Geologic column of Section A and list of radiolarians. Legend shown in Fig. 4.

occur with small scale intercalations of B-type chert beds between horizons Q-11 and Q-12. A thick white chert bed is intercalated between the horizons Q-22 and Q-23.

(2) Kakamigahara City

The studied section, named Section L, is located on CH-2 of Yao *et al.* (1980). The strata become younger northward similar to the above described sections in Inuyama City, since the area place is also located on the southwest flank of the Sakahogi Synform.

Section L is situated at a famous outcrop previously studied by Yao *et al.* (1980) and Yao (1982). It was also investigated by Mizutani and Kanaori (1976) and Tsukamoto (1989) from structual and mineralogical viewpoints. This section is a composite section consisting of four subsections. Between two foldings, an approximately 9 m interval of continuous bedded chert sequence was reconstructed based on some horizons of white chert bed; 23 samples were examined from this section (Fig. 16).

All chert beds are brick red and belong to B-type. The thickness of the chert and claystone beds gradu-

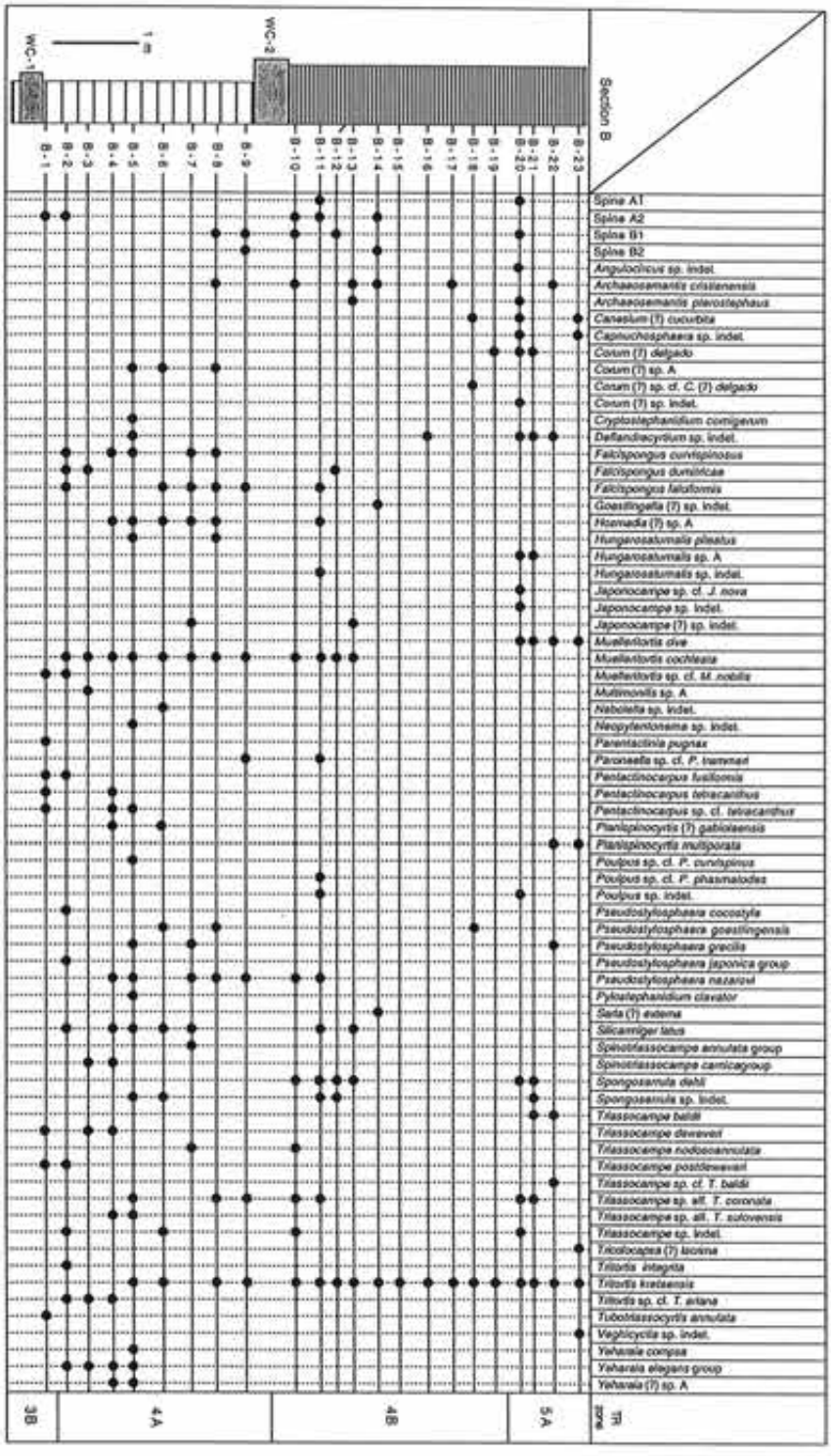


Fig. 12. Geologic column of Section B and list of radiolarians. Legend shown in Fig. 4.

ally decreases upward as shown in Fig. 9. Seven conspicuous white chert beds are observed, which are named WC-4 to WC-10 corresponding to Tsukamoto's (1989) same labelings.

(3) Sakahogi Town

On the northeast frank of the Sakahogi Synform, the following sections are located on CH-2 and CH-3, thus the strata become younger westward in each sheet (Kimura and Hori, 1993). The following

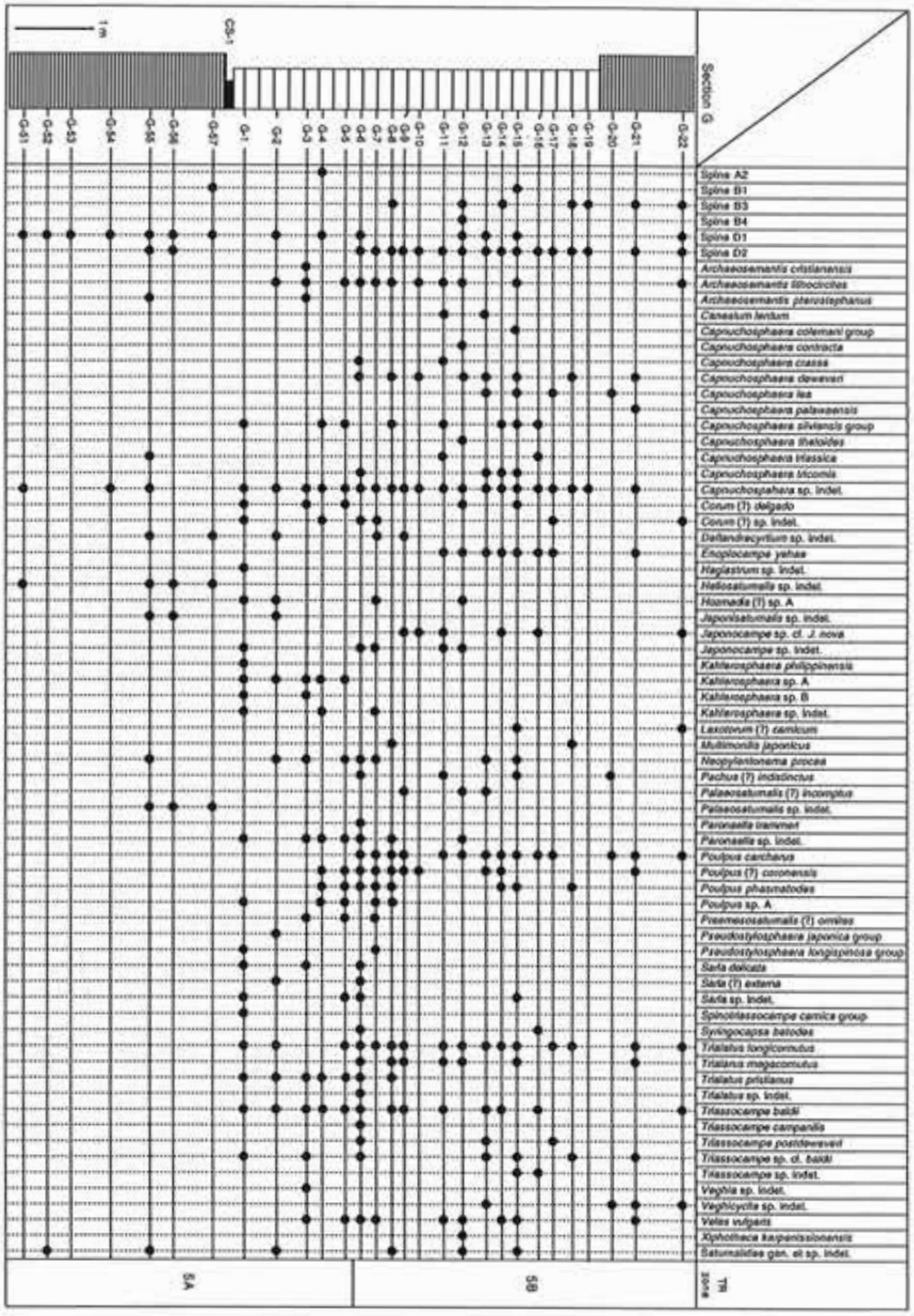


Fig. 13a. Geologic column of Section G and list of radiolarians. Legend shown in Fig. 4. 13a, lower part of the section; 13b, upper part of the section.

descriptions are arranged stratigraphically from the lower to upper section.

Section M

Section M, located on CH-3, is a continuous bedded chert interval of approximately 11 m; 16 samples were examined from this section (Fig. 17). The top is in fault contact with a neighboring bedded cherts sequence, and below the lowest horizon M-16 it is difficult to recognize continuous sequences owing to the bush and foldings.

All chert beds are B-type. Below horizon M-12

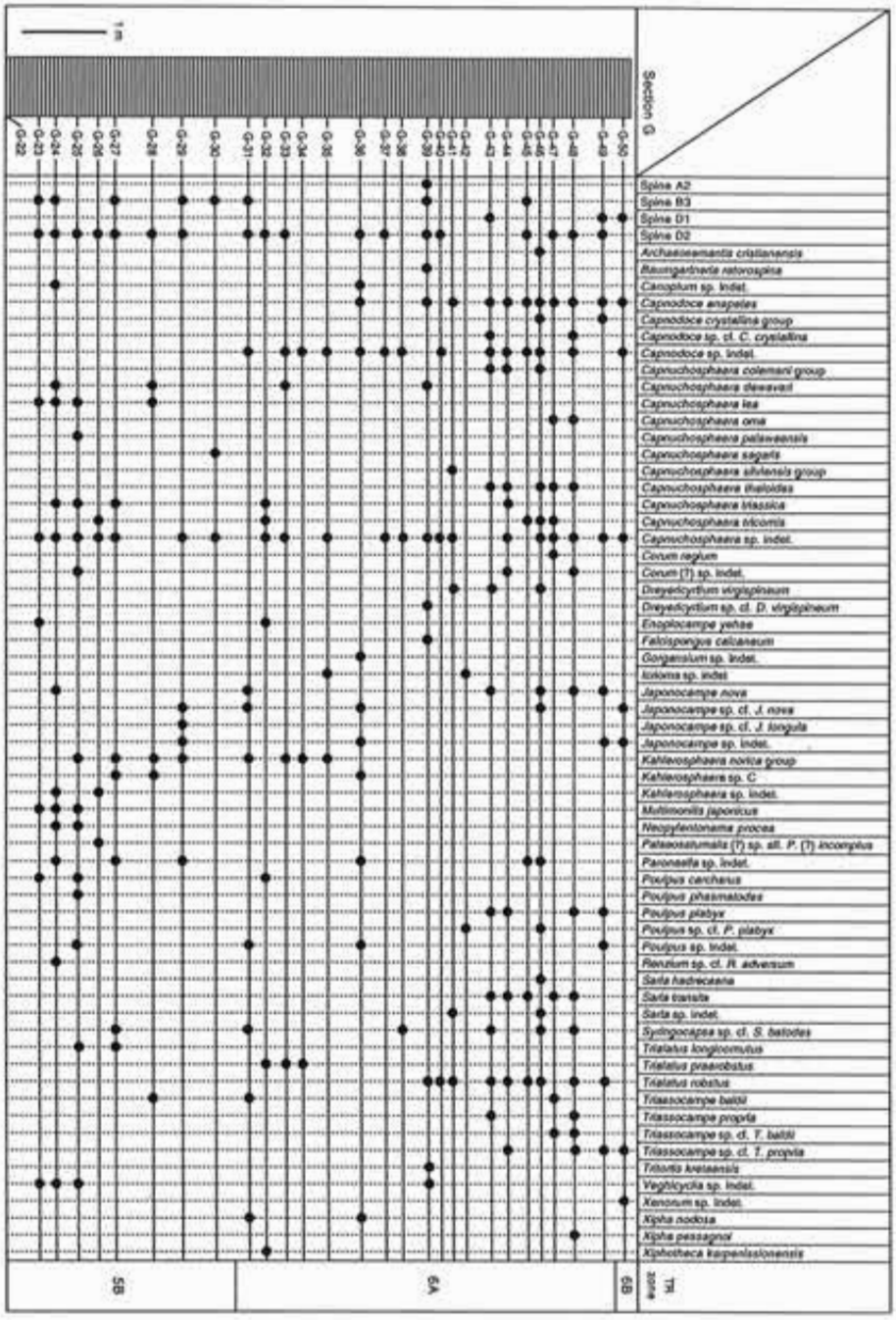


Fig. 13b. Geologic column of Section G and list of radiolarians. Legend shown in Fig. 4. 13a, lower part of the section; 13b, upper part of the section.

chert beds are gray to blackish gray in color, and two horizons of black chert are present; one corresponds to the lowest horizon M-16 and the other to just above the horizon M-14. Between horizons M-12 and M-8 the chert beds are purple red, but one just above horizon M-10 is gray. The purple red color changes laterally into green or greenish gray. Above M-8 the chert beds again change completely into gray or greenish gray. This change is sharp while one near the M-12 is relatively gradual. Above horizon M-5 the chert beds abruptly become thin (Fig. 6), and blackish chert beds occur in three horizons; the uppermost is markedly conspicuous.

Section O

Section O located in CH-2 is a continuous B-type

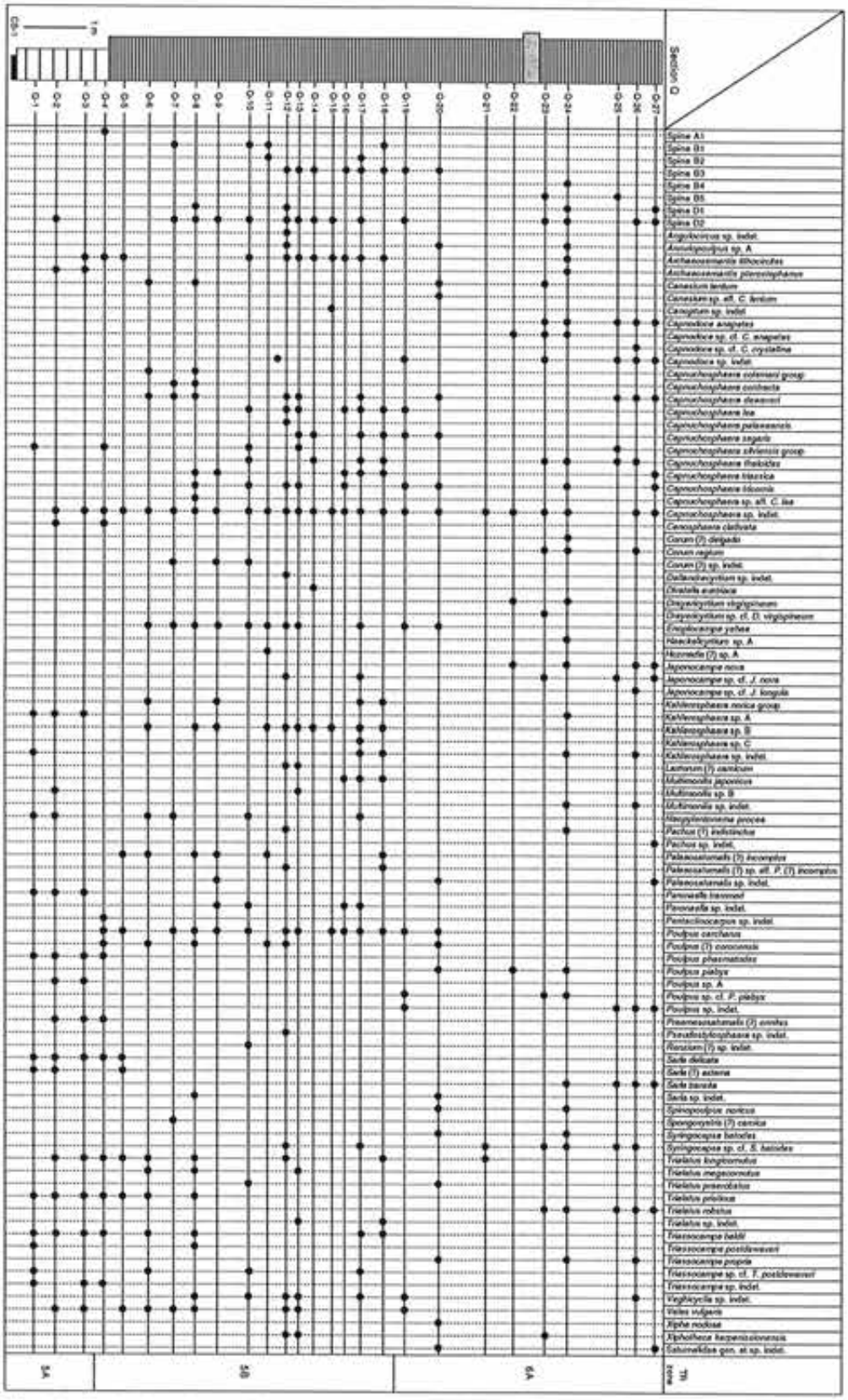


Fig. 15. Geologic column of Section Q and list of radiolarians. Legend shown in Fig. 4.

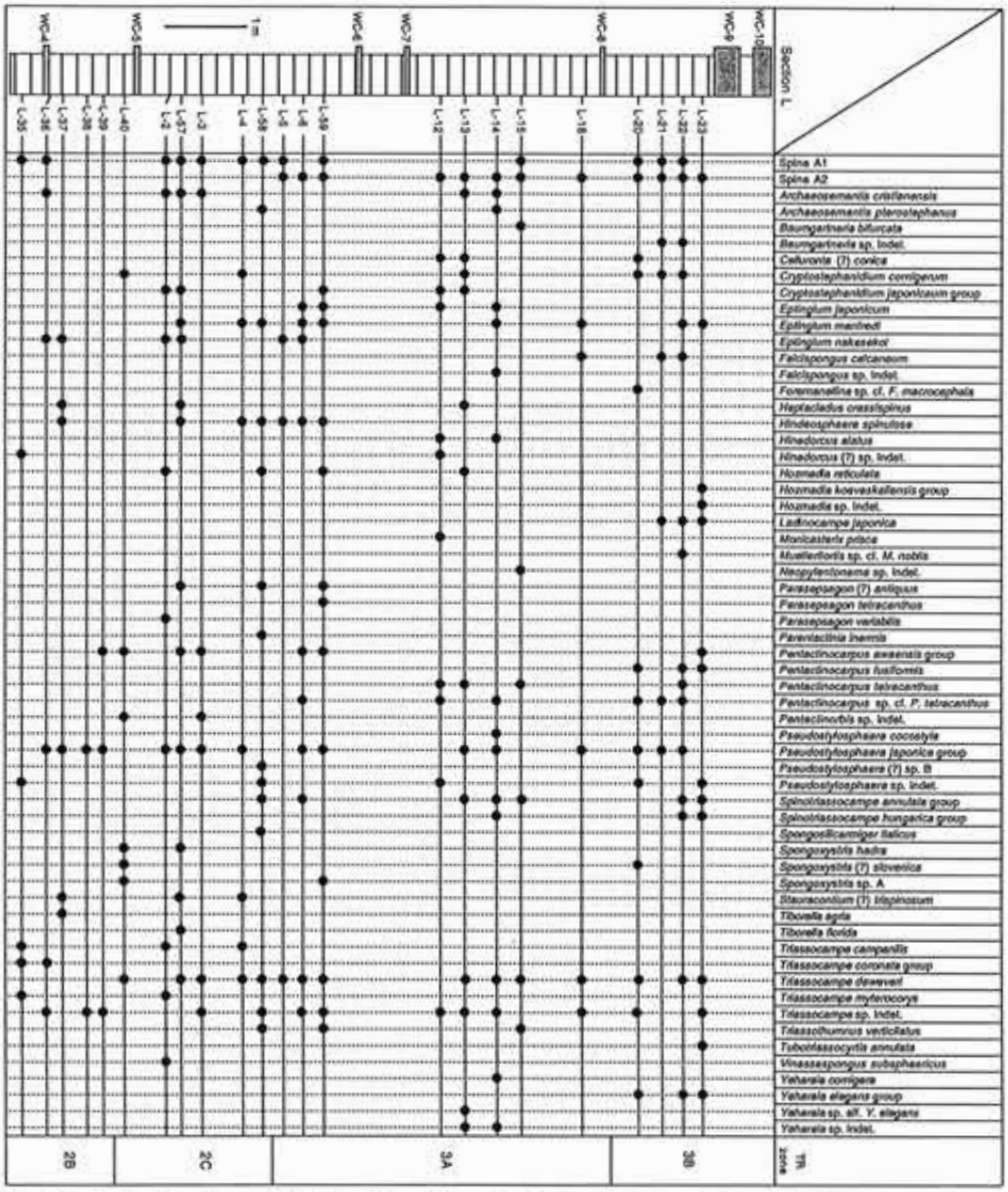


Fig. 16. Geologic column of Section L and list of radiolarians. Legend shown in Fig. 4.

Below horizon N-14 the chert beds abruptly become thin-bedded accompanied by relatively thick claystone (named CS-2); A-type bedded chert is present from horizons N-14 to N-18. White chert beds are distributed in seven horizons.

Section H

Section H is a composite section consisting of Subsections H1, H2 and H3. It is located on CH-3 and situated east of the Katsuyama (UF) Section of Hori (1992).

Subsection H1 is a continuous bedded chert interval of approximately 10 m between a pool side and a fault; 27 samples shown in Fig. 20 were examined. Below a thick claystone bed (CS-2) the bedded chert is F-type; above CS-2 chert beds abruptly change into A-type. At the horizon of a key bed named KB-1, the bedded chert again changes into B-type. It is very characteristic that the lowest part the B-type bedded chert is markedly thin-bedded, and the number of

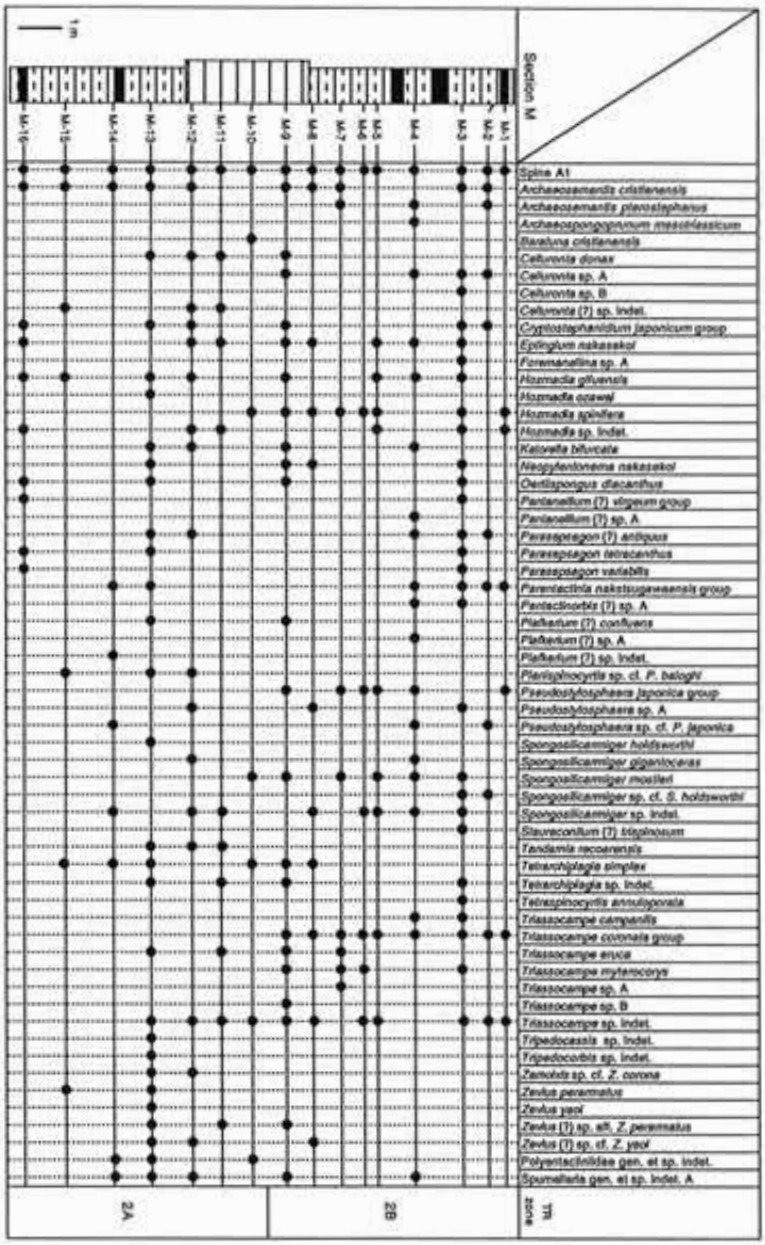


Fig. 17. Geologic column of Section M and list of radiolarians. Legend shown in Fig. 4.

rhythmical insertion of relatively thicker and more siliceous beds gradually increases upsection; this is well marked by the ruggedness of the outcrop surface.

The bottom of Subsection H2 is estimated to be 50 cm or less above the top of Subsection H1. This subsection is a continuous bedded chert interval of approximately 9 m between a fault at the botttom and a folding at the top; 25 samples were examined as shown in Fig. 21. The bedded chert periodically shifts the aspect from B-type into A-, B-, A-, F-, A-, B, F- and finally into A-type upward.

The bottom of Subsection H3 corresponds to the KB-1, and the top is defined by a fault. This subsection is a continuous bedded chert interval of approximately 8.5 m; 30 samples were examined as shown in Fig. 22. The bedded chert successively changes from B-type into A-, B-, A-, F- and A-type. These horizons can be correlated to the preceding subsection.

Section K

Section K, located on CH-2, is a bedded chert interval of approximately 25 m, but in the lower part there

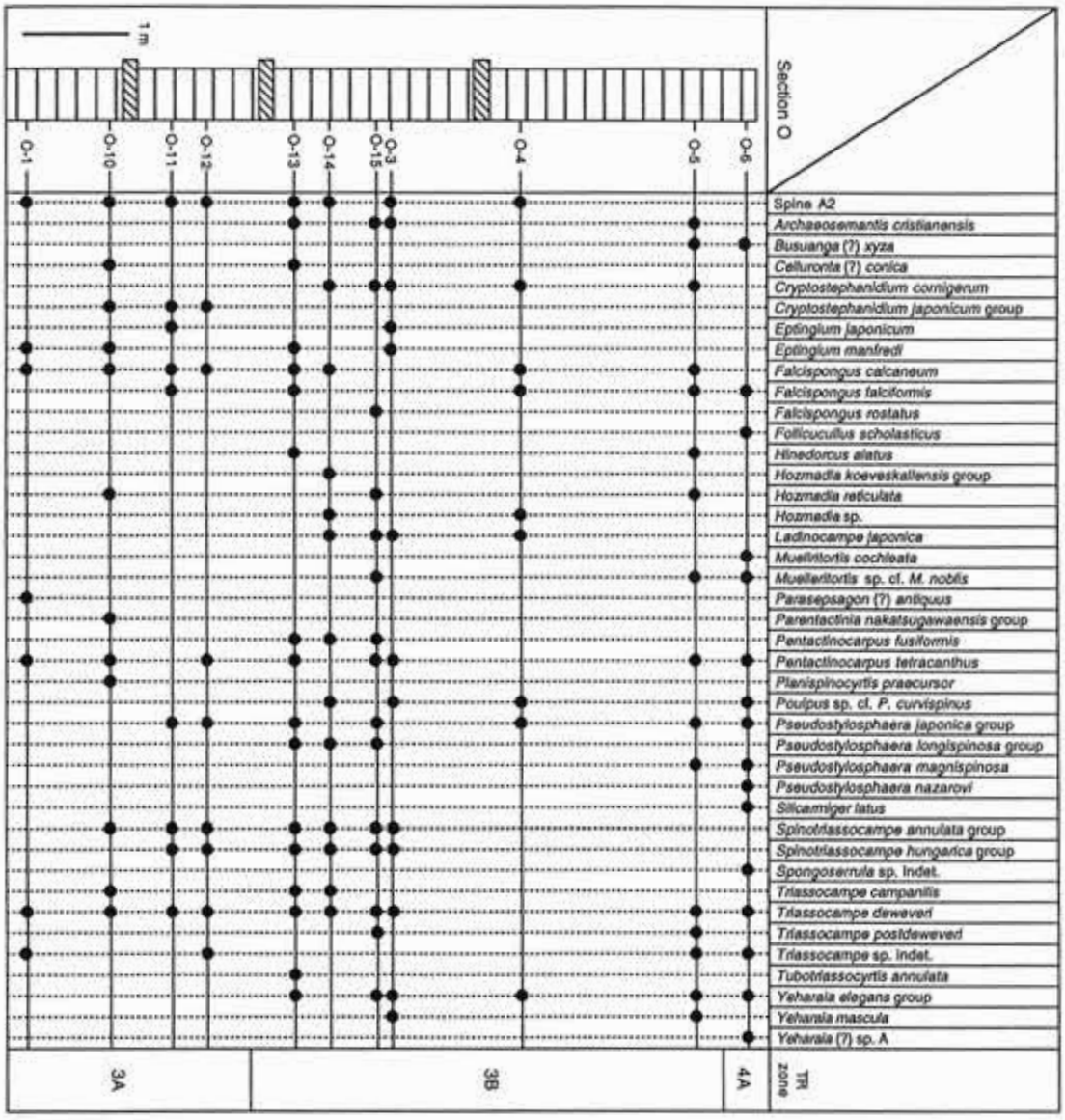


Fig. 18. Geologic column of Section O and list of radiolarians. Legend shown in Fig. 4.

may be a lack of strata owing to deformation by fault and/or folding. The bottom of this section overlies apparently massive F-type bedded cherts accompanied by a relatively thick claystone bed which corresponds to CS-2 observed also in Section N; strata above this section were not investigated. Ninety-four samples were examined from this section (Fig. 23).

The bedded chert is A-type below horizon K-12 and B-type below the horizon K-22. The chert beds are conspicuously thin between the horizons K-12 and K-15. An apparent fault exists between horizons K-22 and K-23 resulting in secondary deformation of strata with shared chert beds. Between the horizons K-23 and K-34 the bedded chert is A-type, and above the interval it successively changes into F-, B-, A-, B-, F-, A-, and F-type until the horizon K-79. Throughout this interval, relatively thick claystone beds are sometimes intercalated between chert beds especially in the lower part. Just below the horizon K-80, there is a thick claystone bed named CS-3 and the type of the bedded chert abruptly alters into argillaceous and thin-bedded B-type. The B-type bedded chert becomes siliceous and hard attributable to the A-type bedding above horizon K-100. A-type bedded chert again becomes argillaceous and thin-bedded B-type

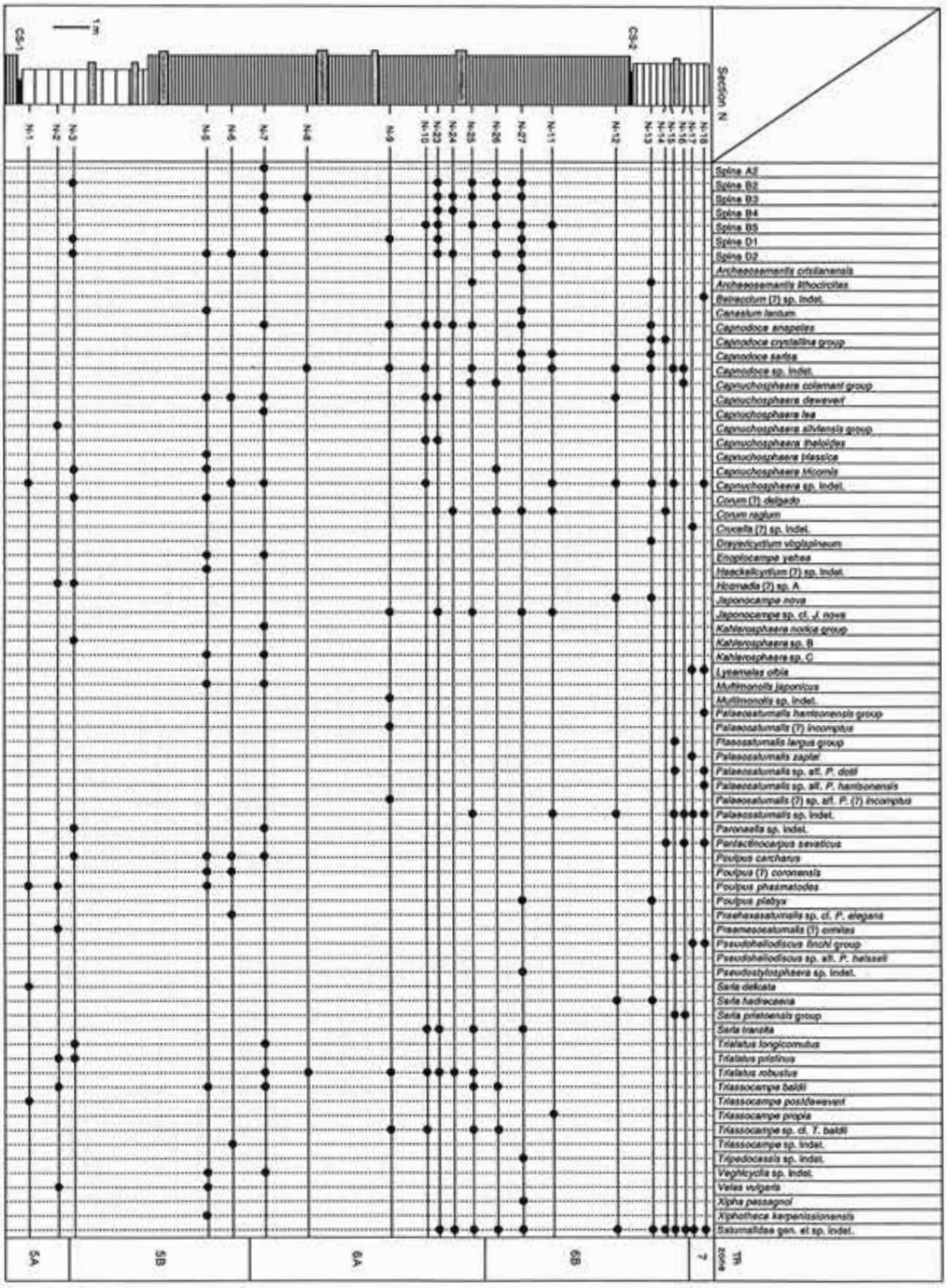


Fig. 19. Geologic column of Section N and list of radiolarians. Legend shown in Fig. 4.

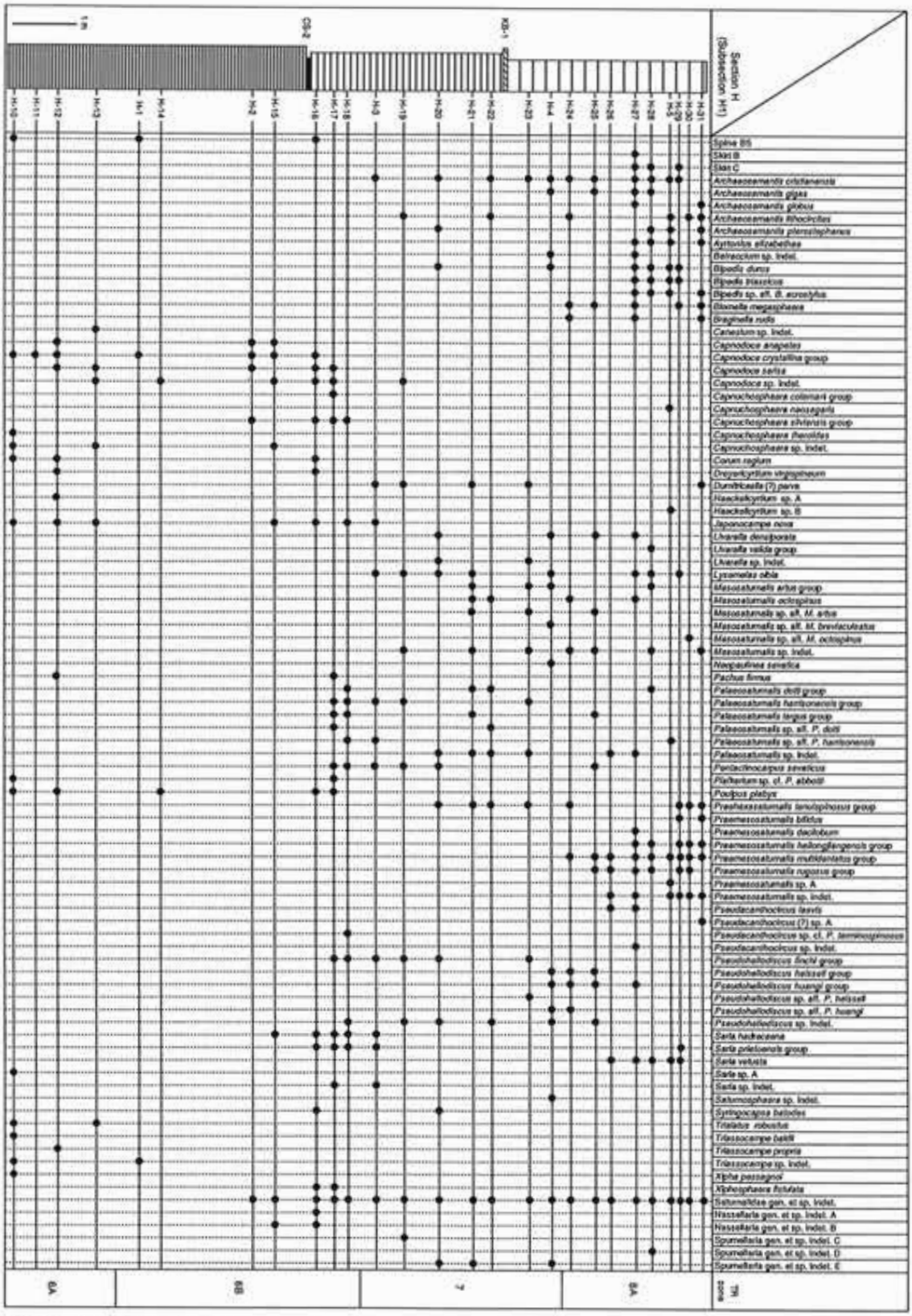


Fig. 20. Geologic column of Section H (Subsection H1) and list of radiolarians. Legend shown in Fig. 4.

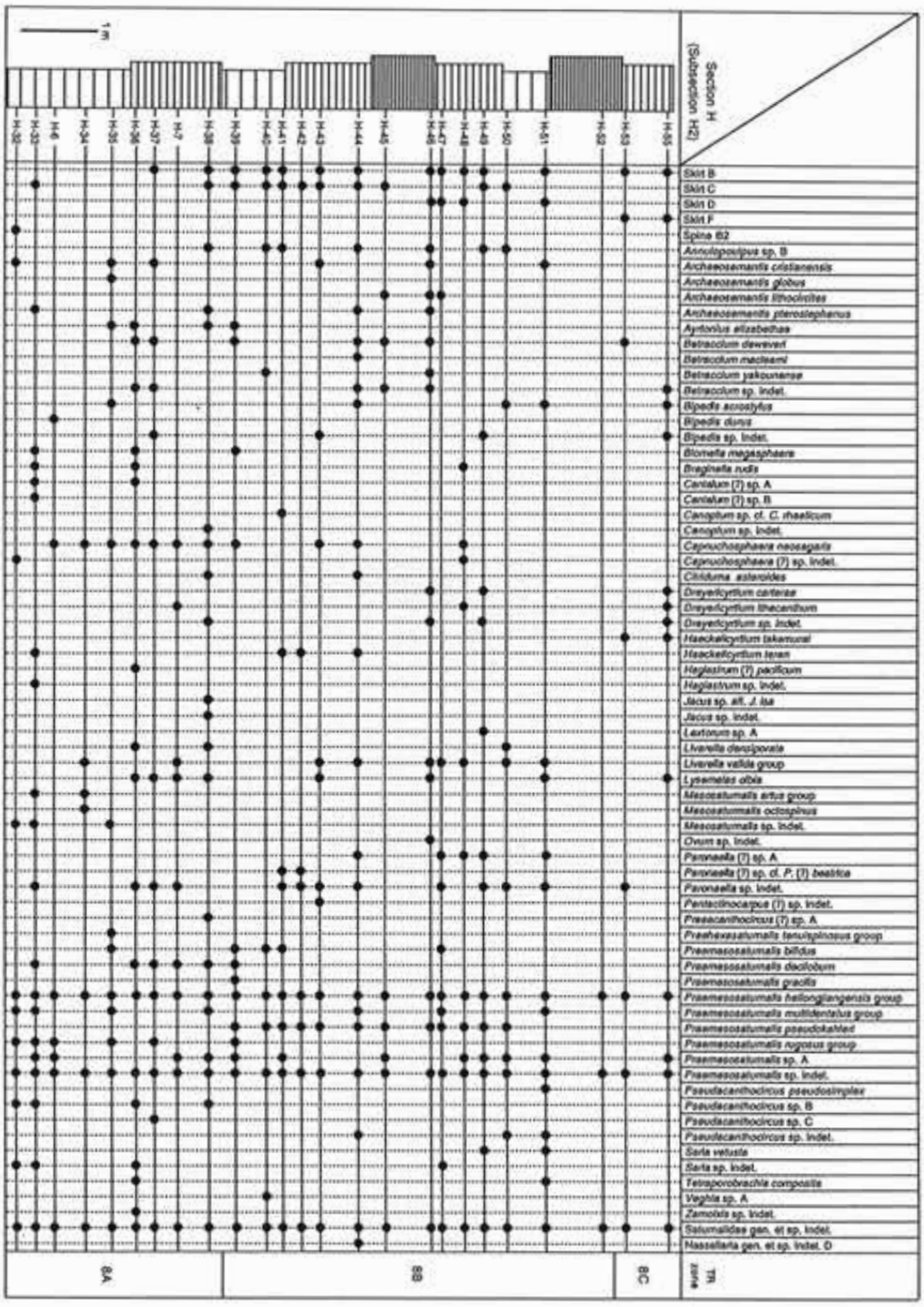


Fig. 21. Geologic column of Section H (Subsection H2) and list of radiolarians. Legend shown in Fig. 4.

below horizon K-108. One white chert bed is inserted just above horizon K-40.

Section P

Section P is juxtaposed with the upper part of Section K beyond 10 m distance. This section is a complete bedded chert interval of approximately 9 m. Nineteen samples were examined from this section (Fig. 24). Below and above this section it is impossible to collect samples owing to topographic obstructions, but a large concavity above the top of this section is traceable and corresponds to horizons K-80

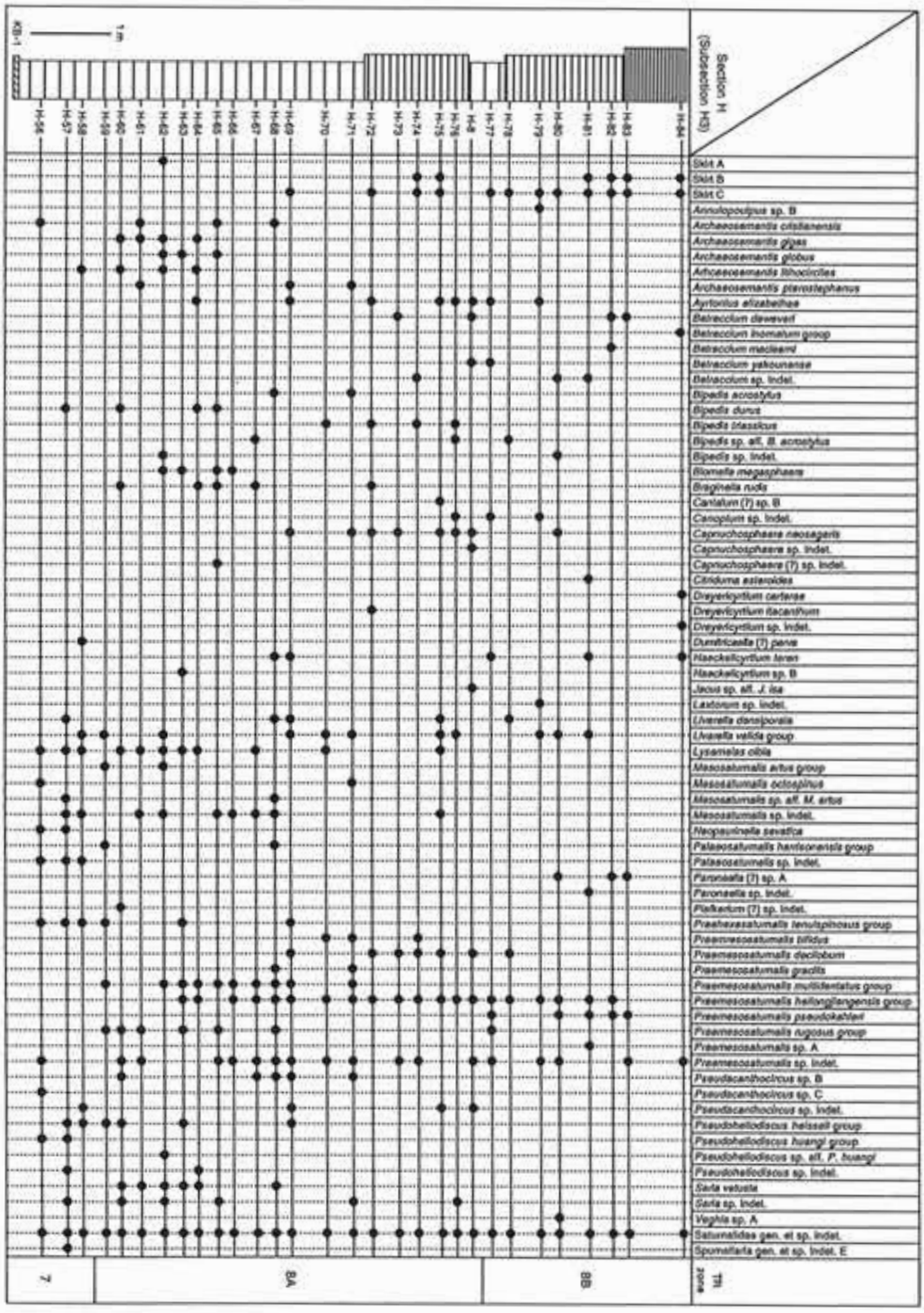


Fig. 22. Geologic column of Section H (Subsection H3) and list of radiolarians. Legend shown in Fig. 4.

to K-100.

The bedded chert in this section begins with A-type, and changes periodically into B-, F-, B-, A- and F-type. As observed in the Section K, relatively thick claystone beds sometimes occur in the lower part of Section P.

3. Hisuikyo area

The Hisuikyo area, 25 km northeast of the Inuyama area, is also famous for its good exposure of Triassic

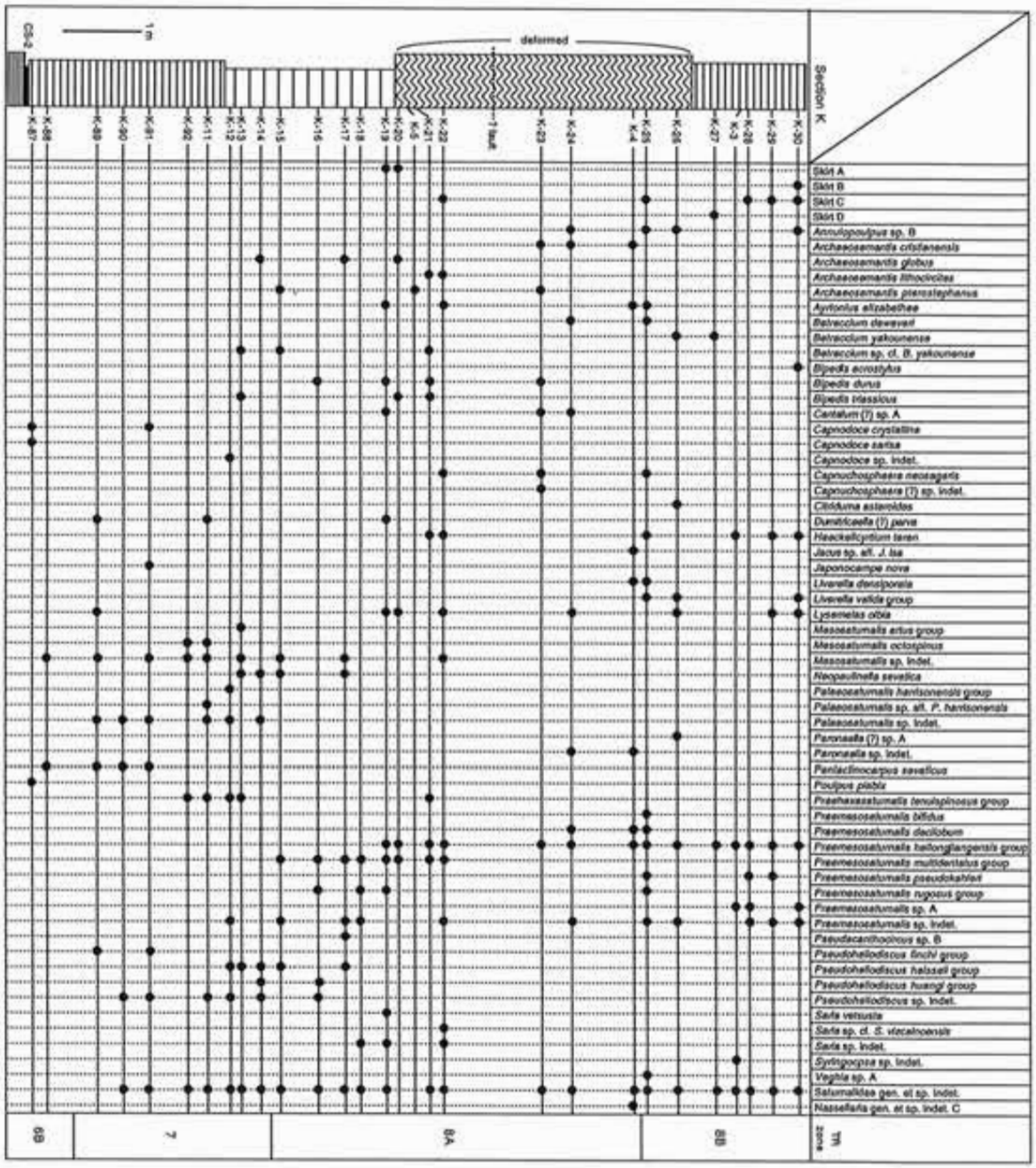


Fig. 23a. Geologic column of Section K and list of radiolarians. Legend shown in Fig. 4 . 23a, lower part of the section; 23b, middle part of the section; 23c, upper part of the section.

to Jurassic chert-clastic sequences. Siliceous claystone and chert units are well observable on the west side of the Kamiaso Bridge over a 100 m interval (Hisuikyo section of Kido, 1982). The detailed geology of the Hisuikyo area was recently summarized by Mizutani and Koido (1992). In this area radiolarian biostratigraphic studies have previously been performed by Matsuda and Isozaki (1982), Kido (1982), Isozaki and Matsuda (1985), and Matsuoka (1986). According to these authors, strata generally become younger eastward although some faults and foldings exist in both the units.

I have performed preliminary field investigations with other colleagues in this area, and only a part of the results regarding a short section, named Section HZ, is presented in this study. Section HZ is a contin-

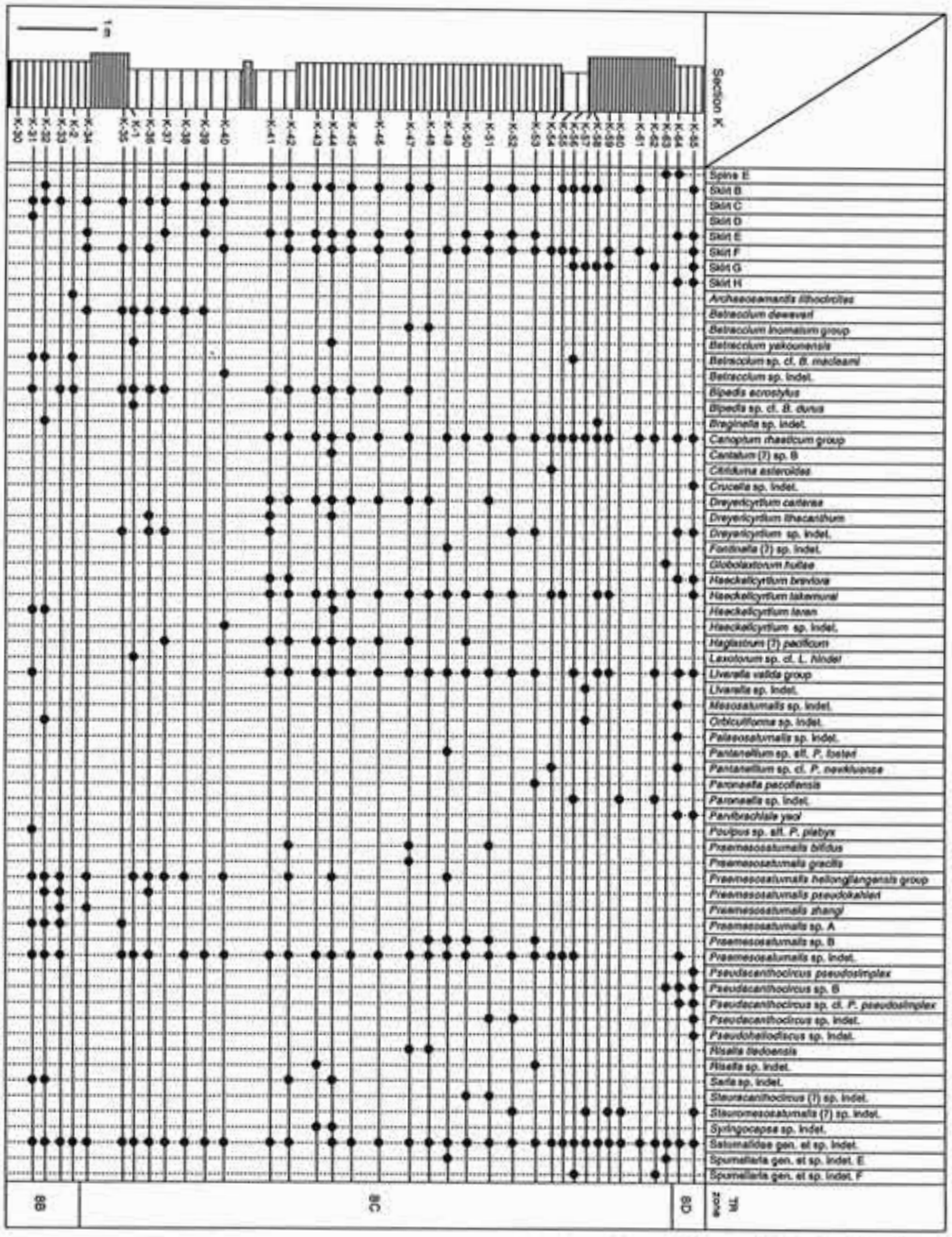


Fig. 23b. Geologic column of Section K and list of radiolarians. Legend shown in Fig. 4 . 23a, lower part of the section; 23b, middle part of the section; 23c, upper part of the section.

uous bedded chert interval of approximately 10 m; 36 samples were examined from this section as shown in Fig. 25. The base and top of this section are defined by the presence of massive F-type bedded chert and a fault, respectively. The bedded chert is composed of A-, F- and B-types in ascending order. The boundaries between over- and underlying chert types are marked by more argillaceous and thin chert beds around horizons HZ-16 and HZ-22. The color of chert beds is quite variable: green, greenish gray, bluish gray, gray and blackish gray, but never red. Nevertheless the bedded cherts are classified into red cherts

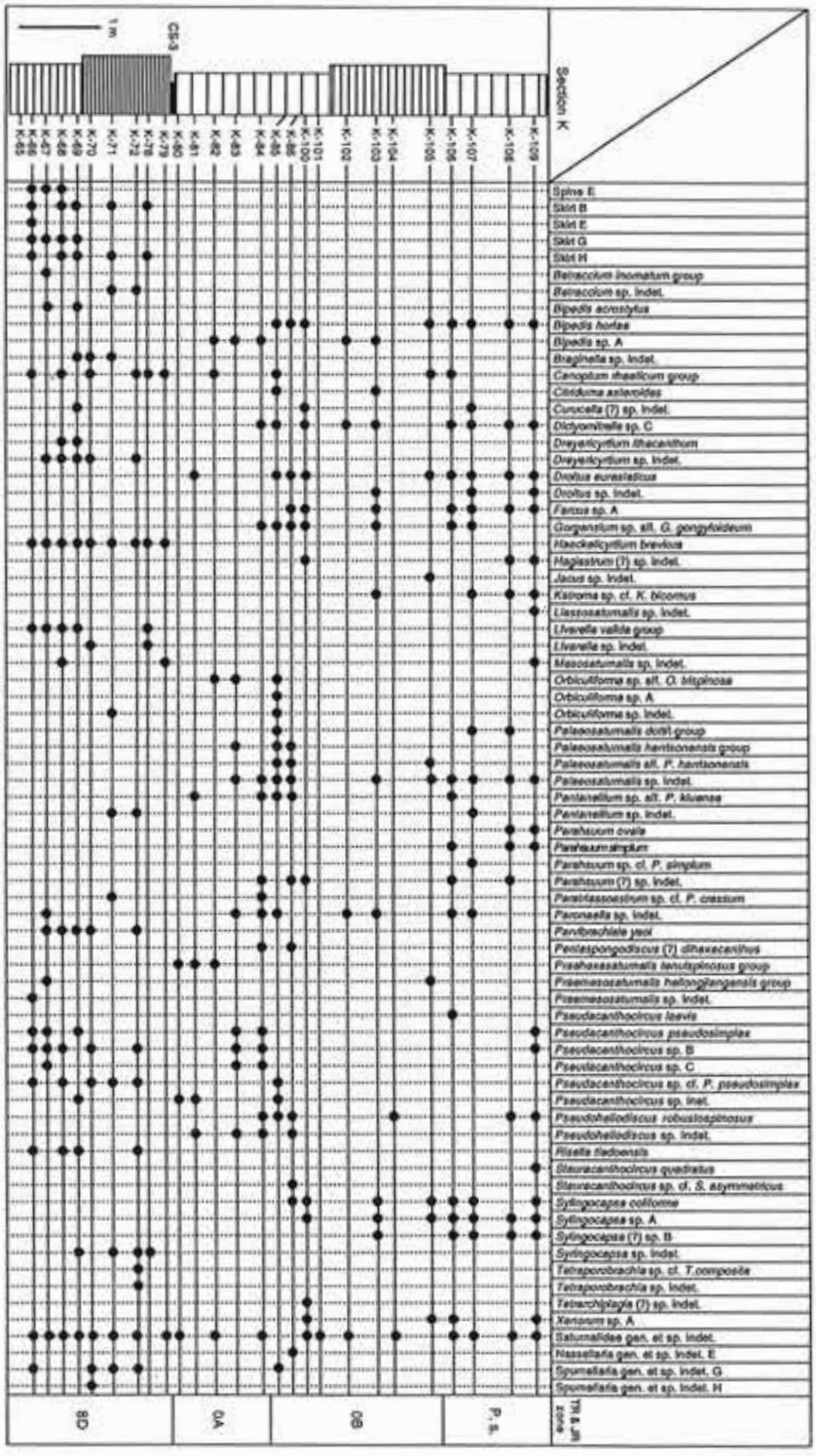


Fig. 23c. Geologic column of Section K and list of radiolarians. Legend shown in Fig. 4 . 23a, lower part of the section; 23b, middle part of the section; 23c, upper part of the section.

in Fig. 25 since some geologic evidence suggest the secondary decolorization. The reason for this is mentioned in the chapter below.

Radiolarian zonation

Based on the stratigraphic distribution of radiolarians in each section (Figs. 4, 5, 7, 8, 10-25), 20 zones

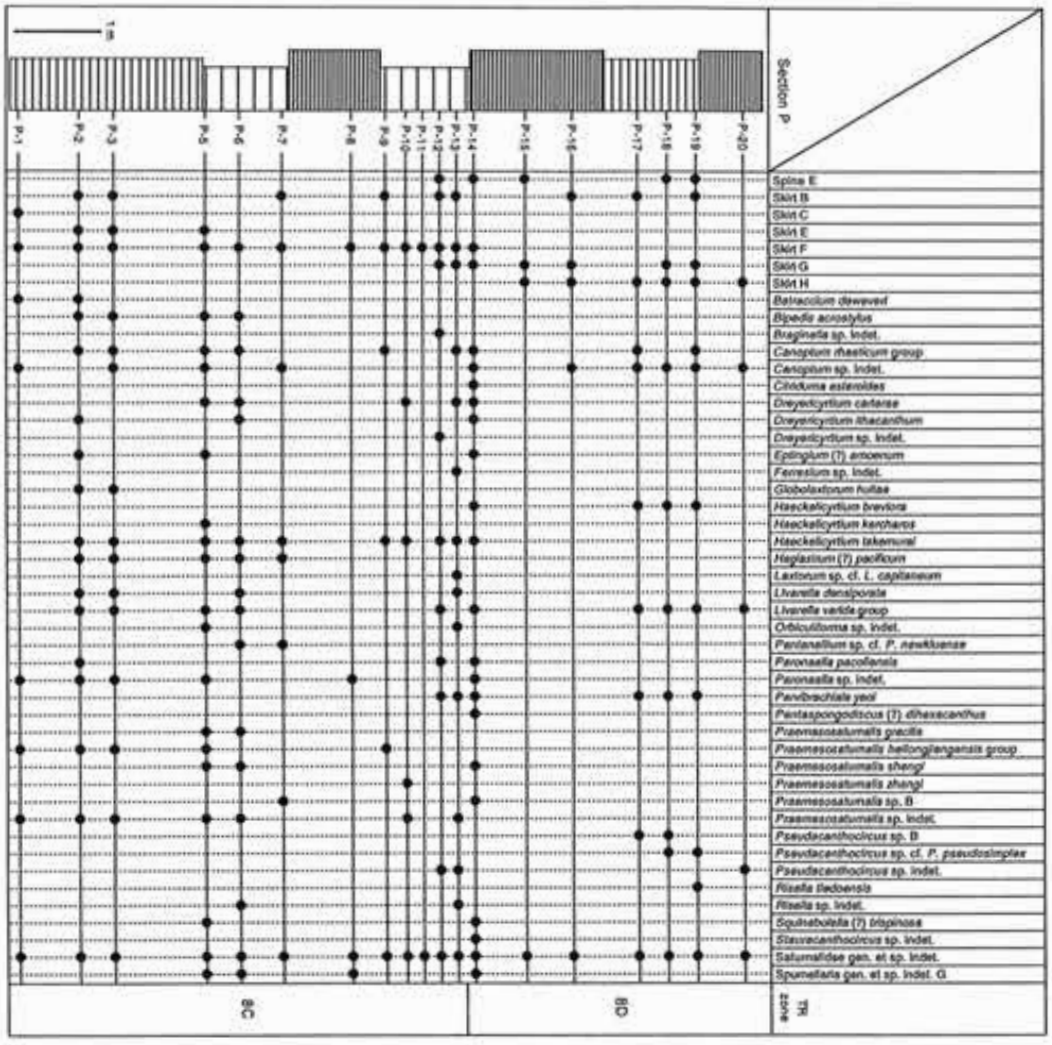


Fig. 24. Geologic column of Section P and list of radiolarians. Legend shown in Fig. 4.

codified by the prefix TR and JR (abbreviation of Triassic and Jurassic Radiolaria) and numbers are established in this study (Fig. 26).

The first ten zones discriminated are TR 0 to TR 8 and JR 0. One can roughly infer the corresponding zones using primary marker taxa even if the available individuals are poorly preserved, because each zone contains a dominant or characteristic taxon in the zones as in the following:

TR 0: Permian-type radiolarians including albaillellarians.

TR 1: Spicular entactinarians.

TR 2: Spine A1 (defined below).

TR 3: Spine A2 (defined below).

TR 4: The genera *Muelleritortis* Kozur and *Tritortis* Kozur.

TR 5: The genus *Capnuchosphaera* De Wever.

TR 6: The genus *Capnodoce* De Wever.

TR 7: The genera *Palaeosaturnalis* Donofrio and Mostler and *Mesosaturnalis* Kozur and Mostler.

TR 8: The genus *Praemesosaturnalis* Kozur and Mostler.

JR 0: Jurassic-type radiolarians.

Except for TR 0 and 1, these are further subdivided into subunits with alphabetical suffixes such as TR 2A, 2B, 2C and 2D. The suffixes are based on the first or last appearance of particular marker taxa (Figs. 27, 28). One can use the subdivided zonal scheme when recovered radiolarians are well-preserved. The definitions of 20 radiolarian zones discriminated by this concept are given below in accordance with the ISSC (1994).

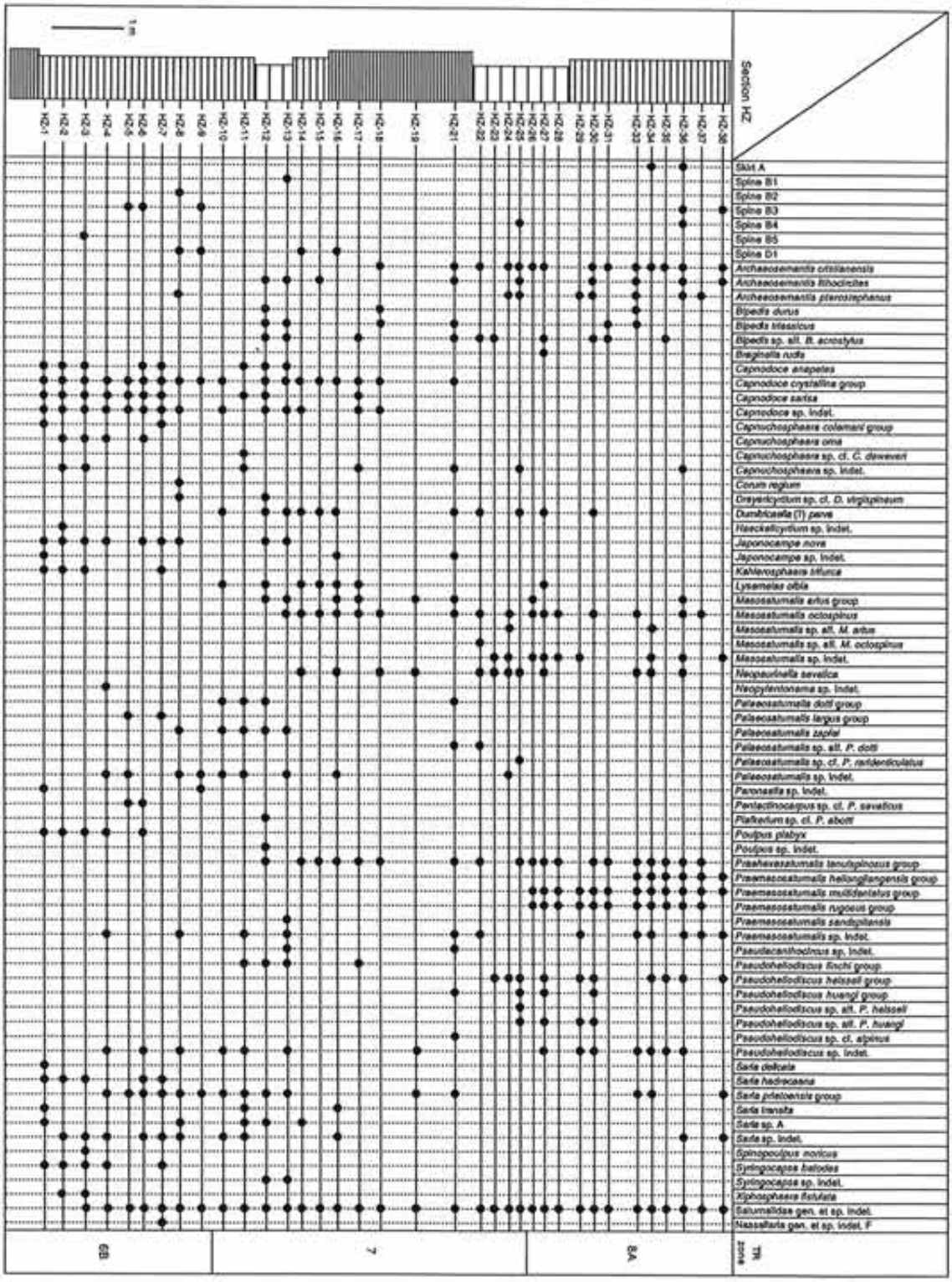


Fig. 25. Geologic column of Section HZ and list of radiolarians. Legend shown in Fig. 4.

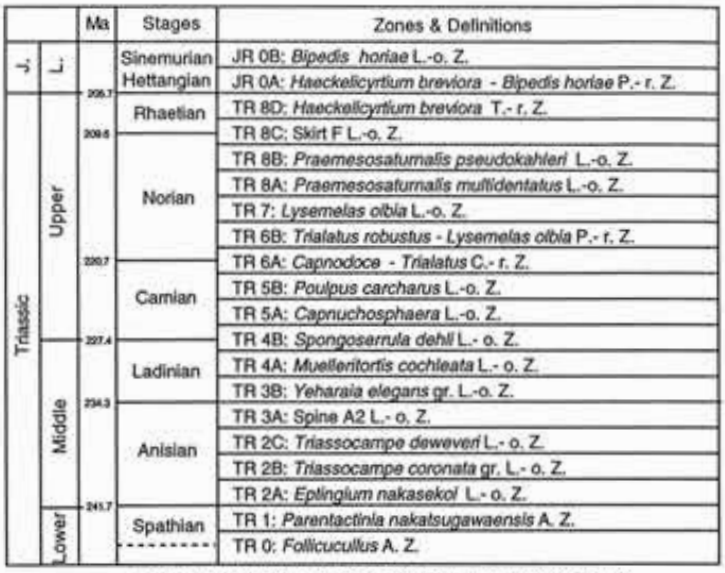


Fig. 26. Newly established radiolarian zonal scheme. The time scale (Ma) after Gradstein et al. (1995).

1. TR 0 (*Follicucullus–Parentactinia* Assemblage Zone)

Definition and remarks: This assemblage zone is defined by the common occurrences of the genus *Follicucullus*, associated with *Parentactinia nakatsugawaensis* Sashida group and *Archaeosemantis cristianensis* Dumitrica. Unnamed entactinarians, spumellarians and *Latentifistula* (?) sp. indet. are also diagnostic of the zone. This zone is characterized by low diversity of included taxa and their poor mode of preservation.

This zone is correlative with the lower part of the *Parentactinia nakatsugawaensis* assemblage (Pn assemblage) of Sugiyama (1992).

Stratotype: The lower part of Section T. The thickness attains more than 10 m, but the details are not known since the the lower limit cannot be observed.

2. TR 1 (*Parentactinia nakatsugawaensis* Assemblage Zone)

Definition and remarks: This assemblage zone is characterized by the presence of diverse entactinarians, nassellarians and spumellarians described by Sugiyama (1992) as members of the Pn assemblage, such as *Archaeosemantis cristianensis* Dumitrica, *Cryptostephanidium japonicum* (Nakaseko and Nishimura) group, *Hozmadia ozawai* Sugiyama, *Parentactinia nakatsugawaensis* group, *Pegoxystris mizutanii* Sugiyama, *Pseudostylosphaera kozuri* Sugiyama, *Tetrarchiplagia simplex* Sugiyama, *Zevius yaoi* Sugiyama and *Z. perarmatus* Sugiyama. Some Permian radiolarians may be present in this zone, but their abundance is far less than in TR O, which is a significant difference between this and the underlying zones.

The main part of this zone is correlative with the Pn assemblage of Sugiyama (1992), whereas the zonal assignment of the uppermost part is not well understood since the first appearance of *Eptingium nakasekoi* Kozur and Mostler was not confirmed in my studied sections. It seems, however, that the first appearance of *Hozmadia gifuensis* Sugiyama, which is the nominal species of the *Hozmadia gifuensis* assemblage (Hg assemblage) of Sugiyama (1992), is slightly younger than that of *Eptingium nakasekoi*. Therefore, I tentatively regard the uppermost part of this zone as correlative to the lowermost part of the Hg assemblage. Further study is necessary for precise correlation and to ascertain the top of this zone.

Stratotype: The upper part of Section T, but it is not complete. The thickness is approximately 7 m.

3. TR 2A (*Eptingium nakasekoi* group Lowest-occurrence Zone)

defined by the first appearance of the *Triassocampe coronata* Bragin group. The top is defined by the first appearance of *Triassocampe deweveri* (Nakaseko and Nishimura).

The first appearances of *Pseudostylosphaera japonica* (Nakaseko and Nishimura) group and *Triassocampe myterocorys* Sugiyama appear to coincide with the base of the zone. This zone includes the first occurrences of *Archaeosemantis pterostephanus* Dumitrica, *Foremanellina* sp. A, *Parasepsagon valiabilis* (Nakaseko and Nishimura), *Pentactinorbis* (?) sp. A and *Stauracontium* (?) *trispinosum* (Kozur and Mostler). The upper part of the zone is characterized further by the first occurrence of *Heptacladus crassispinus* Dumitrica, Kozur and Mostler and *Spongosilicarmiger italicus* Kozur. Spine A1, *Cryptostephanidium japonicum* (Nakaseko and Nishimura) group and *Hozmadia gifuensis* Sugiyama also occur throughout the zone as prominent constituents.

The species composition indicates that this zone is correlative to the *Triassocampe coronata* assemblage (Tc assemblage) of Sugiyama (1992).

Stratotype: Section D, but it lacks the lowest and uppermost parts which are observed in Sections C, E and M. The thickness is estimated to be more than 5 m.

5. TR 2C (*Triassocampe deweveri* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Triassocampe deweveri* (Nakaseko and Nishimura). The top is defined by the first appearance of Spine A2.

The first appearance of *Cryptostephanudium cornigerum* Dumitrica, *Pentactinocarpus awaensis* (Nakaseko and Nishimura) group and the genus *Spongoxystris* Sugiyama gen. nov. seem to coincide with or occur slightly below the base of the zone. *Eptingium manfredi* Dumitrica, *Hozmadia reticulata* Dumitrica, Kozur and Mostler, *Hozmadia rotunda* (Nakaseko and Nishimura), *Spinotriassocampe annulata* (Nakaseko and Nishimura) group and *Tiborella florida* (Nakaseko and Nishimura) make their first appearances in this zone. Other characteristic constituents are Spine A1, *Eptingium nakasekoi* Kozur and Mostler and the *Pseudostylosphaera japonica* (Nakaseko and Nishimura) group.

Stratotype: The middle part of Section C. The thickness is approximately 2.5 m. This zone is also complete in Section L.

6. TR 3A (Spine A2 Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of Spine A2. The top is defined by the first appearance of the *Yeharaia elegans* Nakaseko and Nishimura group. Most Spine A2 defined in the following chapter may be derived from *Oertlispongus inaequispinosus* Dumitrica, Kozur and Mostler. Therefore, this zone can be interpreted as the "*Oertlispongus inaequispinosus* Lowest-occurrence Zone".

Pentactinocarpus tetracanthus Dumitrica, *Spinotriassocampe hungarica* Kozur group and *Yeharaia cornigera* Sugiyama sp. nov. make their first appearances in this zone. In addition to them, *Baumgartneria bifurcata* Dumitrica, *Celluronta* (*?*) *conica* Sugiyama sp. nov., *Hinedorcus alatus* Dumitrica, Kozur and Mostler, *Ladinocampe* sp. A and *Pentactinocarpus tetracanthus* Dumitrica also occur in this zone.

Abundant taxa include *Cryptostephanidium cornigerum* Dumitrica, *C. japonicum* (Nakaseko and Mishimura) group, *Eptingium manfredi* Dumitrica, *Pseudostylosphaera japonica* (Nakaseko and Nishimura) group, *Triassocampe deweveri* (Nakaseko and Nishimura) and *Spinotriassocampe annulata* (Nakaseko and Nishimura) group. The abundance of Spine A1 and species of *Hozmadia* decreases towards the top of the zone. The upper part of this zone is distinguished from the lower part by the presence of flattened and winged spines derived from the genus *Falcispongus* Dumitrica, 1982a.

Stratotype: The Section L, the thickness is approximately 4 m.

7. TR 3B (*Yeharaia elegans* group Lowest-occurrence Zone)

Definition and remarks: The base of this zone is derfined by the first appearance of the *Yeharaia elegans* Nakaseko and Nishimura group. The top is defined by the first appearance of *Muelleritortis coch-*

letum (Nakaseko and Nishimura).

Abundant taxa include Spine A2 and detached spines from *Falcispongus* as observed in the underlying zone. *Ladinocape japonica* (Nakaseko and Nishimura), *Turbotriassocyrtis annulata* Kozur and Mostler and *Pentactinocarpus fusiformis* Dumitrica make their first appearances near the base of this zone. *Hozmadia koeveskallensis* Kozur and Mostler group, *Silicarmiger latus* Kozur and Mostler, *Triassocampe transita* (Kozur and Mostler), *Yeharaia mascula* Sugiyama sp. nov. and *Y.* (?) sp. A first occur in this zone. The occurrence of *Cryptostephanidium cornigerum* Dumitrica, *Pseudostylosphaera japonica* (Nakaseko and Nisimura) group and *Triassocampe deweveri* (Nakaseko and Nishimura) are also characteristic of this zone. The radiolarian assemblage from the upper part of this zone also contains *Busanga* (?) *xyza* sp. nov., *Panispinocyrtis* (?) *gabiolaensis* Kozur and Mostler and *Pseudostylosphaera magnispinosa* Yeh, which are good zone indicators. *Muelleritortis* sp. cf. *M. noblis* Dosztály and *Tritortis integrita* (Cordey *et al.*), which are apparently precursors of *M. cochletum* (Nakaseko and Nishimura) and *T. kretaensis* (Kozur and Krahl) respectively, gradually increase in abundance in this zone. Strata assignable to this zone and the overlying zone are especially rich in detached spines of *Muelleritortis* Kozur, 1988a, and *Tritortis* Kozur, 1988b, and also in sponge spicules consisting of isometric three bars.

Stratotype: Section O. The thickness is approximately 4.5 m.

8. TR 4A (*Muelleritortis cochletum* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Muelleritortis cochletum* (Nakaseko and Nishimura). The top is defined by the first appearance of *Spongoserrula dehli* Cordey *et al.*

The genus *Yeharaia* makes its final occurrence near the base of this zone. This horizon is well-marked by *Yeharaia compsa* Sugiyama sp. nov., a good indicator whose chronologic range is very short. On the other hand, different types of multisegmented nassellarians such as the genus *Multimonilis* Yeh and indeterminable species of *Corum* Blome first occur in this zone. The genus *Hungarosaturnalis* Kozur and Mostler appears to have evolved from *Tiborella* sp. A in this zone. Other characteristic species which first occur in this zone are *Falcispongus duitricae* Dosztály, *Hozmadia* sp. A, *Pseudostylosphaera goestlingensis* (Kozur and Mostler) and *P. nazarovi* (Kozur and Mostler). Spines B1 and B2 also appear in the upper part. In the lower part of the zone, *Muelleritortis cochletum* (four-spined) is much more abundant than *Tritortis kretaensis* (three-spined). Towards the top of the zone, however, the latter becomes much more abundant.

Stratotype: The lower part of Section B. The thickness is approximately 2.5 meters. This zone is also complete in Section R.

9. TR 4B (*Spongoserrula dehli* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Spongoserrula dehli* Cordey *et al.* The top is defined by the first appearance of the genus *Capnuchosphaera* De Wever.

The first occurrence of *Praeheliostaurus ingridae* (Mostler and Krainer) and *Pseudostylosphaera gracilis* Kozur and Mostler seem to be coincident with or slightly lower than the base of this zone. *Canesium* (?) *cucurbita* Sugiyama sp. nov., *Corum* (?) *delgado* Sugiyama sp. nov., *Praeheliostaurus levis* Kozur and Mostler, *Hungarosaturnalis* sp. A, *Sarla* (?) *externa* Blome and *Tricolocapsa* (?) *lacrima* Sugiyama sp. nov. first occur in this zone. *Muelleritortis cive* Sugiyama sp. nov. first occurs in the upper part, and gradually becomes abundant. The genus *Deflandrecyrtium* Kozur and Mostler and specimens possibly defined as the genus *Japonocampe* Kozur, 1984, also first occur in this zone. The diversity of taxa in this and the lower part of the overlying zone is apparently low, but this may be due to preservational bias.

Stratotype: The lower part of Section R. The thickness is approximately 3 m. This zone is also complete in Section B.

10. TR 5A (*Capnuchosphaera* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is

defined by the first appearance of the genus *Capnuchosphaera* De Wever. The top is defined by the first appearance of *Poulpus carcharus* Sugiyama sp. nov.

The first appearance of the genus *Paleosaturnalis* Donofrio and Mostler may be coincident with or slightly lower than the base of this zone. The first appearances of *Laxtorum* (?) *carnicum* sp. nov. and *Triassocampe baldii* Kozur also coincide with the base of this zone. Besides thesemand diverse capnuchosphaerids including the *Capnuchosphaera silviensis* Blome group, *C. triassica* De Wever, *C. deweveri* Kozur and Mostler, characteristic taxa which first occur in this zone include Spines D1 and D2, *Archaeosemantis lithocircites* Sugiyama sp. nov., *Canesium lentum* Blome, *Multimonilis japonicus* Sugiyama sp. nov., *Neopylentonema procea* Sugiyama sp. nov., *Poulpus phasmatodes* De Wever, *Poulpus* (?) *coronensis* Yeh, *Praemesosaturnalis* (?) *ormites* Sugiyama sp. nov., *Sarla delicata* Blome, *Trialatus longicornutus* Yeh, *T. pristinus* Sugiyama sp. nov., *Veles vulgaris* Sugiyama gen. *et* sp. nov., *Xiphotheca karpenissionensis* De Wever, and the genera *Hagiastrum* Haeckel, 1881, *Heliosaturnalis* Kozur and Mostler, 1972, *Japonisaturnalis* Kozur and Mostler, 1972, *Kahlerosphaera* Kozur and Mostler, 1979, *Paronaella* Pessagno, 1971, and *Veghicyclia* Kozur and Mostler, 1972.

Stratotype: The middle to upper part of Section R. The thickness is approximately 7 m.

11. TR 5B (*Poulpus carcharus* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Poulpus carcharus* Sugiyama sp. nov. The top is defined by the first appearance of the genus *Capnodoce* De Wever.

This zone includes the first appearance of *Enoplocampe yehae* Sugiyama gen. *et* sp. nov., *Kahlerosphaera norica* Kozur and Mostler group, *Palaeosaturnalis* (?) *incomptus* Sugiyama sp. nov., *Syringocapsa batodes* De Wever and *Trialatus megacornutus* Yeh, *Japonocampe nova* (Yao), *Poulpus piabix* De Wever, *Trialatus praerobusta* Sugiyama sp. nov. and *Xipha nodosa* Sugiyama sp. nov. in the upper part. Besides Spines D1 and D2, Spine B3 ranging upwards from the underlying zone becomes abundant in this zone. Spine B4 also appears in this zone. Diverse capnuchosphaerids include the *Capnuchosphaera colemani* Blome group, *C. lea* De Wever, *C. theoides* De Wever, *C. tricornis* De Wever and *C. sagaris* Sugiyama sp. nov. The occurrences of radiolarians from the upper part of this to the overlying zone are relatively rare owing to preservational bias.

Stratotype: The middle part of Section Q. The thickness is approximately 5 m. This zone is also complete in Sections G.

12. TR 6A (*Capnodoce-Trialatus* Concurrent-range Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Capnodoce* De Wever. The top is defined by the last appearance of *Trialatus* Yeh.

Capnodoce in this zone is represented by *C. anapetes* De Wever, and the *C. crystallina* Pessagno group. The first occurrence of the latter species is later than that of the former. *Capnodoce sarisa* De Wever is rare. Spine B5, *Corum regium* Blome, *Dreyericyrtium virgispineum* Sugiyama sp. nov., *Sarla transita* (Kozur and Mock) and *Trialatus robustus* (Nakaseko and Nishimura), which is the last representative of the genus, make their first appearances in the lower part of this zone, whereas *Capnuchosphaera oma* Sugiyama sp. nov., *Sarla hadercaena* (De Wever) and *Xipha pessagnoi* (Nakaseko and Nishimura) first appear in the upper part. In addition, *Triassocampe propria* Blome and typical morphotype of *Japonocampe nova* first occur in the upper part.

Stratotype: The lower to middle part of Section N. The thickness is approximately 4.5 m.

13. TR 6B (*Trialatus robustus-Lysemelas olbia* Partial-range Zone)

Definition and remarks: The base of this zone is defined by the disappearance of *Trialatus robustus* (Nakaseko and Nishimura). The top is defined by the first appearance of *Lysemelas olbia* Sugiyama gen. *et* sp. nov. This zone represents a part of the entire range of *Capnodoce*.

Capnodoce sarisa De Wever and the *Capnodoce*

crystallina group are abundant in this zone, whereas *C. anapetes* De Wever is fairly rare. Besides these taxa the lower part of the zone is characterized by the common ocuurence of *Japonocampe nova* (Yao), *Kahlerosphaera* sp. D, *Poulpus piabyx* De Wever, *Sarla hadrecaena* (De Wever) and *Syringocapsa batodes* De Wever. *Pentactinocarpus sevaticus* Kozur and Mostler, *Sarla prietoensis* Psessagno group and *Xiphosphaera fistulata* Carter first occur in this zone. The most distinctive feature is the strong diversification of saturnalids, especially *Palaeosaturnalis* Donofrio and Mostler and *Pseudoheliodiscus* Kozur and Mostler, in the upper part. These include *Palaeosaturnalis dotti* Blome, *P. harrisonensis* Blome, *P. largus* Blome and the *Pseudoheliodiscus finchi* Pessagno group. These features are well observed in the radiolarian assemblage from Section N.

Stratotype: The upper part of Section N. The thickness is approximately 5.5 m.

14. TR 7 (*Lysemelas olbia* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Lysemelas olbia* Sugiyama gen. *et* sp. nov. The top is defined by the first appearance of *Praemesosaturnalis multidentatus* (Kozur and Mostler) group.

The first appearances of *Bipedis durus* Sugiyama sp. nov., *Dumitricaella* (?) *parva* Sugiyama sp. nov. and *Mesosaturnalis artus* (Donofrio and Mostler) are approximately synchronous with that of *Lysemelas olbia* Sugiyama gen. *et* sp. nov. *Neopaulinella sevaticus* Kozur and Mostler, *Praehexasaturnalis tenuispinosus* (Donofrio and Mostler) and *Mesosaturnalis octospinus* sp. nov. appear first in the lower part. *Pseudoheliodiscus heisseli* (Kozur and Mostler) group and *P. huangi* Yeh group become abundant in the upper part. Moreover, *Archaeosemantis gigas* Sugiyama sp. nov., *A. globus* Sugiyama sp. nov., *Livarella densiporata* Kozur and Mostler and *L. valida* Yoshida group make their first appearances in the upper part. In general, the genera *Mesosaturnalis* Kozur and Mostler and *Pseudoheliodiscus* Kozur and Mostler occur abundantly in the lower and upper part, respectively. Species of *Capnodoce* De Wever and *Japonocampe nova* (Yao) disappear in this zone.

Stratotype: Section H (the middle to upper part of Subsection H1). The thickness is approximately 3.2 m. This zone is also complete in Sections K and HZ.

15. TR 8A (*Praemesosaturnalis multidentatus* group Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of the *Praemesosaturnalis multidentatus* (Kozur and Mostler) group. The top is defined by the first appearance of *Praemesosaturnalis pseudokahleri* Sugiyama sp. nov.

The first appearance of the *Praemesosaturnalis rugosus* Yeh group is approximately synchronous with the base of this zone; the first appearance of the *P. heilongjiangensis* Yang and Mizutani group seems to be slightly higher. Other *Praemesosaturnalis* species which first appear in this zone are *P. bifidus* (Kozur and Mostler), *P. decilobum* (Carter) and *P. gracilis* (Kozur and Moster). The lower part is characterized by the first occurrences of Skirts A, B and C, *Ayrtonius elizabethae* Sugiyama gen. *et* sp. nov., *Bipedis* sp. aff. *B. acrostylus* Bragin, *Blomella megasphaera* Sugiyama sp. nov., *Braginella rudis* (Bragin) and *Sarla vetusta* Pessagno. *P. multidentatus* (Kozur and Mostler) group rapidly decrease in abundance in the middle of this zone. In contrast, *Bipedis acrostylus* Bragin, *Capnuchosphaera neosagaris* Sugiyama sp. nov. and *Haeckelicyrtium teren* Sugiyama sp. nov. become abundant. The upper part is characterized by the first occurrences of *Betraccium deweveri* Pessagno and Blome and *Dreyericyrtium ithacanthum* sp. nov., *Jacus* sp. aff. *J. isa* and *Annulopoulpus* sp. B are also diagnostic for the upper part.

Stratotype: Section H (the lower to middle part of Subsection H3). The thickness is approximately 5 m.

16. TR 8B (*Praemesosaturnalis pseudokahleri* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Praemesosaturnalis pseudokahleri* Sugiyama sp. nov. The top is defined by the first appearance of Skirt F.

The first appearances of Skirt D, *Cirtiduma asteroides* Carter, *Paronaella* (?) sp. A and *Veghia* sp. A are synchronous with the base of the zone. Skirt F,

Haeckelicyrtium takemurai Yeh and Cheng and *Globolaxtorum hullae* (Yeh and Cheng) first occur in the upper part. *Annulopoulpus* sp. B, *Jacus* sp. aff. *J. isa*, *Tetraporobrachia composita* Carter and rare individuals of *Hagiastrum* sp. A, which range from the upper part of the underlying zone, also occur. This zone is characterized by diverse *Praemesosaturnalis* species and abundant Skirts B and C in the entire interval, and species of *Betraccium* Pessagno and *Livarella* Kozur and Mostler gradually increase in abundance stratigraphically upward. *Arcaeosemantis* species ranging from the Lower Triassic disappear in this zone.

Stratotype: Section H (the middle part of Subsection H2). The thickness is approximately 5 m.

17. TR 8C (Skirt F Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first occurrence of Skirt F. The top is defined by the first appearance of *Haeckelicyrtium breviora* Sugiyama sp. nov.

The first appearance of Skirt E is synchronous with the base of the zone. *Canoptum rhaeticum* Kozur and Mostler group make its first appearance in the lower part of this zone. The upper part is comprised of the first appearances of Skirt G, *Betraccium chengi* Yeh, *Dreyericyrtium trispinosum* (Carter), *Haeckelicyrtium karcharos* Carter, *Paronaella pacofiensis* Carter and *Risella tledoensis* Carter. The genus *Pantanellium* Pessagno represented by *P.* sp. aff. *P. fosteri* Pessagno and Blome and *P.* sp. cf. *newkluense* Carter also first occur in the upper part. *Betraccium deweveri* Pessagno and Blome, *Bipedis acrostylus* Bragin, *Hagiastrum* (?) *pacificum* Sugiyama sp. nov., *Dreyericyrtium* (?) *carterae* (Yeh and Cheng) and the *Livarella valida* Yoshida group with long and markedly curved arms exhibit acme in the lower part of this zone, and they as well as *Praemesosaturnalis* species rapidly decrease in abundance in the upper part.

The upper part of this zone is separable in future based on the first appearances of Skirt H, and the genus *Orbiculiforma* Pessagno, etc.

Stratotype: The middle to upper part of Section K. The thickness is approximately 7.5 m.

18. TR 8D (*Haeckelicyrtium breviora* Taxon-range Zone)

Definition and remarks: This zone is defined by the entire stratigraphic range of *Haeckelicyrtium breviora* sp. nov.

Characteristic taxa which first appear in this zone are Skirt H, *Pentaspongodiscus* (?) *dihexacanthus* Carter, *Paratriassoastrum* sp. cf. *P. crassum* Carter and *Pseudacanthocircus pseudosimplex* Kozur and Mostler as well as the nominal species. The first appearance of Spine E and *Parvibrachiale yaoi* Sugiyama gen. *et* sp. nov. is slightly below the base of the zone. Others ranging from the underlying zones are Skirts B and G, *Betraccium chengi* Yeh, *Bipedis acrostylus* Bragin, *Canoptum rhaeticum* Kozur and Mostler group, *Cirtiduma asteroides* Carter, *Dreyericyrtium ithacanthum* Sugiyama sp. nov., *Squinabolella* (?) *trispinosum* Carter, *Livarella valida* Yoshida group, *Risella tledoensis* Carter. Except for the *Canoptum rhaeticum* group and *Cirtiduma asteroides* all other species disappear in the upper part. This zone contains a low-diversity radiolarian assemblage, for example saturnalids are represented only by poorly preserved individuals assignable to *Pseudacanthocircus* Kozur and Mostler in the upper part. This is mainly due to preservational bias, but it is also seems to be possible that most Triassic-type radiolarians disappear in this zone.

Stratotype: The upper part of Section K. The thickness is approximately 2 m, but in Section P it attains more than 3 m.

19. JR OA (*Haeckelicyrtium breviora-Bipedis horiae* Partial-range Zone)

Definition and remarks: The base of this zone is defined by the last appearance of *Haeckelicyrtium breviora* Sugiyama sp. nov. The top is defined by the first appearance of *Bipedis horiae* Sugiyama sp. nov. This zone represents the upper range of the *Canoptum rhaeticum* Kozur and Moster group.

This zone is characterized by the first appearances of the Jurassic-type multisegmented nassellarians such as *Droltus* Pessagno and Whalen. Characteristic taxa include *Bipedis* sp. aff. *B. horiae* Sugiyama sp. nov., *Canoptum rhaeticum* Kozur and Mostler group, *Cirtiduma asteroides* Carter, *Dictyomitrella* sp. C,

Gorgansium sp. aff. *G. gongyloideum* Kishida and Hisada, *Paratriassoastrum* sp. cf. *P. crassum* Carter, *Pentaspongodiscus* (?) *dihexacanthus* Carter, *Pseudacanthocircus pseudosimplex* Kozur and Moster and *P.* sp. B. In addition, *Orbiculiforma* sp. aff. *O. trispina* Yeh and *Pantanellium* sp. aff. *P. kluense* Pessagno and Blome, *Pseudoheliodiscus robustspinus* Kozur and Mostler and indeterminable species of *Parahsuum* Yao first occur in the upper part of this zone. Saturnalids such as the genera *Palaeosaturnalis* and *Pseudoheliodiscus* become abundant again in this zone.

Stratotype: The upper part of Section K. The thickness is approximately 1.3 m.

20. JR OB (*Bipedis horiae* Lowest-occurrence Zone)

Definition and remarks: The base of this zone is defined by the first appearance of *Bipedis horiae* sp. nov. The top is defined by the first appearance of *Parahsuum simplum* Yao.

The first appearances of *Farcus* sp. A, *Syringocapsa coliforme* Hori, *S.* sp. A and *Xenorum* sp. A are coincident with the nominal species. *Katroma* sp. cf. *K. bicorne* De Wever and *Syringocapsa* (?) sp. B make their first appearances in the upper part. Abundant species such as *Droltus eurasiaticus* Kozur and Mostler and *Dictyomitrella* sp. C and *Pantanellium* sp. aff. *P. kluense* in this zone are in common with those of the underlying zone.

Stratotype: The upper part of Section K. The thickness is approximately 2 m.

Correlation between new and previously established zonal schemes

1. Domestic correlation

After Nakaseko and Nishimura's (1979) pioneeer work, many Japanese investigators have studied Triassic radiolarians in order to determine the age of siliceous claystone and bedded cherts units which occur in the Mino and Chichibu Terranes. In the 1980's many workers independently proposed Triassic radiolarian assemblages or zones, and Yao (1990) presented correlation tables of their results. Later, Sugiyama (1992) and Sashida *et al.* (1993) newly discriminated characteristic assembalges ranging in age from early to late Triassic. This chapter presents comparisons of zonal schemes proposed by this study and Yao (1982), Kishida and Sugano (1982), Igo and Nishimura (1984), Kishida and Hisada (1986), Sato *et al.* (1986), Yoshida (1986) and Sashida *et al.* (1993). The results are shown in Fig. 29 correlated with conodont zones proposed by Koike (1981). For the correlation with Sugiyama (1992) refer the zonal definition chapter above.

(1) Correlation with Yao (1982)

Yao (1982) reexamined the results of Yao *et al.* (1980) and established three assemblage-zones in the Inuyama area as follows: *Triassocampe deweveri, T. nova* and *Canoptum triassicum* assemblages in chronological order.

The oldest *Triassocampe deweveri* assemblage is roughly correlative with TR 2C to the lower part of TR 4A based on the stratigraphic range of the nominal species. Moreover, Yao (1982) listed *Pentactinocarpus fusiformis, Poulpus* aff. *curvispinus* (*Hozmadia koeceskaensis* group herein), *Triassocampe* (?) *annulata* (*Spinotriassocampe annulata* group herein), *T.* (?) *japonica* (*Ladinocampe japonica* herein), *Yeharaia elegans* as characteristic species of the assemblage. Most these taxa range from TR 3A to 3B. In contrast, Yao (1982) did not refer to the occurrence of *Muelleritortis cochleta* which is exclusively abundant in TR 4A. Therefore, the main part of the *Triassocampe deweveri* assemblage is considered to be restricted to TR 3A and 3B.

The *Triassocampe nova* assembalge is correlative to the upper part of TR 5A to the lower part of TR 7 based on the stratigraphic range of the nominal species (*Japonocampe nova* herein). This is suppported by the presence of *Capnodoce sarisa*, abundant in the lower part of TR 7, and *Praemesosaturnalis* (?) *ormites*, restricted in occurrence from the upper part of TR 5A to the lower part of TR 5B, in the assemblage.

The youngest *Canoptum triassicum* assemblage is roughly correlative to TR 8C to JR 0B based on the stratigraphic range of the nominal species (*Canoptum rhaeticum* group herein). However, the precise lower limit of this assemblage is difficult to estimate

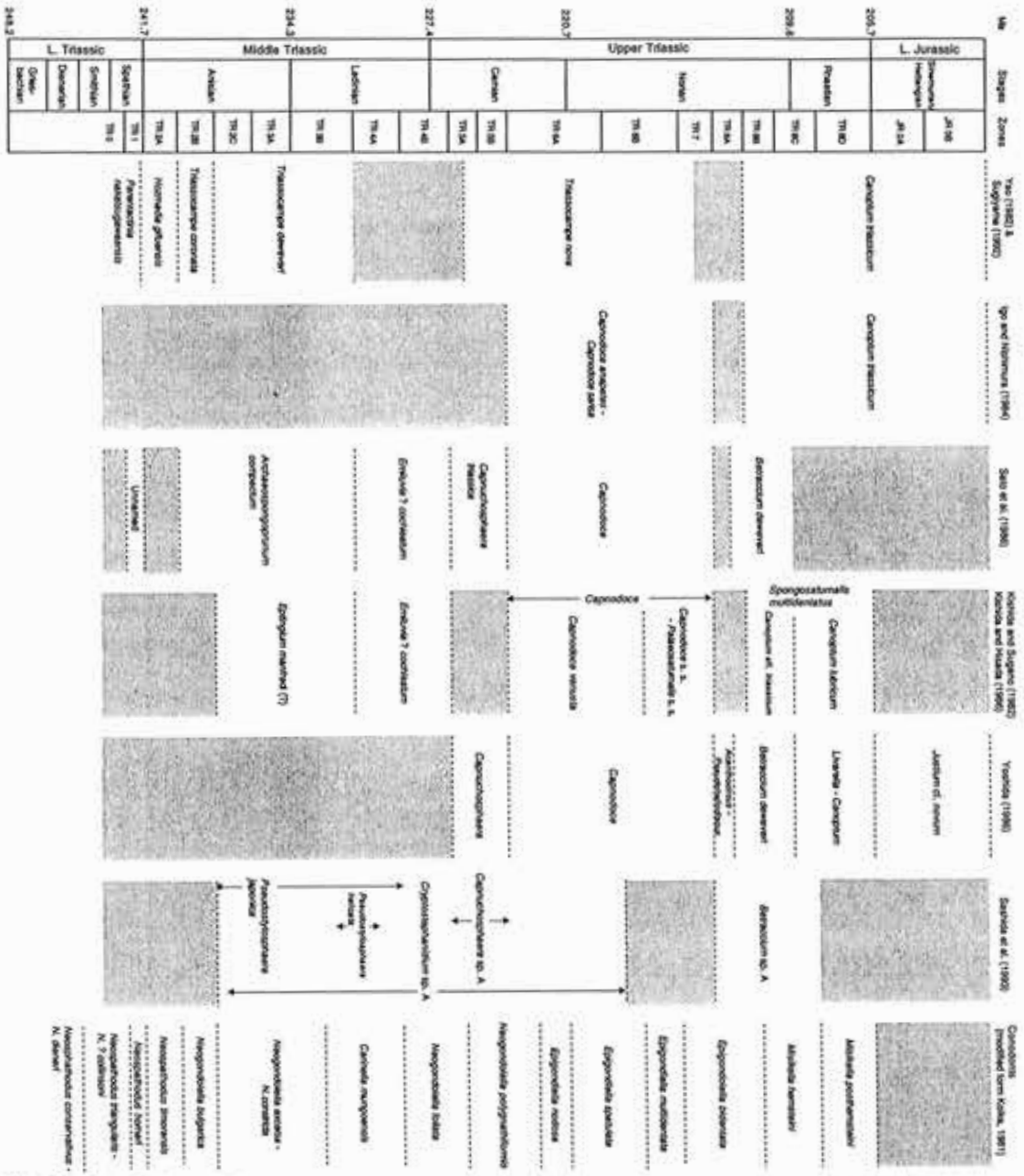


Fig. 29. Correlation of Triassic radiolarian zones and assemblages and conodont zone in Japan.

because the identification of *Canoptum* in many cases remains problematic owing to the preservation of available individuals. In addition, the split taxonomy by previous investigators, as indicated by Hori (1990), camplicates the issue. Some of the characteristic species shown in Yao (1982) are abundant also in the underlying TR 8B. Consequently, it seems reasonable to consider that the *Canptum triassicum* assemblage is correlative with TR 8B to JR 0B.

(2) Correlation with Igo and Nishimura (1984)

Igo and Nishimura (1984) discriminated two Triassic asemblage-zones in the bedded cherts in the Kuzuu area, Tochigi Prefecture. They were named *Capnodoce anapetes-Capnodoce sarisa* and *Canoptum triassicum* assemblage-zones in chronologic order.

The *Capnodoce anapetes-Capnodoce sarisa* assemblage-zone is correlative with TR 6A to 7 based on the range of *Capnodoce*. Moreover, judging from the

presence of *Triassocampe nova* (*Japonocampe nova* herein) and capnuchosphaerids in this assemblage-zone, the upper limit may be restricted to the lower part of TR 7.

The definition of the *Canoptum triassicum* assemblage zone of Igo and Nushimura (1984) corresponds to that of Yao (1982), thus it is correlative with TR 8B to JR 0B as discussed above.

(3) Correlation with Sato *et al.* (1986)

Sato *et al.* (1986) proposed six Triassic interval- and range-zones in the Southern Chichibu Terrane, Kumamoto and Ooita Prefectures, Kyushu. They were named as follows: Unnamed, *Archaeospongoprunum compactum, Emiluvia? cochleta, Capnuchosphaera triassica, Capnodoce* and *Betraccium deweveri* zones in ascending order.

The lowest Unnamed zone is correlative to TR 1 to 2A based on the presence of Nassellaria I (=*Hozmadia ozawai* Sugiyama). Sato *et al.* (1986) mentioned that *Eptingium manfredi* occurs in this zone, but these individuals may belong to *E. nakasekoi*. The occurrence of *Follicucullus* was not reported by Sato *et al.* (1986), and the lithology of the zone is referred to as muddy chert, which corresponds to black bedded cherts developed near the base of the bedded chert lithologic unit. Therefore their Unnamed zone does not include TR 0.

The *Archaeospongoprunum compactum* zone is correlative with TR 2B to TR 3B based on the range of the nominal species and the absence of *Emiluvia? cochleta* (*Muelleritortis cochletum* herein). *Muelleritortis cochletum* is very abundnt above the TR 3B/4B boundary even in poorly preserved materials, therefore its absence can safely restrict the age of examined samples.

The *Capnuchosphaera triassica* zone is correlative with TR 5A to 5B based on the range of the nominal species, and the absence of *Capnodoce*.

The *Capnodoce* zone is correlative with TR 6A to 7 based on the genus range.

The *Betraccium deweveri* zone is correlative with the upper part of TR 8A to the lower part of TR 8C based on the range of the nominal species.

(4) Correlation with Kishida and Sugano (1982) and Kishida and Hisada (1986)

Kishida and Sugano (1982) established five Triassic assemblage-zones in the Sakawa area, Shikoku, belonging to the Southern Chichibu Terrane; *Emiluvia? cochleata, Eptingium manfredi* (?), *Capnodoce anapetes, Spongosaturnalis multidentatus*, and *Pantanellium* sp. B - *Gorgansium* sp. A Zones in ascending order. Kishida and Hisada (1986) discriminated three assemblages in the Kanto Mountains underlain also by the Southern Chichibu Terrane: these are the *Eptingium manfredi* (?), *Capnodoce anapetes* and *Palaeosaturnalis multidentatus* assemblages in chronologic order. Their definitions follow Kishida and Sugano (1982).

The *Emiluvia ? cochleata* Zone is correlative with TR 4A to 4B based on the range of the nominal species (*Muelleritortis cochleta* herein).

The *Eptingium manfredi* (?) Zone (assemblage in Kishida and Hisada, 1986) is correlative to TR 2C to 3B based on the range of the nominal species and the absence of *Muelleritortis cochleta*. It is apparent that this and the preceding zones were originally recognized upside down.

The *Capnodoce anapetes* Zone (assemblage in Kishida and Hisada, 1986) is subdivided into the lower *Capnodoce venusta* and the upper *Capnodoce* s.s.-*Palaeosaturnalis* s.s. Subzones. The former subzone is correlative with TR 6A to the lower part of TR 6B since occurrences of saturnalids are rare, whereas the latter part is correlative with the upper part of TR 6B to TR 7 based on the abundance of saturnalids and the upper limit of *Capnodoce*.

The *Spongosaturnalis multidentatus* Zone (*Palaeosaturnalis multidentatus* assemblage in Kishida and Hisada, 1986) is subdivided into the *Canoptum* aff. *triassicum* and *Canoptum lubricum* Subassemblages by Kishida and Hisada (1986). The former subassemblage is correlative with TR 8b to the lower part of TR 8C because of the common occurrences of *Canoptum* and the absence of *Orbiculiforma*, whereas the latter with the upper part of TR 8C to TR 8D based on the common occurrences of *Orbiculiforma* and *Squinabolella* (*Dreyericyrtium* and *Haeckelicyrtium* herein, the specimen shown in their Pl. 1, fig. 9 is *H.*

breviora sp. nov.).

(5) Correlation with Yoshida (1986)

Yoshida (1986) established six Triassic interval zones in the Kagamihara section located approximately 4 km west of Mt. Kinkazan. These are the *Capnuchosphaera, Capnodoce, Acanthocircus-Pseudoheliodiscus, Betraccium deweveri, Livarella-Canoptum* and *Justium* cf. *novum* Zones in ascending order. The *Acanthocircus-Pseudoheliodiscus* and *Livarella-Canoptum* Zones are further subdivided into the *Acanthocircus, Pseudoheliodiscus, Livarella* and *Canoptum* Subzones.

The *Capnuchosphaera* Zone is fairly correlative with TR 5A and 5B based on the presence of *Capnuchosphaera* without *Capnodoce*.

The *Capnodoce* Zone is also correlative with TR 6A to most of TR 7 because *Capnodoce* disappears in the uppermost part of TR 7.

The *Acanthocircus-Pseudoheliodiscus* Zone is correlative with the uppermost part of TR 7 to the lower part of TR 8A based on the component species including *Acanthocircus heisseli* (Kozur and Mostler) (*Praemesosaturnalis multidentatus* group herein), *A. convertus* (Kozur and Mostler) (*Praemesosaturnalis rugosus* group herein) and Nassellaria A (*Dumitricaella* (?) *parva* sp. nov. herein).

The *Betraccium deweveri* Zone is correlative with the upper part of TR 8A to the lower part of TR 8C based on the range of the nominal species.

The *Livarella-Canoptum* Zone is correlative with the upper part of TR 8C and 8D based on the presence of abundant and diverse *Canoptum, Dreyericyrtium* (?) and *Livarella* species.

The last *Justium* cf. *novum* Zone is correlative to JR 0A to 0B bacause of the presence of *Justium* cf. *novum* (*Gorgansium* sp. aff. *G. gongyloiderum* herein).

(6) Correlation with Sashida *et al.* (1993)

Sashida *et al.* (1993) discriminated five Triassic radiolarian assemblages from bedded cherts in the Kiso Mountains, eastern part of the Mino Terrane. They are the *Pseudostylosphaera japonica, Pseudostylosphaera helicata, Ctyptostephanidium* sp., *Capnuchosphaera* sp. and *Betraccium* sp. Assemblages in chronological order.

The *Pseudostylosphaera japonica* Assemblage is roughly correlative to TR 2C to 4A based on the characteristic species such as *Eptingium manfredi, Emiluvia? cochleta* (*Muelleritortis cochleata* herein) and *Triassocampe deweveri*.

The *Pseudostylosphaera helicata* Assemblage is probably correlative with the lower part of TR 4A based on the included species such as *Emiluvia? cochleta* (*Muelleritortis cochletum* herein), *Pseudostylosphaera helicata* (*P. goestlingensis* herein) and *Triassocampe deweveri*.

The *Cryptostephanidium* sp. Assemblage is possibly correlative with the upper part of TR 3A and the lower part of TR 4A based on characteristic species including *Emiluvia? cochleta* (*Muelleritortis cochletum* herein), *Hozmadia rotunda* and *Yeharaia elegans*. However, there are discrepancies in my results because they reported the co-occurrence of *Trialatus longicornutus* in their sample KR-11, which never occurs below TR 5A.

The *Capnuchosphaera* sp. Assemblage is correlative with a part of TR 5A to 5B, but the details are unconclusive due to the poor characteristic species.

The *Betraccium* sp. Assemblage is correlative to a part of TR 8A to 8C, but the details are also uncertain owing to the poor characteristic species.

2. International correlation

The age of radiolarian zones and assemblages proposed in foreign countries are in many cases controlled by other index fossils such as conodonts and ammonoids. Therefore, internal correlation is very important to determine the ages of the TR zones. The result of comparison to the following nine studies are shown in Fig. 30.

(1) Correlation with Pessagno *et al.* (1979)

Pessagno *et al.* (1979) discriminated two radiolarians zones in the Upper Triassic San Hipólito Formation, Baja California. They are named the *Capnodoce* and *Pantanellium silberlingi* Zones in ascending order.

The *Capnodoce* Zone, defined by the entire range of the genus, is considered to be correlative with TR 6A to the lower part of TR 6B, whereas the *Pantanellium*

silberlingi Zone with the upper part of TR 6B or younger zone, although *Capnodoce* ranges from the base of TR 6A to the upper part of TR 7. It is based on that the characteristic species of the *Pantanellium silberlingi* Zone includes *Pseudoheliodiscus finchi* and *Sarla prietoensis* which first occur in the upper part of TR 6B.

(2) Correlation with Blome (1984)

Blome (1984) subdivided the *Capnodoce* Zone into *Justium novum, Xipha striata* and *Latium paucum* Subzones and subdivided the *Betraccium* Zone into the *Pantanellium silberlingi* and *Betraccium deweveri* Subzones based on the Upper Triassic radiolarians from eastern Oregon (Rail Cabin Mudstone), Baja California (San Hipólito Formation) and Queen Charlotte Islands ("middle member" of the Kunga Formation).

The *Justium novum* Subzone of the lower *Capnodoce* Zone is defined by the first occurrence of *Capnodoce* and the last occurrence of *Justium*, so that the base is correlative with that of TR 6A. In contrast, the top horizon is not well correlative with the TR zones because the occurrence of *Justium* was not confirmed in my studied sections.

The *Xipha striata* Subzone of the middle *Capnodoce* Zone was originally defined by the first appearance of the genus *Xipha* and the last appearance of *Pseudosaturniforma minuta* Blome, *Latium mundum* Blome (*Japonocampe nova* herein) and *X. pessagnoi*. However indeterminable species of *Xipha* first appear as early as TR 5A, and *Xipha nodosa* sp. nov. is common in the lower part of TR 6A. Therefore Blome's (1984) zonal definition is not consistent with true stratigraphic distribution of taxa. But the base of the *Xipha striata* Subzone is inferred to be within the upper part of the TR 6A since *Xipha pessagnoi*, which seems to be phylogenetically very close to *X. striata* Blome, appears in the upper part of TR 6A. This means that the underlying *Justium novum* Subzone is restricted to the lower part of the TR 6A. The top horizon of the Subzone is correlative with the middle part of TR 7 where *Latium mundum* (*Japonocampe nova* herein) disappears.

The *Latium paucum* Subzone of the upper *Capnodoce* Zone is almost correlative with the upper part of TR 7 because the top of the subzone is defined by the last occurrence of *Capnodoce*.

The base of the *Pantanellium silberlingi* Subzone of the lower *Betraccium* Zone is correlative with the uppermost part of TR 7 where indeterminable species of *Betraccium* first occur. The top is probably correlative with the upper part of TR 8A above which *Betraccium deweveri*, the nominal species of the overlying subzone, occurs as a common constituent species of the radiolarian assemblage.

The base of the *Betraccium deweveri* Subzone of the upper *Betraccium* Zone is correlative with a horizon immediately above the top of the underlying subzone. The top is probably correlative with the lower part of TR 8C in which *Betraccium deweveri* disappears.

(3) Correlation with Yeh (1989)

Yeh (1989) discriminated the following four radiolarian assemblages, which range in age from Ladinian (?) to Norian/Hettangian, in the Fields Creek Formation, east-central Oregon: *Corum parvum, Poulpus karnicus, Pseudostylosphaera magnispinosa* and *Orbiculiforma* sp. A Assemblages.

The *Corum parvum* Assemblage includes *Capnodoce* and *Capnuchosphaera* species, *Justium novum, Kahlerosphaera* spp., *Syringocapsa turgida* Blome (*S. batodes* herein) and *Xipha pessagnoi* as characteristic species along with the nominal species. This composition indicates that the assemblage is correlative with TR 6A to 6B, probably restricted to an interval near the boundary between TR 6A and 6B.

The *Poulpus karnicus* Assemblage contains *Capnuchosphaera* diagnostic of TR 5A and 5B. Moreover, it includes *Xiphotheca longa* (*X. karpenissionensis* herein) and *Triassocyrtium* (?) sp. A which is similar to *Enoplocampe yehae* gen. *et* sp. nov. They characterize the upper part of TR 5A to the entire TR 5B. Therefore the assemblage is almost correlative with the upper part of TR 5A to 5B. This assemblage is obviously older than the preceding assemblage.

The *Pseudostylosphaera magnispinosa* Assemblage includes *Parasepsagon variabilis, Triassocampe* sp. A (*T. campanilis* herein) and *Yeharaia elegans* as well as the nominal species *Pseudostylosphaera*

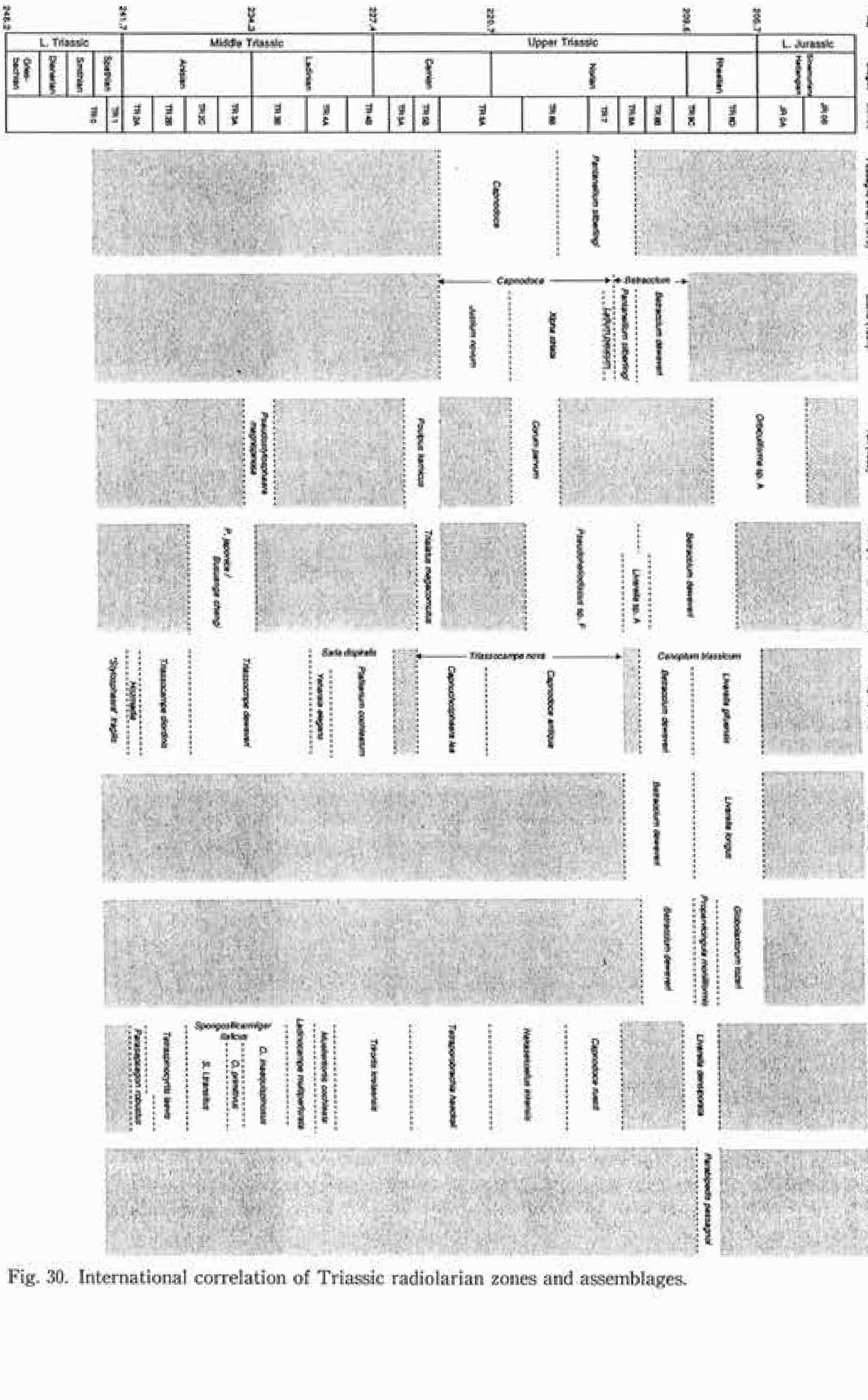


Fig. 30. International correlation of Triassic radiolarian zones and assemblages.

magnispinosa. Although they do not co-occur in the studied section, the *Pseudostylosphaera magnispinosa* Assemblage is correlative with near the boundary between TR 3A and 3B based on co-occurrences of such characteristic species.

The *Orbiculiforma* sp. A Assemblage is difficult to be correlated with other biostratigraphic scheme. However, its characteristic constituent Spumellaria gen. and sp. indet. C is very similar to *Paratriassoastrum crassum* that is characteristic of the upper Rhaetian according to Carter (1993). In the section K, *Paratriassoastrum* sp. cf. *P. crassum* also occurs in TR 8D and JR 0A (samples K-71 and K-84). Consequently, it seems that the assemblage is tentatively correlative with TR 8D to JR 0A.

(4) Correlation with Cheng (1989) and Yeh (1990)

Cheng (1989) and Yeh (1990) studied Permian and Triassic radiolarians from bedded cherts in the Busuanga Islands, Philippines. For the Triassic, Cheng (1989) recognized the *Pseudostylosphaera japonica, Pseudoheliodiscus* sp. F, and *Betraccium deweveri* Assemblages and Yeh (1990) also discriminated the *Busuanga chengi, Trialatus megacornutus* and *Livarella* sp. A Assemblages.

The *Pseudostylosphaera japonica* Assemblage of Cheng (1989), characterized by the occurrence of *Cryptostephanidium* sp. A (*C. japonicum* group herein), *Archaeosemantis* sp. A (*A. cristianensis* herein), *Silicarmiger* sp. A (*Spongosilicarmiger italicus* herein) and *Triassocampe deweveri* together with the nominal species, is correlative with TR 2C to 3A.

The *Pseudoheliodiscus* sp. F Assemblage of Cheng (1989) consisting of *Capnodoce, Capnuchosphaera* and various saturnalids is correlative with TR 6B to the lower part of TR 8A.

The *Betraccium deweveri* Assemblage of Cheng (1989) is correlative with the upper part of TR 8A to the lower part of TR 8D based on the occurrence of *Betraccium deweveri*, Nassellaria gen. and sp. indet. A (*Dreyericyrtium ithacanthum* herein) and Nassellaria gen. and sp. indet. F which is similar to *Dreyericyrtium trispinosum*.

The *Busuanga chengi* Assemblage of Yeh (1990) is correlative with TR 2C to 3A because the assemblage comprises *Eptingium manfredi, Pseudostylosphaera japonica, Triassocampe annulata* (*Spinotriassocampe annulata* group herein) and *Triassocampe deweveri*, but lacks *Yeharaia, Ladinocampe* and *Muelleritortis* species.

The *Trialatus megacornutus* Assemblage is fairly correlative with TR 5B because the nominal species has a short range restricted to TR 5B.

The *Livarella* sp. A Assemblage, characterized by diverse saturnalids associated with *Betraccium maclearni, Livarella* sp. A (*Livarella valida* group herein) and *Capnodoce* species, is probably correlative with TR 8A since the assemblage contains *Pseudoheliodiscus* sp. aff. *P. multidentatus* (*Praemesosaturnalis multidentatus* group herein), *Pseudoheliodiscus rugosus* (*Praemesosaturnalis rugosus* group herein), although *Capnodoce* disappears within TR 7 in the studied sections.

(5) Correlation with Bragin (1991)

Bragin (1991) studied Triassic radiolarians from siliceous claystone and bedded chert units in Sikhote-Alyn, Sakhalin and the Koryak Upland, and established seven zones from the Lower Triassic to the Triassic/Jurassic boundary. They are the "*Stylosphaera*" *fragilis, Hozmadia, Triassocampe diordinis, Triassocampe deweveri, Sarla dispiralis, Triassocampe nova* and *Canoptum triassicum* Zones in ascending order.

The lower part of the "*Stylosphaera*" *fragilis* Zone is correlative with TR 0 based on the presence of *Follicucullus excelsior* (*F. scholasticus* herein), whereas the upper part is tentatively correlative with TR 1. Since the nominal species somewhat resembles *Pseudostylosphaera* sp. A that first occurs in TR 2A, the top of "*Stylosphaera*" *fragilis* Zone may be near the boundary between TR 1 and TR 2A. However, such a form having two bladed spines has not been obtained from TR 0 and TR 1, thus the zone may not range down to the main part of TR 1.

The *Hozmadia* Zone is correlative with the lower part of TR 2A based on the stratigraphic position of the overlying zone.

The *Triassocampe diordinis* Zone is correlative with the upper part of TR 2A to TR 2B because of the

presence of "*Stylosphaera*" *compacta* (*Pseudostylosphaera japonica* group herein) and "*S.*" *spinulosa* (*Hindeosphaera spinulosa* herein) and the absence of *Triassocampe deweveri*.

The *Triassocampe deweveri* Zone is correlative with TR 2C to 3B since *Pentactinocaprus fusiformis* and *Yeharaia elegans* occur in the zone.

The bottom of the *Sarla dispiralis* Zone, the nominal species is referred to as *Tritortis kretaensis* herein, corresponds to that of TR 4A, and is subdivided into the lower *Yeharaia elegans* and upper *Plafkerium cochleatum* Subzones. The *Yeharaia elegans* Subzone is correlative with the lower part of TR 4A based on the upper limit of the nominal species. The *Plafkerium cochletum* Subzone, the nominal species is referred to as *Muelleritortis cochleta* herein, is correlative with the middle part of TR 4A to 4B based on the range of the nominal species.

The *Triassocampe nova* Zone is subdivided into lower *Capnuchosphaera lea* Subzone and upper *Capnodoce antiqua* Subzone. The former is correlative with TR 5B to the lower part of TR 6A based on the range of the nominal species. The latter is correlative with the upper part of TR 6A to TR 7 based on the range of *Capnodoce*.

The *Canoptum triassicum* Zone is subdivided into the lower *Betraccium deweveri* and upper *Livarella gifuensis* Subzones. The former is correlative with the upper part of TR 8A to the lower part of TR 8C, whereas the latter is correlative with the upper part of TR 8C to TR 8D, based on the range of the nominal species.

(6) Correlation with Yeh (1992)

Yeh (1992) recognized the *Betraccium deweveri* and *Livarella longus* Assemblages in bedded cherts of Uson Island, Philippines.

The *Betraccium deweveri* Assemblage characterized by various *Betraccium* species is correlative with TR 8A to 8C. In more detail, Yeh's (1992) samples Uson 03, 04, X and 310 containing *Betraccium chengi*, Nassellaria indet. gen. C. sp. A (*Dreyericyrtium itacanthum* sp. nov. herein) and Nassellaria indet. gen. C. sp. B which is similar to *D. trispinosum* are correllative with the upper part of TR 8B to the lower part of TR 8C. The sample Uson 334 appears to be older than the others because it yields *Pseudoheliodiscus* sp. aff. *P. multidentatus* (*Praemesosaturnalis multidentatus* group herein) and Nassellaria indet. gen. A sp. A which is similar to *Bipedis durus* sp. nov. or *Bipedis* sp. aff. *B. acrostylus* rather than *B. acrostylus* (=Nassellaria indet. gen. B sp. A in her study).

The *Livarella longus* Assemblage characterized by diverse *Livarella* and lacking *Betraccium* is probably correlative with the middle to upper part of TR 8C, since *Betraccium* decreases in abundance above the lower part of TR 8C and also *Livarella* in TR 8D.

(7) Correlation with Carter (1993)

Carter (1993) examined the Rhaetian radiolarian biostratigraphy of the Queen Charlotte Islands using Unitary Association method (Guex, 1977; Guex and Davaud, 1984). She discriminated Assemblage 1, Assemblage 2 that is subdivisible into Subassemblages 2a, 2b, 2c and 2d, and Assemblage 3, and proposed two zones above the Norian *Betraccium deweveri* Zone; namely *Proparvicingula moniliformis* and *Globolaxtorum tozeri* Zones in ascending order.

The base of the *Proparvicingula moniliformis* Zone containing members of Assemblages 1 and 2 is correlative with the middle part of TR 8C where *Betraccium deweveri* disappears.

Since in my available individuals there are only several species in common with Carter's (1993) listed species, it is unfortunately impossible to make a further detailed correlation. However, *Risella tledoensis*, which is characteristic of the upper part of TR 8C and younger zones, first occur in the Subassemblage 2C and *Squinabolella* sp. D (*Haeckelicyrtium breviora* sp. nov. herein), the nominal species of TR 8D, is included in the Assemblage 3. Therefore, the boundary between the *Proparvicingula moniliformis* and *Globolaxtorum tozeri* Zones may correspond to a horizon near the boundary between TR 8C and 8D. Carter (1993) mentioned that *Bipedis acrostylus, Livarella valida*, etc. persist throughout the *Globolaxtorum tozeri* Zone. The top of the zone is thus stratigraphically below the base of JR 0A.

(8) Correlation with Kozur and Mostler (1994)

Kozur and Mostler (1994) investigated several sections in Hungary, Italy and Austria with additional samples from other countries, and established the following zones: *Parasepsagon robustus, Tetraspinocyrtis laevis, Spongosiicarmiger italicus, Ladinocampe multiperforata, Mulleritortis cochleata, Tritortis kretaensis, Tetraporobrachia haeckeli, Nakasekoellus inkensis, Capnodoce ruesti*, and *Livarella densiporata* zones in ascending order. The *Spongosiicarmiger italicus* Zone is further subdivided into the *Spongosiicarmiger italicus transitus, Oertlispongus primitivus*, and *Oertlispongus inaequispinosus* Subzones in ascending order. The *Ladinocampe multiperforata* Zone is also subdivisible into two: the *L. annuloperforata* and *L. vicentinensis* Subzones.

The lowest *Parasepsagon robustus* Zone is defined at the base by the first appearance of *Parasepsagon robustus* Kozur and Mostler, *P. asymmetricus asymmetricus* Kozur and Mostler, and *Plafkerium? anisicum* Kozur and Mostler, which possess stout, coplannar four-bladed spines and at the top by their disappearance. Such forms never occur in TR 0 and 1; thus it is apparent that this zone is correlative with TR 2A or younger TR zones. Kozur and Mostler (1994) assigned the age of this zone to late Pelsonian. However precise correlation with the TR zones cannot be accomplished only using Kozur and Mostler's (1994) diagnostic taxa. The position of this zone can be inferred by that of the overlying *Tetraspinocyrtis laevis* Zone.

The base of the second *Tetraspinocyrtis laevis* Zone corresponds to the top of the preceding zone, and the top is defined by the first appearance of the genera *Oertlispongus* and *Yeharaia* and also *Triassocampe deweveri* and *T. scalaris* (synonymized to *T. deweveri* herein). According to my results, the first appearance of *Yeharaia* is obviously later than the other diagnostic taxa. In contrast, *Oertlispongus* species make the first appearance at the lowest horizon. It is difficult to make precise correlation between the *Tetraspinocyrtis laevis* Zone with the TR zone in this study. However, a rough estimation is as follows.

Triassocampe deweveri characterizing the overlying *Silicarmiger italicus* Zone is absent below TR 2C. It is possible to place the top of the *Tetraspinocyrtis laevis* Zone slightly below the TR 2B/2C boundary where *Spongosilicarmiger italicus* first appears. The base can be placed around the TR2A/2B boundary since *Tetraspinocyrtis* sp. cf. *T. annuloperforata*, which seems closely related to the nominal species *Tetraspinocyrtis laevis* Kozur and Mostler, occurs in Sections E and M. It is also possible to correlate the base of this zone below the TR2A/2B boundary. Therefore I tentatively place the base at the middle of TR 2A.

This means that the preceding *Parasepsagon robustus* Zone can be correlative with the lower part of TR 2A. It seems, however, that a part of the *Parasepsagon robustus* and *Tetraspinocyrtis laevis* Zones overlap since *Parasepsagone asymmetricus praetetracanthus* Kozur and Mostler, which characterizes only the latter zone but is quite similar to *Parasepsagon* (?) *antiquus* which first appears near the TR 1/2A boundary, is absent in the former zone. Ramovs and Goricăn (1995) also pointed out the similarity between *Parasepsagone asymmetricus praetetracanthus* and *P.* (?) *antiquus*. This suggests that the diagnostic taxa of the *Parasepsagon robustus* Zone indicated by Kozur and Mostler (1994) have undergone preservational bias and do not represent natural assemblage.

The *Spongosiicarmiger italicus transitus* Subzone of the *Spongosiicarmiger italicus* Zone immediately overlies the *Tetraspinocyrtis laevis* Zone, and the top is defined by the first appearance of *Oertlispongus primitivus* Kozur and Mostler, *Baumgartnernia bifurcata* Dumitrica, and *Spongosilicarmiger italicus italicus*. Among these species, the first appearance of *Oertlispongus primitivus* indicates that the top corresponds to the TR 2C/3A boundary.

The top of the *Oertlispongus primitivus* Subzone of the *Spongosiicarmiger italicus* Zone is defined by the disappearance of *Spongosilicarmiger gabiolaensis* Kozur and Mostler (a junior objective synonym of *S. mostleri*) and the first appearance of *Oertlispongus inaequispinosus inaequispinosus* and *Falcispongus falciformis* Dumitrica. The first appearance of *Falcispongus* indicates that the horozon is correlative to the lower part of TR 3A.

Likewise, the *Oertlispongus inaequispinosus* Subzone of the *Spongosiicarmiger italicus* Zone is defined at the

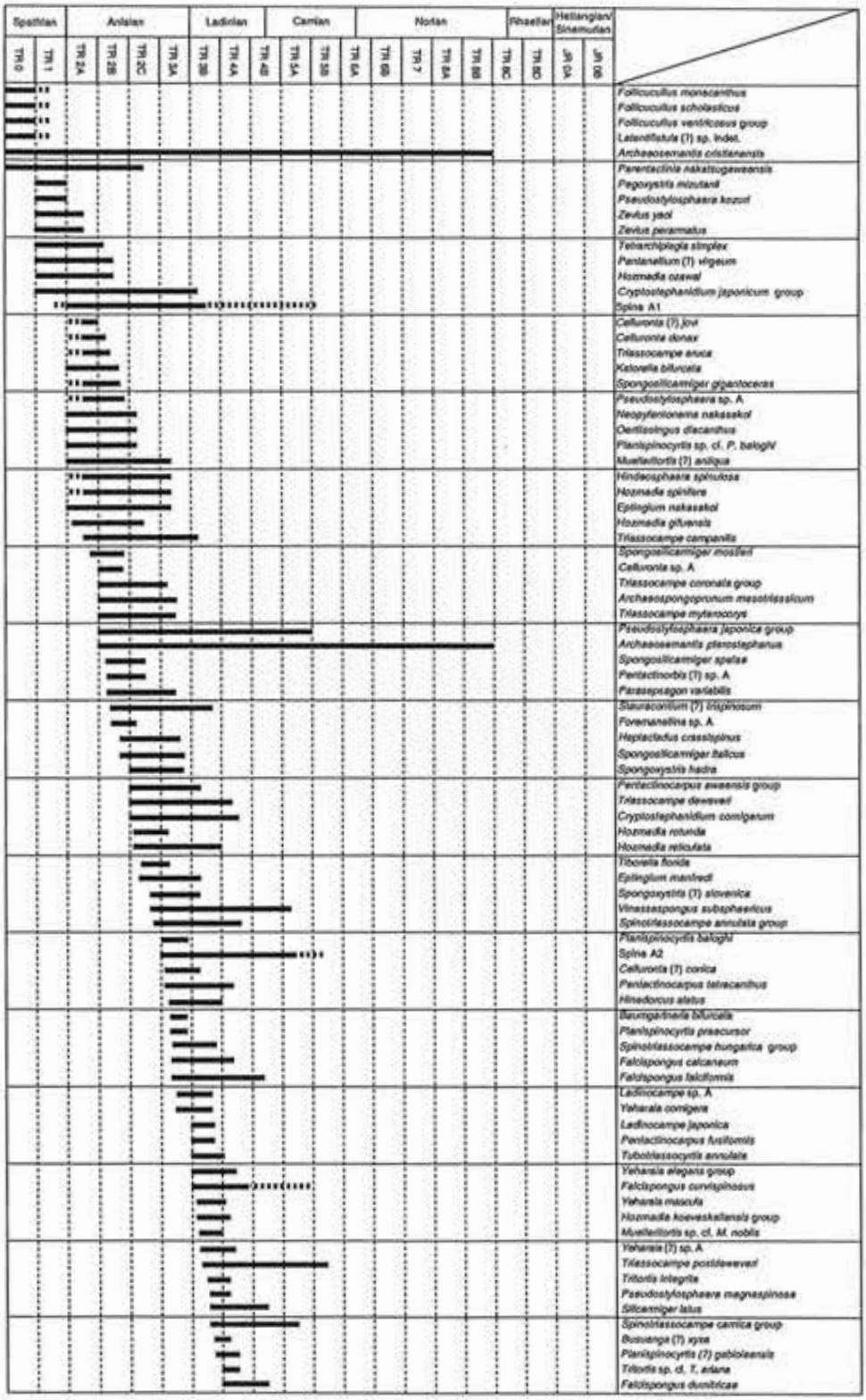


Fig. 31a. 31a, b and c: Stratigraphic distribution of 247 selected radiolarian taxa.

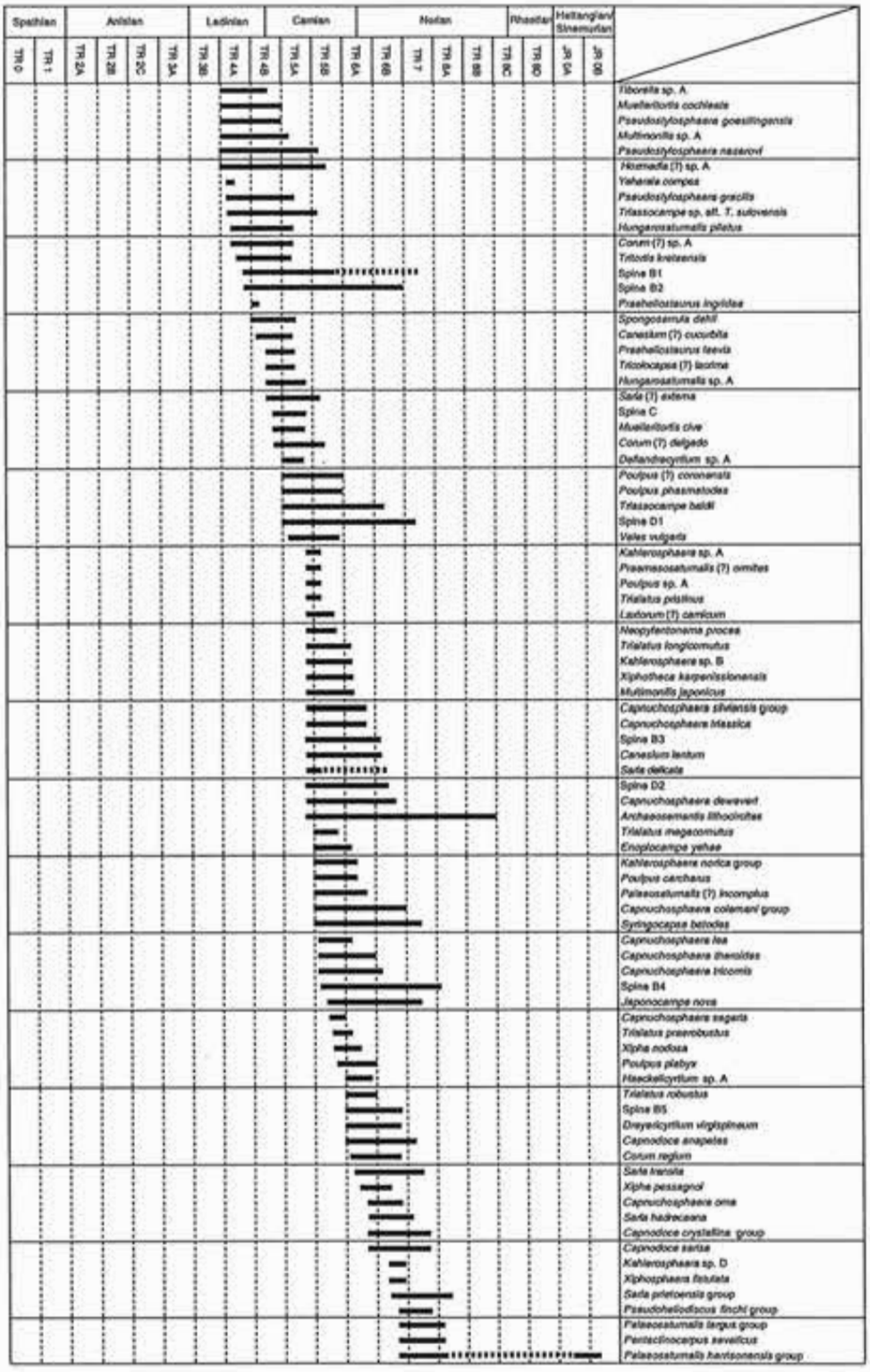


Fig. 31b. 31a, b and c: Stratigraphic distribution of 247 selected radiolarian taxa.

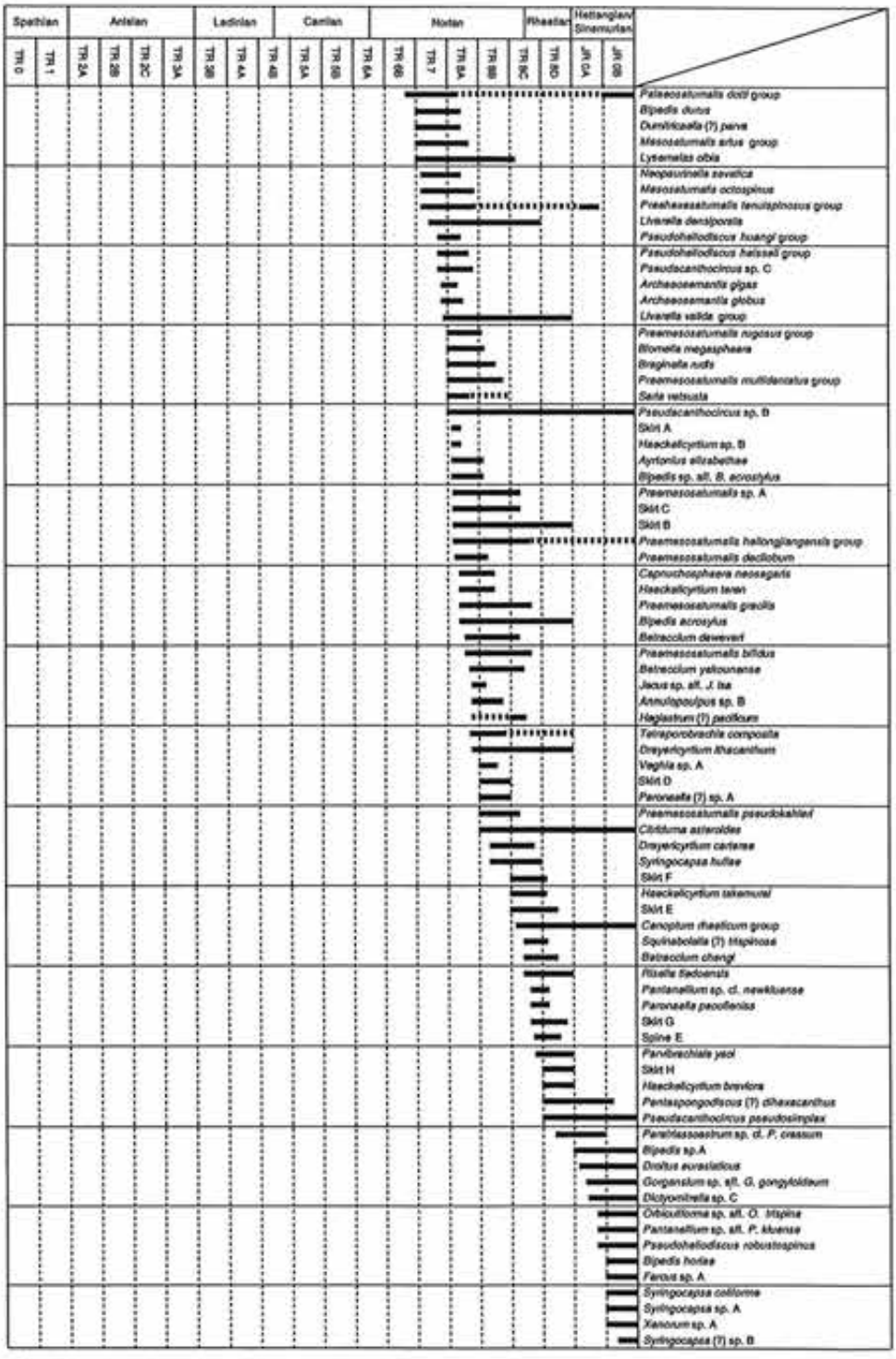


Fig. 31c. 31a, b and c: Stratigraphic distribution of 247 selected radiolarian taxa.

extensive area including central Japan and Far East Russia. Presently, it is more suitable to consider that some Permian-type radiolarians survived the P/T extinction, and became extinct near the TR 0/1 boundary. *Follicucllus* and other Permian-type radiolarians sometimes occur even in the Middle Triassic above TR 1. I believe that such sporadic occurrences probably represent reworking of radiolarian tests.

Another problem concerning the occurrence of *Follicucullus monacanthus* from TR 0 is that its range is restricted to the upper Middle to lower Upper Permian (Ishiga, 1986), which may again suggest reworking. It is worthy of notice that Yamashita *et al.* (1991) recognized the occurrence of *Follicucullus monacanthus* associated with latest Permian *Neoalbaillella ornithoformis* Takemura and Nakaseko. My unpublished data also confirm that *Follicucullus monacanthus* and even *Pseudoalbaillella fusiformis* (Holdsworth and Jones) occur throughout the Upper Permian although they are rare. It seems that the final appearance datum of *Follicucullus monacnthus* is not yet determined, and also that further reexamination of the Upper Permian zonation is necessary.

TR 1 is represented by members of the Pn Assemblage and the lowest part of the Hg Assemblage (Sugiyama, 1992). This zone is restricted to the upper Spathian to lowest Anisian, based on discussion by Sugiyama (1992). This zone is almost correlative with the upper *"Stylosphaera" fragilis* Zone (Bragin, 1991) whose upper limit is slightly below the Spathian/Anisian boundary. These data suggest that the TR 1/2A boundary is around the Spathian/Anisian boundary. Although further research is necessary to fix the precise age of the TR 1/2A boundary, I believe that the TR 1/2A boundary probably corresponds to the Spathian/Anisian boundary.

The first appearance datum of *Oertlispongus inaequispinosus*, the diagnostic species of TR 3A, is below the Anisian/Ladinian boundary according to Dumitrica (1982a) and Lahm (1984) although Kozur and Mostler (1994) place the datum just at the Anisina/Ladinian boundary. Therefore, TR 2A, 2B and 2C and at least the lower part of TR 3A are apparently of Anisian age. The bedded chert section studied by Mizutani and Koike (1982) involves the TR 2B/2C boundary (below their horizon SMT 02) across which the conodont *Neogondolella bulgarica* (Budurov and Stefanov) occurs. In my studied sections, samples M-5 and D-12, both assigned to TR 2B, also yield *Neogondolella bulgarica*. Based on this information, TR 2B is almost correlative with the *Neogondolella bulgarica* Zone, which is mid Anisian in age, of Koike (1981) who summarized the Triassic conodont biostratigraphy in Japan. Therefore, TR 2A and 2C are automatically set in the lower and upper Anisian, respectively.

The first appearance of the genus *Falcispongus* in the upper part of TR 3A is also placed below the Anisian/Ladinian boundary (Dumitrica, 1982a), but the precise age of the TR 3A/3B boundary defined by the first appearance of *Yeharaia elegans* group is not well understood. Ishida (1984) reported the occurrence of *Yeharaia elegans* in the uppermost Anisian bedded chert, dated by conodonts, in the southern Chichibu Terrane, Shikoku. Goricăn and Buser (1990) studied diverse radiolarian assemblages in the upper Illyrian to Longobardian of NW and central Slovenia. However their upper Illyrian to Fassanian samples do not yields *Yeharaia elegans* but contain characteristic species for TR 3A such as *Falcispongus* species, *Oertlispongus inaequispinosus, Spongosilicarmiger italicus, Triassocampe scalaris* (*T. deweveri* herein) and *Yeharaia annulata* (*Spinotriassocampe annulata* group herein). Judging from these studies, however, it seems that the first appearance of *Yeharaia elegans* group is very close to the Anisian/Ladinian bounday. I therefore tentatively place the TR 3A/3B boundary just onto the Anisian/Ladinian bounday. The TR 3B/4A boundary defined by the first appearance of *Muelleritortis cochleta* seems to correspond to the base of the Longobardian, upper substage of Ladinian, in accordance with Kozur (1988a, b).

The base of TR 4B is defined by the first appearance of the typical morphotype of *Spongoserrula dehli*, which was originally described from siliceous argillite of possibly Ladinian age, Camp Cove Formation, Canada. This species is associated with *Plafkerium cochleatum* (*Muelleritortis cochleata* herein), *Pseudos-*

tylosphaera nazarovi, and *Sarla kretaensis* (*Tritortis kretaensis* herein). The radiolarian assemblage of this zone is characterized by abundant occurrence of *Tritortis kretaensis* as mentioned earlier. This feature is similar to the uppermost Longobardian to lower Cordevolian association of Kozur (1988a, b). Therefore the TR 4A/4B boundary is placed within the upper Longobardian. According to Mostler and Krainer (1993), *Ornatisaturnalis ingridae* (*Praeheliostaurus ingridae* herein) and *Praeheliostaurus laevis* occur in the upper Longobardian and lower Cordevolian, respectively; in my sections, the former occurs in the lower part of TR 4B, the latter in the upper part. This suggests that the Ladinian/Carnian boundary lies within TR 4B, and the top of TR 4B is correlative with the lowest part of the Cordevolian. Obtained conodonts include *Neogondolella foliata* (Budurov) from the samples B-20, R-25 and R-31. This agrees well with Koike's (1981) conodont zonation.

The precise age of TR 5A and 5B is not well fixed. According to Carter (1991), the genus *Capnodoce* which defines the bottom of the overlying TR 6A is present in the upper Carnian. Based on this, TR 5A and 5B may be lower to middle Carnian, at least below the Welleri Zone (Tozer, 1979) and the Nodosa Zone (Orchard, 1983).

Capnodoce becomes abundant and diverse in the upper part of TR 6A associated with the genus *Sarla* Pessagno. This assocoation is also observed in the lower Norian radiolarian assemblage reported by Carter (1991). Moreover, according to Carter (1991), *Capnodoce fragilis* which seems related to *C. sarisa* first occurs in the upper lower Norian associated with conodonts from the *Abneptis* A Zone (Orchard, 1983). It is thus concluded that TR 6A contains the Carnian/Norian boundary. The upper part of TR 6B is characterized by diverse saturnalids with rare occurrences of *Xiphosphaera fistulata* which is a good index for the the upper lower Norian, up to the Triangularis Zone of Orchard (1983) (Carter, 1991). The top of TR 6B is thus correlative with the middle Norian.

Livarella first appears within TR 7, and *Betraccium deweveri* ranges from the upper part of TR 8A to the lower part of TR 8C. According to Carter (1991, 1993), *Livarella* first occurs in the upper Norian and *Betraccium deweveri* disappears at the very end of the Norian. Thus zoneso TR 7 to 8B are probably correlative with the upper Norian, and TR 8C strides the Norian/Rhaetian boundary.

Many Triassic-type radiolarians disappear at the top of TR 8D corresponing to the CS-3 horizon. The CS-3 is fairly correlative with the mudstone bed in the Katsuyama Section studied by Hori (1992, figs. 3, 4), who revealed that the last occurrence datum of conodont *Misikella posthernsteini* Kozur and Mock corresponds to the horizon. In Section K, this horizon is ca. 3 m below the first appearance datum (FAD) of *Parahsuum simplum* (K-106) which defines the top of JR 0B and the base of the Jurassic *Parahsuum simplum* Assemblage-Zone (Yao, 1982; Hori, 1990). These mean the Triassic/Jurassic (T/J) boundary can be placed at least within JR 0A and JR 0B, ca. 3m interval. Matsuoka *et al.* (1994) mentioned that the T/J boundary can be placed within the interval between Kb01 and Kb04 in the Katsuyama Section, based on the FAD of *Syringocapsa coliforme* whose FAD corresponds to the TR 9A/9B boundary. In this study I tentatively regard the CS-3 horizon as the T/J boundary and correlate JR 0A and JR 0B to the Hettangian and lower Sinemurian on the basis of the following reason: Lithology of the bedded chert abruptly changes from F-type to B-type beyond the CS-3 horizon. This strongly suggests that paleoceanographic conditions changed drastically at this horizin and the change damaged marine organisms including conodonts and some radiolarians, which is possibly identical to the end-Triassic mass extinction event (Benton, 1990). Further reserch is necessary to determine the precise position of the T/J boundary.

Lithologic change of siliceous claystone and bedded chert units and its paleoceanographic implications

The correlation of the investigated 21 sections is shown in Fig. 32 in accordance with field investigations and radiolarian biostratigraphy. The generalized column of siliceous claystone and bedded chert units of the southeastern Mino Terrane is reconstructed in Fig. 33, where the following seven lithologic units can be discriminated based on the following

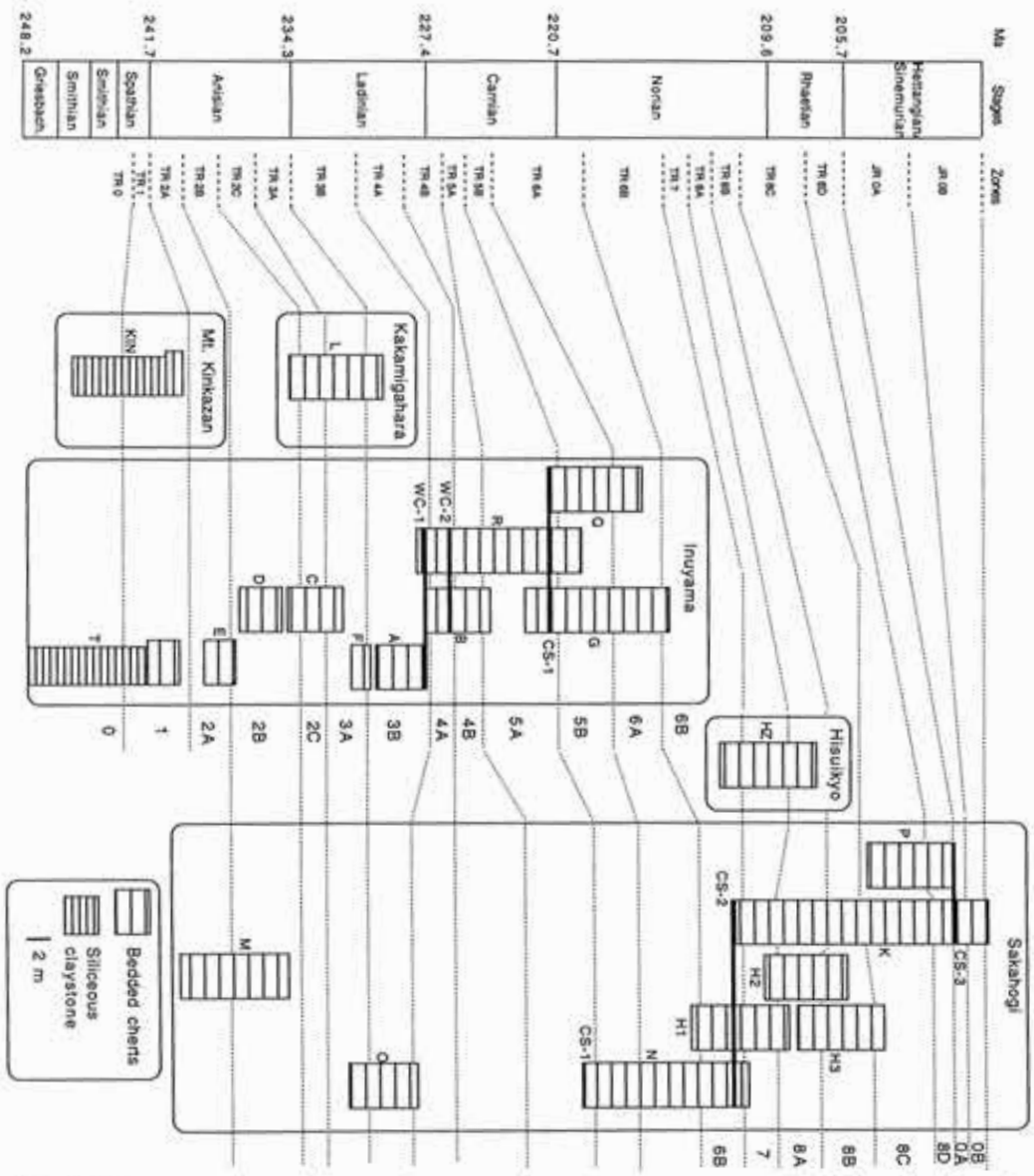


Fig. 32. Correlation of the studied 21 sections. Bedded cherts are not subdivided into A-, B- and F-types in this Fig.

features.

Unit 1: Composed of siliceous claystone and blackish to grayish bedded cherts, correlative with TR 0 to lowest part of TR 2A, Nammalian to earliest Anisian in age, and more than 25 m in thickness. In the lowest part siliceous claystone strata contain nodular insertions of dolostone and beds of black carbonaceous claystone. These features gradually disappear upward with a rapid increase of frequency and thickness of chert beds. In the upper part, the proportion of chert beds to siliceous claystone beds is reversed, which means apparent lithologic change from siliceous claystone to bedded cherts occurs in TR 1. All chert beds are B-type.

Unit 2: Composed of B-type bedded cherts, approximately 10 m in thickness, and correlative with lower part of TR 2A to upper part of TR 2B, early Anisian in age. The base is defined by the occurrence of the lowest reddish bedded chert. The color of chert beds are dominated by purplish red in a few intervals, and by gray to blackich gray in other; chert beds exhibiting the latter color sometimes contain conspicuous

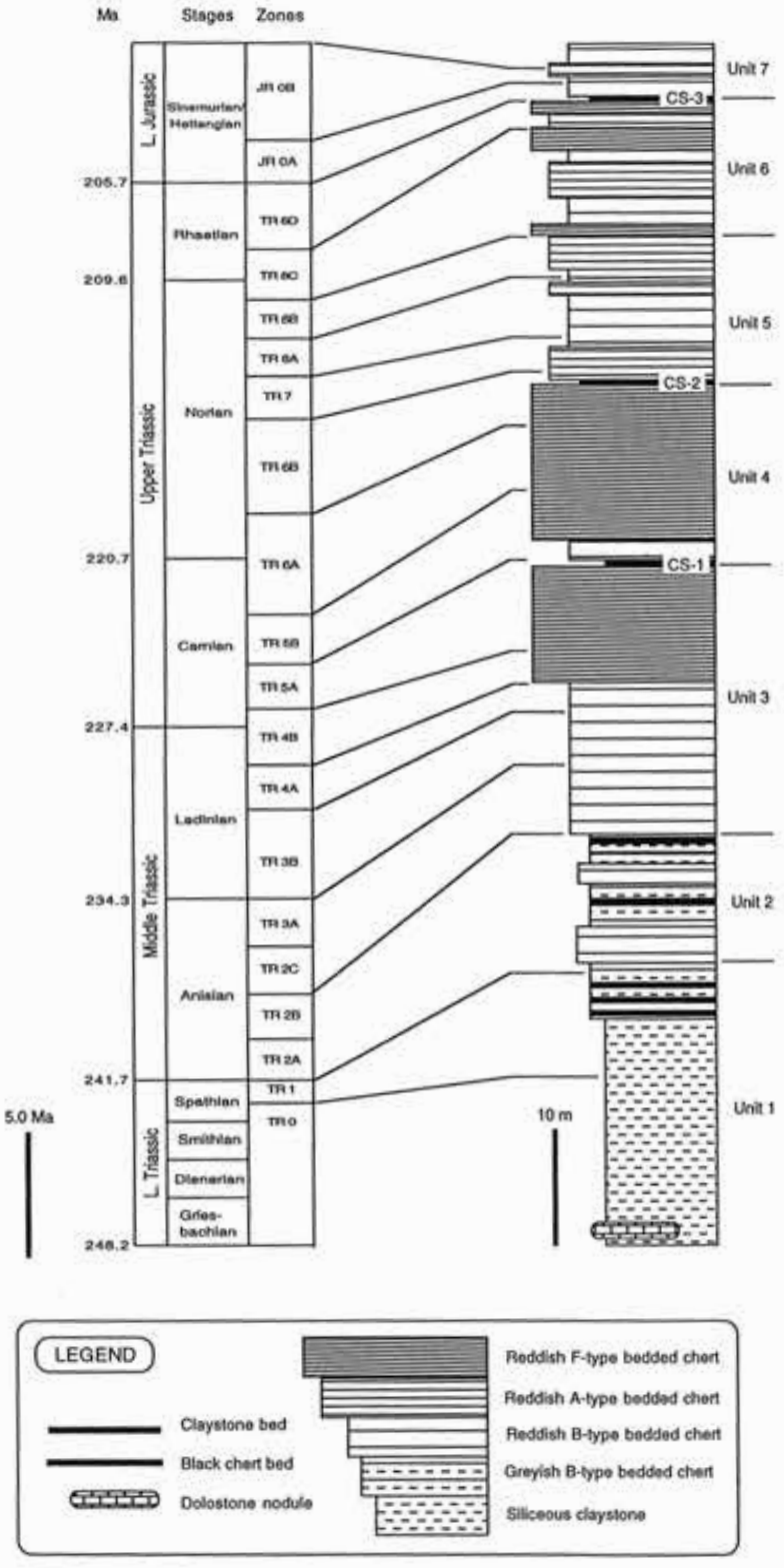


Fig. 33. Generalized columnar section of the Triassic sequence reconstructed in the studied areas.

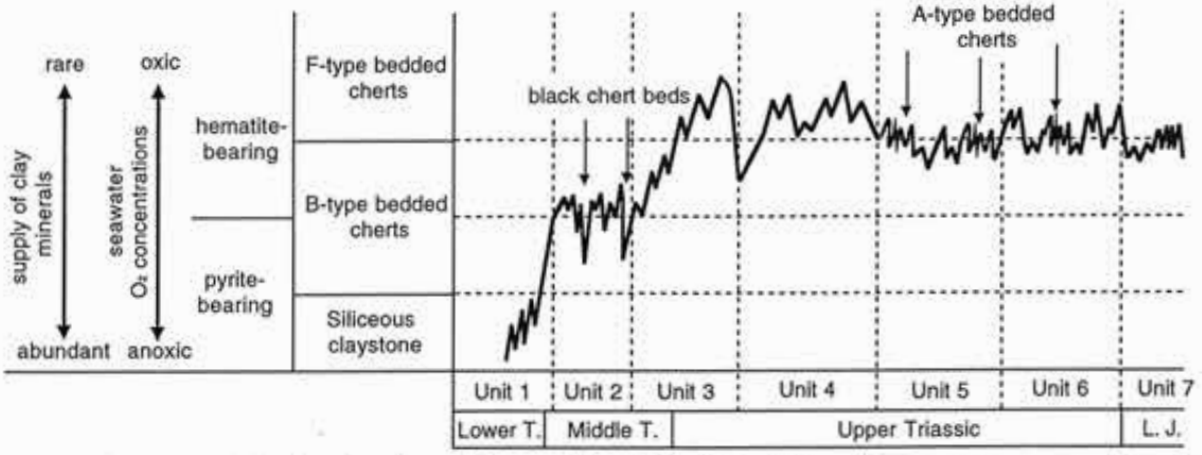


Fig. 34. Scheme of vissitudes of marine environment through the Triassic time. Zigzaged line represents possible changes of the Triassic marine environmental changes.

black chert beds.

Unit 3: Consisting of the lower, brick red, B-type bedded chert correlative with the uppermost part of TR 2B to 4A, late Anisian to late Ladinian, and the upper F-type bedded chert showing various colors is correlative with TR 4A to most part of TR 5A, late Ladinian to early Carnian. The total thickness of this lithologic unit is estimated to be approximately 23 m. The base is defined by brick red bedded chert. The F-type bedded chert is further subdivided into two: mainly reddish orange in the lower part and pigmented with gray, crimson, dark brown in the upper part.

Unit 4: The lowest part is brick red B-type bedded chert but upper beds consist of variably colored, chiefly red, F-type bedded chert, correlative with the uppermost part of TR 5A to middle part of TR 6B, mid Carnian to early Norian. The total thickness of this lithologic unit is approximately 15 m. The base is defined by the horizon CS-1.

Unit 5: Composed of alternating A- and B-type bedded cherts which are brick red in color. The lower part is subdivisible into lower A-type and upper B-type bedded cherts, correlative with the upper part of TR 6B to middle part of TR 8A, mid Norian, whereas the upper part shows a cyclic change of A-type and B-type although A-type is dominant and is correlative with the upper part of TR 8A to TR 8B, late Norian. The total thickness of the unit is approximately 13 m. The base is defined by the horizon CS-2.

Unit 6: Consisting of A-, B- and F-types of bedded cherts that are cyclically alternated, and correlative with the uppermost part of TR 8C to 8D, latest Norian to Raetian in age. The total thickness of the unit is approximately 12 m in thickness. The B-type chert beds are brick red, whereas the F-type ones are mainly reddish but sometimes grayish, pinkish, purplish in color. Thick claystone beds are also intercalated in some horizons. This unit shows more intense lithologic change than the underlying unit. The base is defined by the F-type bedded cherts located at the base of TR 8C.

Unit 7: Composed of the lower and upper B-type and the middle A-type bedded cherts, correlative with JR 0A and 0B, Hettangian to Sinemurian, and more than 5 m in thickness. All chert beds are brick red. The base is defined by the horizon CS-3. The overlying strata are not referred in this study.

According to previous studies such as Hori *et al.* (1993) and Nakao and Isozaki (1994), pelagic sediments including bedded chert are very good monitors to infer past paleoceanographic environmental global changes. Therefore, successive lithologic changes above described is useful to infer Triassic to Jurassic paleoceanographic environments. The following discussion is schematically expressed in Fig. 34.

Nakao and Isozaki (1994) considered that color change from grayish or blackish (pyrite-bearing) to red (hematite-bearing) in the Anisian bedded cherts represents the recovery processes from anoxic marine condition developed around the P/T boundary to oxic.

This is also supported by ^{57}Fe Mössbauer spectroscopic study by Kubo *et al.* (1996). The horizon indicated by Nakao and Isozaki (1994), at which bedded cherts change in chemical composition from pyrite-bearing to hematite-bearing, is correlative with the upper part of TR 2B which corresponds to the top of Unit 2, based on the biostratigraphic examination. It is easy to understand that marine condition had already reached hematite-bearing condition in earliest Anisian time, the base of Unit 2, and fluctuated between hematite- and pyrite-bearing conditions throughout the Unit 2. That is to say, Unit 1 represents for completely pyrite-bearing (anoxic) marine conditions, Unit 2 transitional conditions, and Unit 3 for completely hematite-bearing (oxic) conditions, respectively. It seems that the environmental shift was surely one-way, but fluctuated in minor order rather than being linear and sharp, which is represented by alternating occurrences of grayish and reddish bedded cherts in Unit 2. Apparent lithologic change from siliceous claystone to bedded chert in Unit 1 is primarily considered to be due to an increase of radiolarian productivity from the P/T extinction.

The environmental changes above Unit 3 are explained mainly by thickness and types of chert beds. Concerning the former, the thickness of chert beds was determined by not only radiolarian productivity but also dissolution rate of siliceous tests during the depositional process, and it is generally accepted that siliceous tests are well-preserved in anoxic condition rather than oxic (e.g., Caulet, 1974; Bjørkulund and De Ruiter, 1987). In Unit 3, B-type chert beds attain maximum thickness in the lowest part (corresponding to TR 2C) and gradually decrease in thickness upward (corresponding to TR 3A to 4A) (Figs. 6, 9). This fact together with the reddish color of chert beds indicates that the effect of radiolarian productivity was considerably superior to the effect of O^2 concentration with respect to accumulation of chert beds at the base of the Unit 3, although both the effects in seawater became higher than in Units 1 and 2. Subsequent upward thinning of chert beds is regarded as gradual inversion of the two effects. This is supported by the presence of overlying F-type bedded cherts in which stylolites, resulting from dissolution, are very common. Stylolite are usually considered as a texture resulting from pressure dissolution but, in this case, it seems to have originated from other causes before diagenesis. As mentioned before, siliceous organic remains are very rare but well-preserved in the fine-grained siliceous matrix in F-type bedded chert. This appears to be related to the dissolution of siliceous tests, which resulted in the only sporadic occurrence of radiolarians in F-type chert beds, and indicates not low-productivity of radiolarians but presevational bias due to dissolution. The upward decrease in accumulation rates of bedded chert which attain a minimum around the middle part of Unit 3, around the Ladinian/Carnian boundary, may be also evidence for intense dissolution of siliceous tests.

One of possible causes resulting in increase in radiolarian productivity is successive activation of seawater circulation from the early Triassic, and it may have reached the acme in Unit 3. Judging from the fact that the Kamura and Taho Limestones representing shallower contemporaneous heterotopic facies have hiatus at the base of the Carnian (Koike, 1979; Watanabe *et al.*, 1979), this may have been accompanied by a drastic fall of sea level especially in late Ladianian to early Carnian time. Taking several lines of evidence showing elevated temperatures in the late Permian to early Triassic into consideration (Frakes *et al.*, 1992), one can suggest the observed lithologic changes may be due to world-wide climatic cooling, although further detailed geochemical studies are necessary to prove this hypothesis.

The occurrence of B-type bedded chert at the base of Unit 4 suggests a very sudden turning back of marine condition, and the overlying thick F-type bedded cherts indicate that conditions soon become oxic again. Therefore, Unit 4 may represent the second O^2 concentration stage in the Triassic.

Units 5, 6 and 7, which are obviously different from the underlying units in having A-type bedded cherts, are characterized by periodical alternation of A-, B- and F-type bedded cherts. Such lithologic changes possibly indicate that O^2 concentration was fluctuating in short terms, and A-type bedded chert could be formed by further short-termed environmental perturbation around the border between B- and F- type

bedded cherts bearing conditions. Unit 6, correlative with the uppermost Norian to Rhaetian and distinguished from the Units 5 and 7 by comprising F-type bedded cherts, is considered to have accumulated under an environment with more amplified periodicity of O^2 concentration changes than Units 5 and 7.

Horizontal changes in lithology surely exist especially in the Norian and Rhaetian, for example it is recognized between Sections H and HZ and between Sections K and P. This appears to be related mainly with the development of A-type bedded cherts. They may originally have had horizontal chemical and/or structural heterogeneity especially in F-type chert beds, and this could be emphasized by diagenetic processes and/or secondary deformation in various degree. The color of chert beds seems to be also changeable by diagenetic processes and deformation, and it is the reason why there are no reddish chert beds in the Section HZ.

As mentioned above, I consider that lithologic changes are explained mainly by vicissitudes of O^2 concentration in seawater that may control productivity and dissolution of siliceous organic remains and affect the apparent accumulation rates of siliceous claystone and bedded cherts. Another factor affecting the accumulation rates of bedded chert is the supply of clayey minerals. Fig. 33 suggests that the development of claystone beds and the bedded chert accumulation rates are closely related, and the decrese of claystone beds decreases the accumulation rate of bedded chert. This is very important for considering the origin of bedded cherts, and indicates that bedded cherts are not always formed by high accumulation rates of chert beds and slow accumulations of clayey minerals through the Triassic.

Description of radiolarian spines and skirts

Siliceous organic remains in chert beds are composed of sponge spicules and radiolarians, making cherts a good lithology to study radiolarians and radiolarian biostratigraphy. However, well preserved individuals are in the residues, and most skeletons are more or less dissolved and/or broken. Thus we must pay attention to those broken or detached parts of radiolarians. In fact, some have very characteristic morphologies and possess a certain potential for biostratigraphic study. A well known example is tumidaspinae which abundantly occur in Carnian to Norian strata even if their completely preserved test are absent (Pessagno *et al.*, 1979).

In this study I have attempted paid to claryfy the stratigraphic distribution of characteristic, detached spines of spumellarians and skirts of nassellarians. Skirts are distal part of the thorax, abdomen or possibly a post-abdominal segment that markedly flares out like a brim. These fragments can sometimes be identical to generic or species level, but the detached parts may be derived from unexpected owners such as capnodocin spines from the genera *Loffa* Pessagno, 1979, and *Renzium* Blome, 1983. They are hence described below under informal names.

Before describing characteristic spines, two terms concerning their types of torsion are mentioned. As viewed from the base to the distal end, the spine can exhibit either clockwise (dextral) or counterclockwise (sinistral) torsion.

1. Spine A

Spine A is apparently of oertlispongids, and two forms are discriminated as follows.

(1) Spine A1 (Fig. 35-1): Rod-like and straight oertlispongid main spine consisting of a conical root and a long stem gradually tapering to a point (for the descriptive terms see Dumitrica, 1982a). The possible derivation of these spines is *Oertlispongus diacanthus* Sugiyama, or other Anisian oertlispongids with straight and thick spines. This form is apparently distinguished from oertlispongid minor spines by the thickness. In the Norian strata above TR 7 there are similarly shaped spines derived from *Neopaurinella sevatica* Kozur and Mostler, but they differ are from Spine A1 by having a shorter and thicker stem with thinner root in addition to their stratigraphic distributions.

(2) Spine A2 (Figs. 35-2, 3): Rod-like and curved oertlispongid main spine. The curvature varies from a form with a slightly curved distal end (Fig. 20-2) to another extreme possessing a strongly curved, sickle-

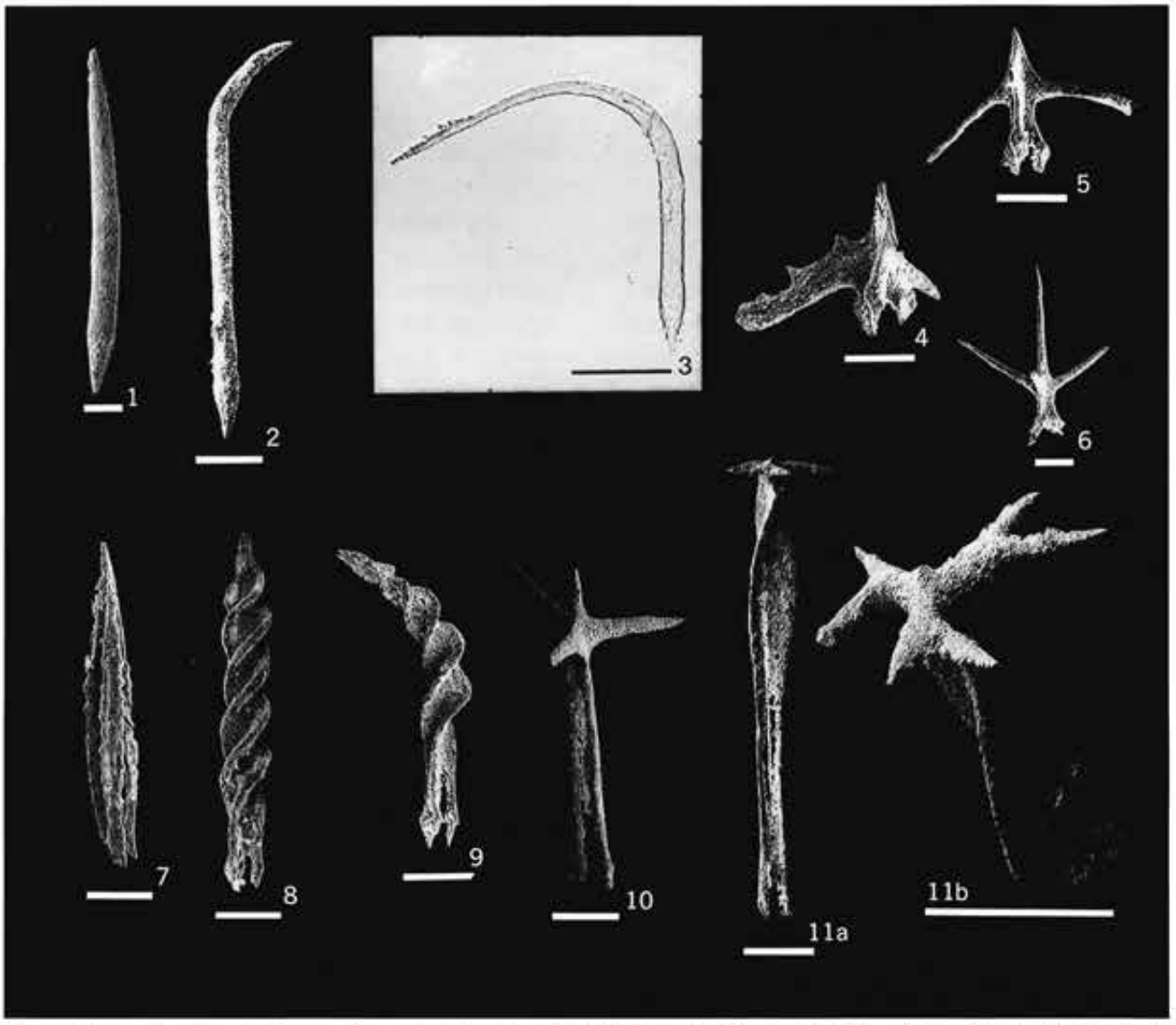


Fig. 35. Characteristic radiolarian spines. 1. Spine A1, ESN 148052, D-11, TR 2B. 2, 3. Spine A2. 2: ESN 148053, C-18, TR 3A, 3: ESN 148062, L-59, TR 3A. 4. Spine B2, ESN 148055, R-38, TR 5A. 5. Spine B1, ESN 148054, R-12, TR 4A. 6. Spine B3, ESN 148056, R-40, TR 5B. 7. Spine C, ESN 148059, R-38, TR 5A. 8. Spine D1, ESN 148060, R-38, TR 5A. 9. Spine D2, ESN 148061, Q-8, TR 5B. 10. Spine B5, ESN 148058, G-25, TR 5B. 11a, b. Spine B4, ESN 148057, Q-25, TR 6A. Scale bar=50 μm.

like shape (Fig. 20-3). The possible derivation of Spine A2 is *Oertlispongus inaequispinosus* Dumitrica *et al.* or *Flexispongus cornubovis* Larm.

2. Spine B

Spine B is a group of straight or nearly straight, three-bladed spines with three blanches extending from the blades. Among many forms, five that are stratigraphycally important are discussed below. These spines may be derived from *Dumitricasphaera* Kozur and Mostler, 1979, or *Kahlerosphaera* Kozur and Mostler, 1979.

Spine B1 (Fig. 35-5): Short spine having simple branches that are slightly curved downward. Axial projection is present.

Spine B2 (Fig. 35-4): General shape similar to Spine B1 but differs in having barbed branches. Axial projection is present.

Spine B3 (Fig. 35-6): Long spine having a verticil of three branches in the proximal third. Length of the

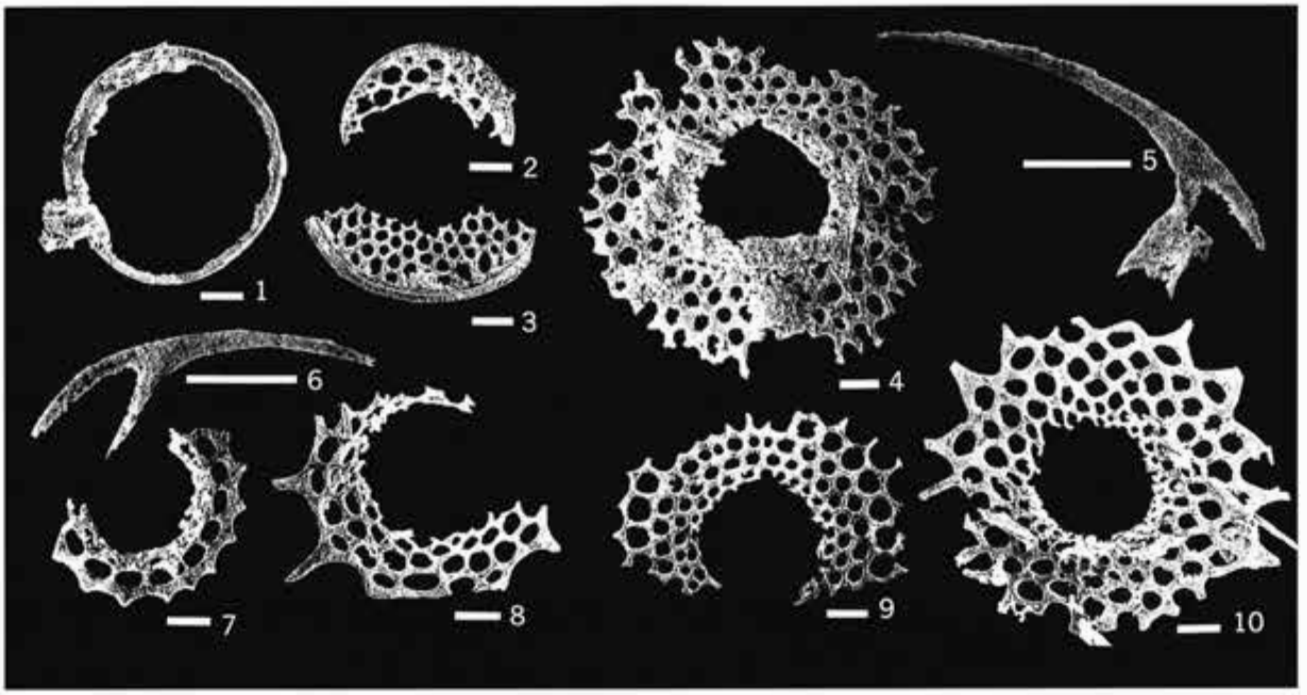


Fig. 36. Characteristic radiolarian spine and skirts. 1. Skirt A, ESN 148190, HZ 36, TR 8A. 2. Skirt B, ESN 148191, K-69, TR 8D. 3. Skirt C, ESN 148192, H-49, TR 8B. 4. Skirt D, ESN 148193, H-48, TR 8B. 5, 6. Spine E. 5: ESN 148194, P-14, TR 8D, 6: ESN 148195, P-14, TR 8D. 7. Skirt H, ESN 148195, K-65, TR 8D. 8. Skirt G, ESN 148197, K-65, TR 8D. 9. Skirt F, ESN 148196, K-61, TR 8C. 10. Skirt E, ESN 148197, K-37, TR 8C. Scale bar=50 μm.

branches variable, axial projection present.

Spine B4 (Figs. 35-11a, b): Long spine having flat and distally bifurcated branches at the distal end. The axial projection is wart- or needle-like, and the distal part often exhibits slight torsion.

Spine B5 (Fig. 35-10): General shape is similar to Spine B3, but axial projection short.

3. Spine C (Fig. 35-7)

Spine C is a straight form having four ridges on which small nodes are developed. Probably derived from *Muelleritortis cive* sp. nov. or *Tritortis* sp. A.

4. Spine D

This group exhibits strong dextral torsion, and is subdivided into the following two forms.

Spine D1 (Fig. 35-8): Straight spines with strong dextral torsion. The possible derivation is *Spongostylus tortilis* Kozur and Mostler. *Muelleritortis cochleta* and *Tritortis kretaensis* also have this type of spines from which Spine D1 is distinguished by having a longer torsionless portion in the proximal part.

Spine D2 (Fig. 35-9): Curved spines with strong dextral torsion. The possible derivation is *Spongostylus carnicus* Kozur and Mostler.

5. Spine E (Figs. 36-5, 6)

Spine E exhibits an asymmetrical shape. It may be a spine but alternately may be derived from saturnalid ring or nassellarian skirt. This spine consists of two arcs, one short and the other long. The shorter arc can be regarded as a stem, and is attached to the middle of the longer arc at an oblique angle; an acute angle is formed by the convex side of the short arc and half of the longer arc.

6. Skirt A (Fig. 36-1)

Skirt A looks like saturnalid ring but rarely one or two, concentric rows of pores are present inside the circular rim. The pores, if present, are subcircular to subpolygonal and equal in size.

7. Skirt B (Fig. 36-2)

Skirt B has a thick, circular rim at the margin, and

its diameter is narrower than other skirts figured here. The pores are circular to subcircular and the lattice bars vary from wide to narrow. Two or three rows of pores are usually preserved almost concentrically.

8. Skirt C (Fig. 36-3)

Skirt C differs from Skirt A only in having more than three, commonly three to five concentric rows mainly of subpolygonal pores. Concentricity of the pore arrangement is clearly recognizable on the flared brim.

9. Skirt D (Fig. 36-4)

Skirt D is very large and flat, and its margin is jagged and missing the marginal rim. The pores are small inside and rapidlly become large outward, no concentric arrangement observed. The shape of the pores is subcircular, oval, or subangular.

10. Skirt E (Fig. 36-10)

Skirt E is also very large and resembles Skirt D above, but is distinguished from the latter by having a zigzaged rim with numerous spines projecting outside. The spines are rod-like or flattened.

11. Skirt F (Fig. 36-9)

Skirt F is somewhat similar to Skirt C, but differs from the latter in being much flatter and lacking a thick rim at the margin. The pores are subangular, mostly subhexagonal, and rapidly increase in size towards the periphery. More than four concentric rows of pores are commonly preserved, but in stratigraphically younger assemblages only two or three rows are present.

12. Skirt G (Fig. 36-8)

Skirt G is relatively large and somewhat resembles Skirt E, but is distinguished from the latter by possessing nearly equal sized subcircular pores arranged in two to three indistinct concentric rows. The margin is gently zigzaged with rod-like spines variable in number and length. The longer spines direct more or less downward and some are curved inward.

13. Skirt H (Fig. 36-7)

Skirt H is similar to Skirt F from which it differs in having only a single row of subhexagonal to subrectangular or subsquare pores. Possible derivation of Skirt H is *Haeckelicyrtium breviora* sp. nov.

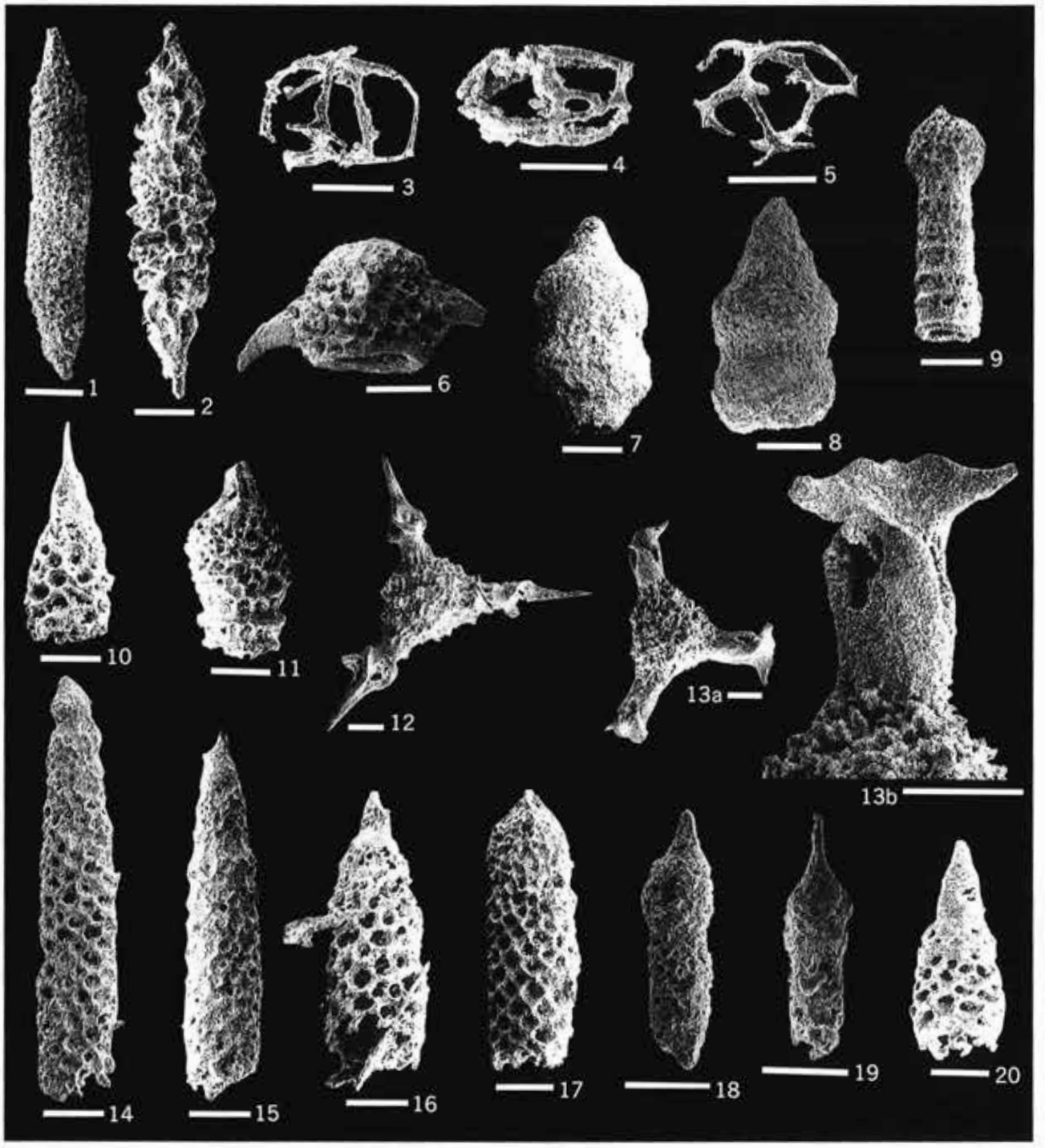
Description of new and some indeterminable taxa

Suprageneric assignment of the following taxa is beyond the scope of the present study. They are simply described in alphabetic order. Desctiptional terms of internal skeletal elements are given in Dumitrica (1991) and Sugiyama (1992). Illustrated specimens are deposited in the Department of Earth and Planetary Sciences, Graduate School of Science, Nagoya University.

Genus *Annulopoulpus* Kozur and Mostler, 1981

Type species: *Annulopoulpus costatus* Kozur and Mostler, 1981.

Fig. 37. 1. *Archaeospongoprunum messotriassicum* (Kozur and Mostler), ESN 148077, D-11, TR 2B. 2. *Busuanga* (?) *xyza* Sugiyama sp. nov., holotype, ESN 148078, O-5, TR 3B. 3-5. *Archaeosemantis lithocircites* Sugiyama sp. nov. 3: Paratype, ESN 148079, R-39, TR 5A, 4: Holotype, ESN 148003, R-40, TR 5B, 5: Paratype, ESN 148080, R-39, TR 5A. 6. *Annolopoulpus* sp. A, ESN 148081, Q-20, TR 6A. 7, 8. *Canesium* (?) *cucurbita* Sugiyama sp. nov. 7: Paratype, ESN 148082, R-14, TR 4B, 8: Holotype, ESN 148010, R-14, TR 4B. 9. *Bulbocyrtium dryites* Sugiyama gen. *et* sp. nov., holotype, ESN 148009, R-25, TR 4B. 10, 20. *Celluronta* (?) *conica* Sugiyama gen. *et* sp. nov. 10: Paratype, ESN 148083, L-12, TR 3A, 20: Holotype, ESN 148014, F-9, TR 3B. 11. *Bulbocyrtium* sp. A, ESN 148084, C-20, TR 3A. 12. *Capnuchosphaera oma* Sugiyama sp. nov., holotype, ESN 148012, HZ-2, TR 6B. 13a, b. *Capnuchosphaera sagaris* Sugiyama sp. nov., holotype, ESN 148013, Q-17, TR 5B. 14, 15. *Celluronta donax* Sugiyama gen. *et* sp. nov. 14: Holotype, ESN 148015, M-12, TR 2A, 15: Paratype, ESN 148085, M-11, TR 2A. 16. *Celluronta* sp. A, ESN 148086, M-5, TR 2B. 17. *Celluronta* sp. B, ESN 148087, M-4, TR 2B. 18, 19. *Celluronta* (?) *jovi* Sugiyama gen. *et* sp. nov. 18: Holotype, ESN 148017, E-1, TR 2A, 19: Paratype, ESN 148088, E-2, TR 2A. Scale bar=50 μm.


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Description: Internal skeleton composed of a short **MB** with four short apical spines and four longe basal spines. **MB** very eccentrically situated in the shell. Spherical lattice shell encloses closing the skeleton but apical spines extend outward as conical external spines. Basal spines incorporated with the shell in the middle to distal part with prominent curvature, whereas in the proximal part delicate bars connect the spines and shell. Pores of the shell oval to circular, pore frames oval or edged in cross section and incompletely developed in some specimens.

Remarks: This species is distinguished from other members of the genus in having a rather complete spherical shell. One can assign this species to other entactinarian genus such as *Polyentactinia* Foreman, but its curved skeleton is a characteristic feature of *Archaeosemantis*. For further comparison see the remarks in *Archaeosemantis lithocircites* sp. nov.

Dimensions (μm): Based on 18 specimens. Maximum diameter of shell 120–150 (holotype 125)

Type material: ESN 148002 (Fig. 39-4), H-65, TR 8A.

Range: Norian (TR 7 to 8A).

Etymology: From the Latin *globus* meaning a ball.

Archaeosemantis lithocircites Sugiyama sp. nov.
Figs. 37-3—5

Description: Completely preserved specimens are elliptical in with or without emphasized sagittal constriction; in the later morphotype the outline is more rounded. **MB** is short, each end of which has three or four spines; the two spines lying in the sagittall plane are thick, and form a rounded or polygonal sagittal ring. Number of shorter spines up to two, one from each end of **MB**, but in some specimens they are completely absent. The other spines extend laterally; in some cases they strongly curved in the middle and directly attached to the sagittal ring, in other cases secondary meshes are irregulary developed from the tips and connecting spines and the sagittal ring. In the former, secondary meshes may be present between spines and sagittal ring.

Remarks: This species is distinguished from *Archaeosemantis pterostephanus* by having a complete sagittal ring with the development of secondary meshes resulting from the fusing of spinules. However, it is very difficult to distinguish these two species if availavle specimens are poorly preserved. This species is very problematic because its skeletal features are identical to nassellarians, although *Archaeosemantis* has conventionally been regarded as a spumellarian or entactinarian. The lateral spines are fairly homologous with **D** and **Ax** (shorter spines) and **L** and **I** (longer spines).

Dimensions (μm): Based on 32 specimens. Maximum width of test 87–120 (holotype 100).

Type material: ESN 148003 (Fig. 37-4), R-40, TR 5B.

Range: Lower Carnian to upper Norian (TR 5A to 8B).

Etymology: For the similarity to the Cenozoic *Lithocircus* species.

Genus *Ayrtonius* Sugiyama gen. nov.

Etymology: Dedicated to the late Ayrton Senna, Brazilian F1 pilot, in honor of his great contribution to the diffusion of motor sports in Japan, masculine gender.

Type species: *Ayrtonius elizabethae* Sugiyama sp. nov. (by monotypy).

Range: Norian to Rhaetian as far as known.

Definition: Three-forked test with spongy wall and an aperture between two tubular feet. With or without an apical spine on tall cephalis. Internal skeleton not observed but two **L** incorporated with the upper wall of the foot inside the shell. Thorax occupies the upper part of the central triangular part of the test. Distinction of cephalis and thorax commonly difficult externally since collar stricure is very shallow or absent. Abdomen situated at the lower central part, frustum in shape with tubular feet attached just beside. Lumbar stricture is also indistinct externally but internal septum is well developed.

Remarks: This genus somewhat resembles *Livarella*, but differs in having nassellarian segmentation. It is also distinguished from *Bipedis* by having tubular feet. Nassellaria gen. and sp. indet. B described by Carter (1993) is probably a member of this new genus.

Ayrtonius elizabethae Sugiyama sp. nov.

Figs. 39-7—9

Description: Test as with genus, but in general apical spines is completely absent. Tubular foot curved inward at the middle and strictures between segments hardly recognized, so that the general shape of the test resembles the Cenozoic spongodiscid *Dictyocoryne*. Aperture is relatively small.

Remarks: This species is distinguished from Nassellaria gen. and sp. indet. B described by Carter (1993) by lacking an apical spines and having curved foot directed downward.

Dimensions (μm): Based on 15 specimens. Height of test 260-380 (holotype 275); Length of arm 125-240 (holotype 160); width at the base of test 180-330 (holotype 260).

Type material: ESN 148004 (Fig. 39-7), H-79, TR 8B.

Range: Norian (TR 8A to 8B).

Etymology: Named after Dr. Elizabeth S. Carter in honor of her great contribution to knowledge of Triassic and Jurassic radiolarians.

Genus *Bipedis* De Wever, 1982a

Type species: *Bipedis calvabovis* De Wever, 1982a (by monotypy).

Bipedis durus Sugiyama sp. nov.

Figs. 39-11a-c

Description: Cephalis imperforate, spherical to subspherical, possessing a long, three-bladed apical spine. The spine sometimes exhibits a slight sinistral torsion and has a tiny, needle-like tip. Collar stricture is shallow but marked externally. Thorax quadrate with basal tubular appendage. Detailed features of the thoracic surface not well observed, probably bumpy with scattered small pores. Divergent two feet are three-bladed.

Remarks: This species is distinguished from *Bipedis acrostylus* by having three-bladed apical spines and feet. It differs from *Bipedis horiae* sp. nov. in having quadrate thorax with a tubular appendage, and lesser numbers of pores on the thorax.

Dimensions (μm): Based on 10 specimens. Height of test 200-250 (holotype 210); length of apical spine 75-115 (holotype 85); of feet 50-80 (holotype 70); width of test at the base 200-250 (holotype 230).

Type material: ESN 148005 (Figs. 39-11a-c), HZ-12, TR 7.

Range: Norian (TR 7 to 8A).

Etymology: From the Latin *durus* meaning harsh.

Bipedis horiae Sugiyama sp. nov.

Figs. 28-7, 39-10

Bipedis sp. A., Hori, 1990, p. 581, figs. 8-12, 13.

Description: Cephalis subspherical and thorax triangular to subtriangular in lateral view. Detailed features of cephalic and thoracic surface not well understood, but it is certain that the thorax is pierced by numerous circular to subcircular pores irregularly arranged. Apical spine and two feet three-bladed with acute tip. Apical spine may be subvertical and feet more or less curved inward.

Remarks: This species is distinguished from *Bipedis calvabovis* by having much acute and slender apical spine and feet.

Dimensions (μm): Height of test 200-280 (holotype 215); length of apical spine 45-100 (holotype 58); of feet 70-100 (holotype 72); width of test at the base 165-240 (holotype 170).

Type material: ESN 148006 (Fig. 28-7), K-100, TR 9B.

Range: ? Sinemurian (TR 9B).

Etymology: Named after Dr. R. S. Hori in honor of her great contribution to knowledge of Jurassic radiolarians.

Bipedis sp. A

Fig. 39-15

Remarks: This species differs from *Bipedis horiae* sp. nov. in its much smaller size and conical cephalothorax.

Range: Hettangian to Sinemurian (JR 0A to 0B).

Bipedis sp. aff. *B. acrostylus* Bragin

Figs. 39-12, 14

Remarks: This species is distinguished from *Bipedis acrostylus* in having a more spherical cephalis and quadrate thorax with tubular appendage at the base.

Range: Norian (TR 8A to 8B).

Genus *Blomella* Sugiyama gen. nov.

Etymology: Named after Dr. C. D. Blome in honor of his great contribution to Triassic radiolarian study, feminine gender.

Type species: *Blomella megasphaera* sp. nov. (by monotypy).

Range: Upper Norian as far as known.

Definition: Spongy and thick cortex comprising a complex internal spicule; eccentrically situated **MB**, and four shorter and four longer rays. The rays often protrude the cortex as conical spines. The longer rays having one or more verticils of three or four beam-like spinules attached to the cortex. Secondary meshes developed between spinules which are recognized inside and often outside the cortex. They also develop between rays, spinules and cortex.

Remarks: One may assign the type species *Blomella megasphaera* to the genus *Polyentactinia* Foreman, 1963. However, it is certain that *B. megasphaera* is closely related to *Archaeosemantis gigas* sp. nov. In my present opinion it was evolved from *A. gigas* or its ancestral morphotype. Hence, the resemblance between *B. megasphaera* and *Polyentactinia* species is considered as homeomorph. This genus is externally similar to *Braginella* gen. nov., but differs in having a spicule system consisting of bar-centered eight rays rather than *Pseudostylosphaera*-type.

Blomella megasphaera Sugiyama sp. nov.

Figs. 39-16—18b

Description: Refer to the genus.

Remarks: Refer to the genus.

Dimensions (*μm*): Based on 25 specimens. Maximum diameter of cortex 200-290 (holotype 270); length of spine up to 120 (holotype 45).

Type material: ESN 148008 (Fig. 39-17), H-65, TR 8A.

Range: Norian (TR 8A to 8B).

Etymology: From the Greek *megas*, great, and *sphaira*, a ball.

Genus *Braginella* Sugiyama gen. nov.

Etymology: Named after Dr. N. Bragin in honor of his great contribution to Triassic radiolarian study, feminine gender.

Type species: *Pentactinosphaera rudis* Bragin, 1986.

Range: Norian to Rhaetian as far as known.

Definition: Spongy cortical shell similar to that of the genus *Blomella* gen. nov. It encloses the internal spicule whose features are identical to that of *Pseudostylosphaera*.

Remarks: As discussed by Dumitrica (1985) the microsphere of *Pentactinosphaera* Nagata and Nishimura in Nakaseko *et al.* (1983) is fundamentally different from that of *Pseudostylosphaera* because the former has only one apical ray extending from the center of **MB** and its basal rays do not directly attach the cortex. This genus differs from *Hexapylomella* Kozur and Mostler, 1979, that may also have a *Pseudostylosphaera*-type microsphere, in having spongy shell rather than latticed with pylome.

Braginella rudis (Bragin) comb. nov.

Figs. 39-19, 40-2—3b

Pentactinosphaera rudis Bragin, 1986, p. 69, pl. 1, fig. 14.

Remarks: See the generic remarks.

Range: Norian (TR 8A to 8B).

Genus *Bulbocyrtium* Kozur and Mostler, 1981

Type species: *Blubocyrtium reticulatum* Kozur and Mostler, 1981.

Bulbocyrtium dryites Sugiyama sp. nov.

Fig. 37-9

Description: Cephalis spherical, with rugged surface and a small apical spine, surrounded by small pores. Collar stricture marked by an abrupt change in contour. Thorax and subsequent segments nearly cylindrical, possess well developed circumferential ridges. One row of circular pores located below each circumferential ridge. Space between two circumferential ridges smooth.

Remarks: This species differs from other species of the genus in lacking flaring of the final segment, and in having more prominent circumferential ridges on the slender thorax and subsequent segment.

Dimensions (*in μm*): Based on four specimens. Height of test 175-200 (holotype 185); maximum width of cephalis 65-80 (holotype 68).

Type material: ESN 148009 (Fig. 37-9), R-25, TR

4B.

Range: Ladinian to Carnian (TR 4B).

Etymology: From the Greek *drys* meaning a tree.

Bulbocyrtium sp. A

Fig. 37-11

Yeharaia (?) sp. A., Yeh, 1990, p. 30, pl. 7, fig. 13, pl. 9, figs. 13, 18.

Remarks: This species is distinguished from *Bulbocyrtium dryites* by having much larger cephalis with a stout apical spine. This species also lacks flaring of the final segment.

Range: Anisian to lower Ladinian (TR 2B to 3A).

Genus *Busuanga* Yeh, 1990

Type species: *Busuanga chengi* Yeh, 1990.

Busuanga (?) *xyza* Sugiyama sp. nov.

Fig. 37-2

Radium ? sp., Sashida *et al.*, 1993, fig. 6-13.

? Multisegmented Nassellaria gen. et sp. indet., Sashida *et al.*, 1993, fig. 6-12.

Description: Spongy test elongated with two poles. It is widest at the equatorial part and gradually tapered to the conical polar part. There are two polar spines, one at each pole, and those are usually short and rod-like. Surface of the shell is rugged by distributuion of spherical to subspherical nodes, and pierced by small, circular pores.

Remarks: This species is tentatively assigned to *Busuanga* based on the similarity of the shell surface character. However, it may be a two-rayed hagiastrid spece is since its surface is also somewhat similar to those of hagiastrids.

Dimensions (μm): Based on seven specimens. Length of test, 285-340 (holotype 295); width of test, 60-85 (holotype 72).

Type material: ESN 148078 (Fig. 37-2), O-5, TR 3B.

Range: Ladinian (TR 3B to 4A).

Etymology: Named by an arbitrary combination of letters (ICZN, 1985, p. 199, Appendix D, pt. V, Recommendation 26).

Genus *Canesium* Blome, 1984

Type species: *Canesium lentum* Blome, 1984 (by monotypy).

Canesium (?) *cucurbita* Sugiyama sp. nov.

Figs. 37-7, 8

Description: Test gourd-shaped and covered by microgranular silica. Cephalis small and subspherical. Thorax frustum, wider than cephalis. Collar stricture indistinct externally. Abdomen and following segment subcylindrical to subspherical, nearly same shape. Lumber and third strictures marked by changes in contour. Aperture circular, rimmed by rised, or cylindrical appendage in some specimens. The pores are not well observed due to preservation and microgranular silica. All segments are internally partitioned one another by thick septa.

Remarks: The generic assignment is tentative. This species is distinguished from *Canesium lentum* by the shape of the shell, especially the large abdomen. It may be related to *Tricolocapsa* (?) *lacrima* sp. nov.

Dimensions (μm): Based on eight specimens. Height of test 150-220 (holotype 185); maximum width of test 80-110 (holotype 102).

Type material: ESN 148010 (Fig. 37-8), R-14, TR 4B.

Range: Ladinian to Carnian (TR 4B to 5B)

Etymology: From the Latin *cucurbita* meaning a gourd.

Genus *Cantalum* Pessagno, 1979

Type species: *Cantalum holdsworthi* Pessagno, 1979

Cantalum (?) sp. A

Fig. 40-1

Remarks: This speceis differs from *Cantalum* (?) sp. B in having straight spines. The generic assignment is tentative since pantanellid pore frames are not clear.

Range: Norian (TR 8A).

Cantalum (?) sp. B

Fig. 40-4

Remarks: This speceis resembles the type species of the genus, from which it is distinguished by having much stronger torsion on the spines and lacking pantanellid pore frames.

Range: Norian (TR 8A to 8C).

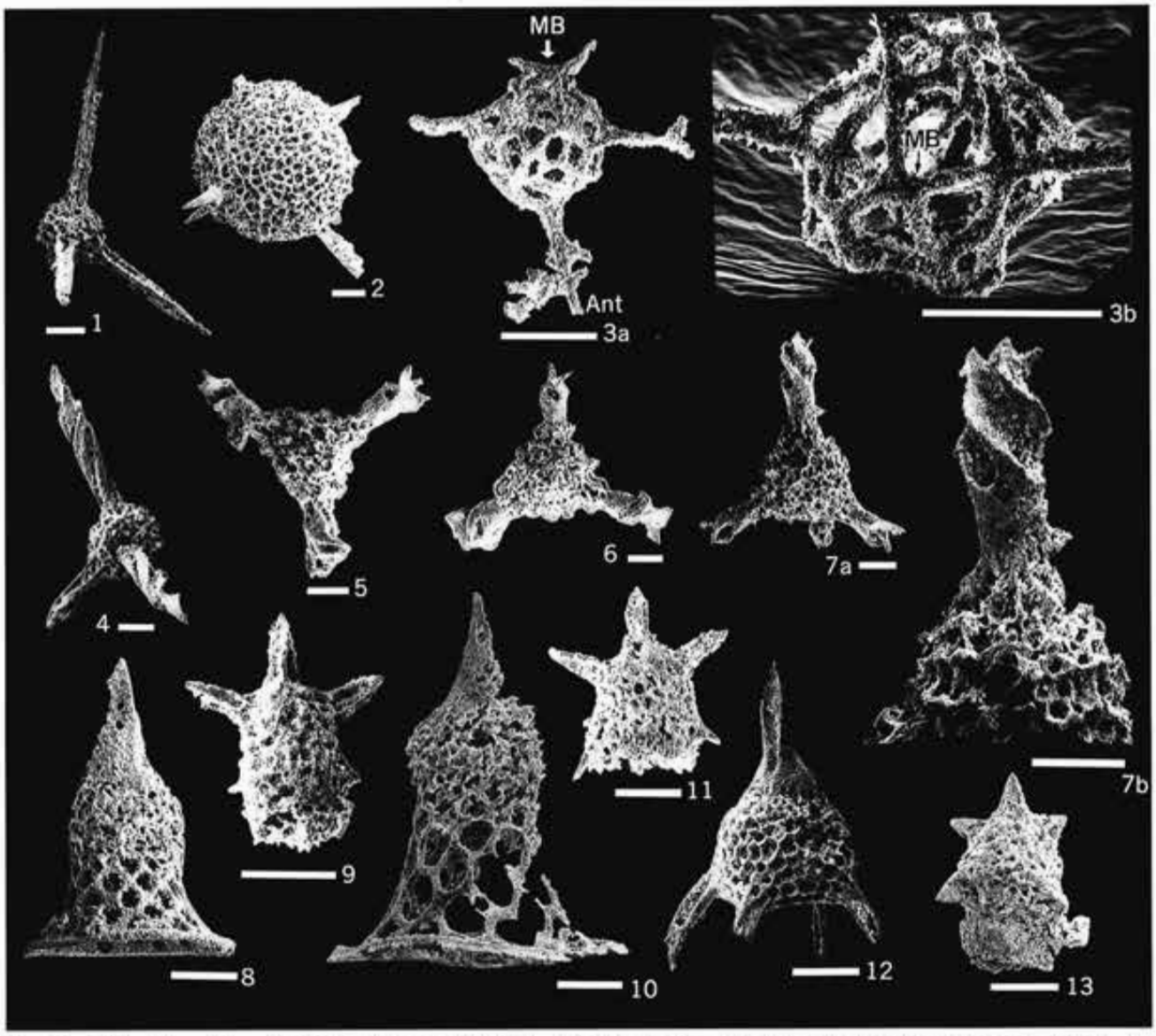


Fig. 40. 1. *Cantalum* (?) sp. A, ESN 148215, H-33, TR 8A. 2-3b. *Braginella rudis* (Bragin). 2: ESN 148216, H-65, TR 8B, 3a, b: Inner microsphere, ESN 148217, H-65, TR 8A. **MB**=median bar. **Ant**=antapical ray. 4. *Cantalum* (?) sp. B, ESN 148218, H-33, TR 8A. 5-7b. *Capnuchosphaera neosagaris* Sugiyama sp. nov. 5: Paratype, ESN 148219, H-36, TR 8A, 6: Paratype, ESN 148220, H-72, TR 8A, 7a, b: Holotype, ESN 148011, H-35, TR 8A. 8, 10. *Dreyericyrtium ithacanthum* Sugiyama sp. nov. 8: Holotype, ESN 148019, K-41, TR 8C, 10: Paratype, ESN 148220, P-14, TR 8D. 9, 11, 13. *Dumitricaella* (?) *parva* Sugiyama sp. nov. 9: Holotype, ESN 148016, H-31, TR 8A, 11: Paratype, ESN 148221, H-23, TR 7, 13: Paratype, ESN 148222, HZ-10, TR 7. 12. *Farcus* sp. A, ESN 148223, K-103, JR 0B. Scale bar=50 μm.

Genus *Capnuchosphaera* De Wever, 1979

Type species: *Capnuchosphaera triassica* De Wever, 1979.

Capnuchosphaera neosagaris Sugiyama sp. nov.

Figs. 40-5—7b

Description: Cortical shell subtriangular to triangular in outline, nodose, pierced by small pores. Tumidaspinae long but spinal shafts completely absent. Spinal tumors, as long as spinal tunnels, display strong sinistral torsion, composed of wider grooves and narrower and acute ridges. Tumors end in small, triangular projection directed slightly outward.

Remarks: The general features of the test including tumidaspinae closely resemble *Capnuchosphaera sagaris* sp. nov. from which it differs in having tumidaspinae whose ends are not prominently divergent. Moreover, torsion of spines of this species is stronger than *C. sagaris*.

Dimensions (*μm*): Based on 21 specimens. Maximum diameter of cortex 115-165 (holotype 130); length of spine 90-130 (holotype 128).

Type material: ESN 148011 (Figs. 40-7a, b), H-35, TR 8A.

Range: Upper Norian (TR 8A to 8B).

Etymology: From the Greek *neos*, new, and species name *sagaris*.

Capnuchosphaera oma Sugiyama sp. nov.

Fig. 37-12

Description: Cortical shell triangular to subtriangular in outline, more or less lenticular, bumpy, pierced by small pores. Tumidaspinae robust; spinal tunnels short, spinal tumors displaying sinistral torsion, spinal shafts very long.

Remarks: This species resembles *Capnuchosphaera mexicana* Pessagno, 1979, from which it is distinguished by having a triangular to subtriangular, lenticular and bumpy cortical shell. It differs from *C. triassica* and *C. deweveri* in having sinistral rather than dextral torsion on the tumidaspinae.

Dimensions (*μm*): Based on seven specimens. Maximum diameter of cortex 120-170 (holotype 165); length of spine 130-190 (holotype 155).

Type material: ESN 148012 (Fig. 37-12), HZ-2, TR 6B.

Range: Lower Norian (TR 6A to 6B).

Etymology: From the Greek *omos* meaning crude.

Capnuchosphaera sagaris Sugiyama sp. nov.

Figs. 37-13a, b

Capnuchosphaera (?) sp., Yoshida, 1986, p. 13, figs. 1, 2 (*non* 3).

Description: Cortical shell subtriangular to triangular in outline, nodose, pierced by small pores. Tumidaspinae long and stout, spinal shafts completely absent. Spinal tumors are short, approximately half the length of the spinal tunnels, composed of wider grooves and narrower and acute ridges and displaying strong sinistral torsion. Tumors ends are wide and laterally divergent to form a funnel-like outline with undulated distal ridges.

Remarks: This species is distinguished from other species of the genus by its funnnel-shaped spinal tumors with strong sinistral torsion without spinal shaft.

Dimensions (*μm*): Based on five specimens. Maximum diameter of cortex 115-165 (holotype 135); length of spine 70-110 (holotype 100).

Type material: ESN 148013 (Figs. 37-13a, b), Q-17, TR 5B.

Range: Carnian (TR 5B).

Etymology: From the Greek *sagaris* meaning a weapon.

Genus *Celluronta* Sugiyama gen. nov.

Etymology: Named by an anagram of the genus *Cornutella* Ehrenberg, 1838, feminine gender.

Type species: *Celluronta donax* Sugiyama sp. nov. (by monotypy).

Range: Anisian to Ladinian (?) as far as known.

Definition: Test long with more than two segments. The details of the internal shell structure are not known. Cephalis imperforate, subspherical to bulbous, having more or less rugged surface, and with or without apical and ventral spines. Collar stricture may be pronounced but other strictures are not prominent, so that the distinction between thorax and subsequent segments is difficult. Final segment is characteristically long and porous, with or without undurations. Pores are large and set in various shaped, mainly subcircular to angular, thick frames.

Remarks: This genus differs from *Zevius* Sugiyama in having a longer test with thicker pore frames on the last segment. *Cornutella* has a very small cephalis in which there is no spicule system. The cephalis of *Celluronta* gen. nov. is much larger than that of *Cornutella*.

Celluronta (?) *conica* Sugiyama sp. nov.

Figs. 37-10, 20

Description: Test relatively short. Cephalis conical to dome-shaped, imperforated, with a thin, needle-like apical spine on the apex. Collar stricture marked

by a change in contour, and another stricture indistinct. Thorax or thoracoabdomen elongated frustum in outline, longer than wide, wider and longer than cephalis, having wall similar to *Celluronta donax* sp. nov.

Remarks: Since the interior side of the shell has not been observed yet, it is uncertain whether the post-cephalic segment is composed only of a thorax or a thorax plus abdomen. This species is distinguished from *Celluronta donax* sp. nov. by having a shorter test, slender cephalis with a needle-like apical spine on the apex, and also shorter and wider post-cephalic segment or segments. The generic assignment remains uncertain because the relationship with the type species is not known.

Dimensions (μm): Based on 12 specimens. Length of apical spine up to 50 (holotype 15); height of cephalis 35-50 (holotype 45); maximum width of test 70-90 (holotype 78).

Type material: ESN 148014 (Fig. 37-20), F-9, TR 3B.

Range: Upper Anisian to Ladinian (TR 3A to 3B).

Etymology: From the Greek *konikos* meaning cone-shaped.

Celluronta donax Sugiyama sp. nov.
Figs. 37-14, 15

Description: Test as with genus, very long and slender. Cephalis subspherical, slightly rugged, and imperforated. Apical and ventral spines present or absent. Collar stricture marked by a change in contour. Post-cephalic segments porous and consist probably of a barrel-like thorax and more than two post-thoracic segments forming a long, nearly cylindrical outline. Strictures between segments indistinct.

Remarks: This species is compared to *Celluronta* (?) *conica* sp. nov. and *C.* sp. A under the latter species.

Dimensions (μm): Based on 10 specimens. Width of cephalis 33-43 (holotype 35); length of test as far as preserved 200-390 (holotype 335).

Type material: ESN 148015 (Fig. 37-14), M-12, TR 2A.

Range: Anisian (TR 2A to 2B).

Etymology: From the Latin *donax* meaning a pipe.

Celluronta (?) *jovi* Sugiyama sp. nov.
Figs. 37-18, 19

Description: Cephalis conicaloval in outline, imperforate, with a short, conical apical spine. Post-cephalic segment cylindrical without constrictions, narrower than cephalis, pierced by small, irregularly arranged pores.

Remarks: This species is tentatively assigned to *Celluronta* gen. nov. based on the similarity of the general outline to *C.* sp. B.

Dimensions (μm): Based on 10 specimens. Width of cephalis 25-35 (holotype 33); length of test as far as preserved 90-130 (holotype 110).

Type material: ESN 148017 (Fig. 37-18), E-1, TR 2A.

Range: Lower Anisian (TR 2A).

Etymology: Named by an arbitrary combination of letters (ICZN, 1985, p. 199, Appendix D, pt. V, Recommendation 26).

Celluronta sp. A
Fig. 37-16

Remarks: This species is distinguished from *Cellyronta donax* sp. nov. in having a wider test with a bladed apical spine.

Range: Anisian (TR 2B).

Celluronta sp. B
Fig. 37-17

Remarks: This species is distinguished from *Celluronta* sp. A in having a larger cephalis with reticulated ridges.

Range: Anisian (TR 2B).

Genus *Corum* Blome, 1984

Type species: *Corum speciosum* Blome, 1984.

Remarks: Prior to Blome (1984), Kozur (1984) established the genus *Whalenella* with the type species *Dictyomitra arrecta* Hinde and considered that *D. arrecta* and *Triassocampe* (?) sp. E of Yao (1982) are synonymous. If so, the genus *Corum* should become a junior synonym of *Whalenella*. It is, however, quite difficult to judge exactly whether *D. arrecta* and *T.* (?) sp. E are one and the same species or not. Therefore, it is profitable for subsequent investigators

to consider that the genus *Whalenella* is a *nomen dubium*.

Corum (*?*) *delgado* Sugiyama sp. nov.
Figs. 41-1, 2

Triassocampe (?) sp. E, Yao, 1982, pl. 2, fig. 11 (*non* fig. 12).

Description: Test relatively slender, consisting commonly of more than five segments. Cephalis small, subconical to subhemispherical and imperforate. Post-cephalic segments barrel-shaped, almost same size, with small pores between longitudinal costae. The distribution of pores on the post-cephalic segments is very variable; in some cases pores are arranged in almost longitudinal rows and in other cases they are scattered. Longitudinal costae discontinuous, developed on all segments including the cephalis. Collar stricture indistinct, subsequent strictures are deep.

Remarks: This species is distinguished from hitherto known species of *Corum* by its slender shaped test and having costae even on the cephalis, and also by possessing numerous pores between costae.

Dimensions (μm): Based on 33 specimens. Length of test 180-240 (holotype 205); maximum width of test 62-88 (holotype 72).

Type material: ESN 148018 (Fig. 41-1), R-31, TR 4B.

Range: Carnian (TR 4B to 5B).

Etymology: From the Spanish *delgado* meaning slender.

Corum (?) sp. A
Fig. 41-3

(?) *Triassocampe* (?) sp. D, Yao, 1982, pl. 1, fig. 6.

Remarks: The general shape of the test is similar to *Triassocampe* species. However, the surface of post-thoracic segments is nodose and circumferential ridges are absent. Pore are not well observed, but at least one row of small, subcircular pores is present in each post-thoracic segment. This species is tentatively assigned to Corum but may be an ancestral species of the genus *Multimonilis* Yeh.

Range: Ladinian to Carnian (TR 4A to 5B).

Genus *Deflandrecyrtium* Kozur and Mostler, 1979

Type species: *Deflandrecyrtium popofskyi* Kozur and Mostler, 1979.

Remarks: See generic remarks of *Dreyericyrtium* Kozur and Mostler below.

Deflandrecyrtium sp. A
Fig. 41-6

Remarks: Test possibly with four segments; an imperforated cephalis and thorax, perforate abdomen, and the fourth segment with a narrow skirt. This species is similar to the type species, but differs in having the final segment wider than abdomen.

Range: Carnian (TR 5A).

Genus *Dictyomitrella* Haeckel, 1887

Type species: *Eucyrtidium articulatum* Ehrenberg, 1873.

Dictyomitrella sp. C
Figs. 43-4, 5

Dictyomitrella sp. C, Yao, 1982, pl. 4, figs. 12, 13; Hori, 1990, p. 581, fig. 8-8.

Remarks: More than 20 specimens were obtained, but they do not retain original pore feature due to preservation. This species is similar to *Proparvicingula moniliformis* Carter, 1993, but the relationship is uncertain.

Range: Hettangian to Sinemurian (JR 0A to 0B).

Genus *Dreyericyrtium* Kozur and Mostler, 1979

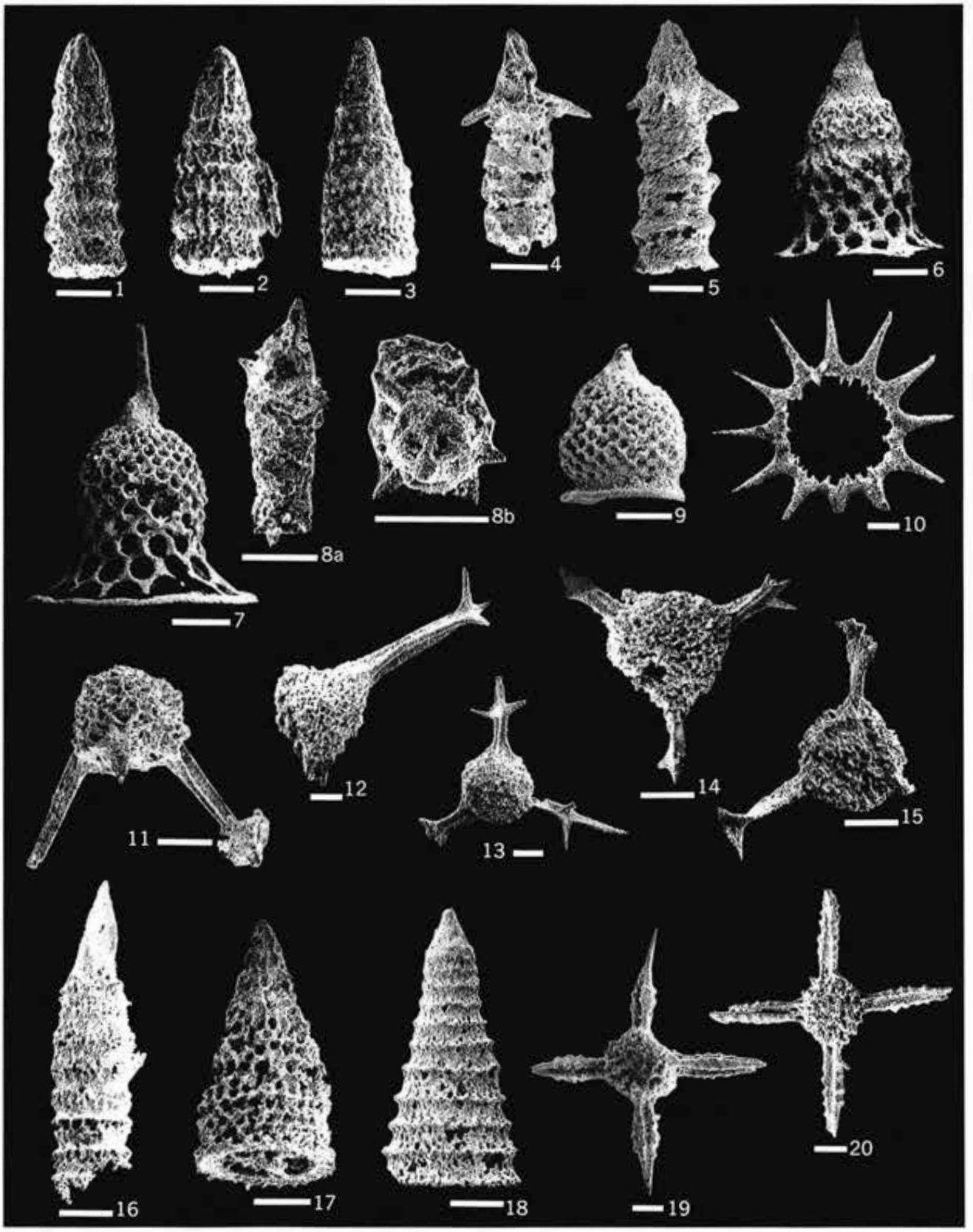
Type species: *Dreyericyrtium curvatum* Kozur and Mostler, 1979.

Remarks: Kozur and Mostler (1981) synonymized this genus and *Deflandrecyrtium*. However, the type species of the latter is probably four-segmented as well as above *Deflandrecyrtium* sp. A. I consider that the name *Dreyericyrtium* should be retained to include two-segmented nassellarians with globular upper and flared lower thorax. Further investigation on the type species is necessary to solve this problem.

Dreyericyrtium ithacanthum Sugiyama sp. nov.
Figs. 40-8, 10

Dreyericyrtium (?) sp., Yoshida, 1986, pl. 8, figs. 5, 6.

(?) *Deflandrecyrtium* sp. A, Hori, 1990, p. 581, fig. 8-1.


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Description: Cephalis subspherical, with a long, three-bladed apical spine without torsion. Cephalis may be fenestrated at the base of grooves of apical spine, but otherwise is imperforate. Collar stricture marked by a gentle change in contour. Upper thorax globular to slightly elongate, composed of spongy mesh. Lower thorax strongly flared, consisting of bars oval shaped in cross section, with circular to subcircular pores. Constriction between the upper and lower thorax shallow, marked by a gentle change in contour; constricted part always narrower than maximum width of the upper thorax. Skirt margin rimmed by a thick ring.

Remarks: This species is a direct ancestor of *Dreyericyrtium carterae* (Yeh and Cheng), from which it is distinguished by lacking torsion on the spine. Moreover, the thorax of this species is much narrower than that of *D. carterae*.

Dimensions (*in* μm): Based on 22 specimens. Length of test 190-280 (holotype 205); width of skirt 145-230 (holotype 152).

Type material: ESN 148019 (Fig. 40-8), K-41, TR 8C.

Range: Norian to Rhaetian (TR 8A to 8D).

Etymology: From the Greek *ithys*, straight, and *akantha*, a thorn.

Dreyericyrtium virgispineum Sugiyama sp. nov.
Fig. 41-7

Squinabolella (?) sp. B, Yao, 1982, pl. 2, fig. 20.

Description: Cephalis subspherical, imperforate, with a long, rod-like apical spine. Collar stricture marked by a sharp change in contour. Upper thorax globular, with nodes developed at the junction of lattice bars; pores subcircular to subhexagonal, longitudinally aligned and quincuncially arranged. Lower thorax strongly flared, consisting of large hexagonal pore frames. Constriction between the upper and lower thorax shallow, marked by a gentle change in contour, but the constricted part is slightly narrower than the maximum width of the upper thorax, whereas the skirt margin is much wider and rimmed by a thick ring.

Remarks: This species is distinguished from *Dreyericyrtium curvatum* by having a rod-like, straight apical spine rather than three-bladed, curved one.

Dimensions (*in* μm): Based on five specimens. Length of test 200-250 (holotype 230); width of skirt 185-235 (holotype 200).

Type material: ESN 148021 (Fig. 41-7), Q-25, TR 6A.

Range: Carnian to Norian (TR 6A to 6B).

Etymology: From the Latin *virga*, a twig, and *spineus*, thorny.

Genus *Dumitricaella* De Wever, 1982a

Type species: *Dumitricaella pauliani* De Wever, 1982a.

Dumitricaella (?) *parva* Sugiyama sp. nov.
Figs. 40-9, 11, 13

Nassellaria A, Yoshida, 1986, pl. 5, figs. 7-9.

Description: Test small, composed of porous cephalis and thorax. Cephalis subspherical, with three, three-bladed spines. Center of the three spines vertical and always well developed but other two obliquely directed are variable from conical to rod-like. Collar stricture indistinct externally, from which arise at

Fig. 41. 1, 2. *Corum* (?) *delgado* Sugiyama sp. nov. 1: Holotype, ESN 148018, R-31, TR 4B, 2: Paratype, ESN 148089, R-15, TR 5A. 3. *Corum* (?) sp. A, ESN 148090, R-15, TR 5A. 4, 5. *Enoplocampe yehae* Sugiyama gen. *et* sp. nov. 4: Paratype, ESN 148091, R-42, TR 5B, 5: Holotype, ESN 148022, Q-11, TR 5B. 6. *Deflandrecyrtium* sp. A, ESN 148092, R-17, TR 5A. 7. *Dreyericyrtium virgispineum* Sugiyama sp. nov., holotype, ESN 148021, Q-25, TR 6A. 8a, b. *Foremanellina* sp. A, ESN 148093, M-3, TR 2B. 9. *Haeckelicyrtium* sp. A, ESN 148094, Q-24, TR 6A. 10. *Hungarosaturnalis* sp. A, ESN 148095, R-15, TR 5A. 11. *Hozmadia* (?) sp. A, ESN 148096, R-40, TR 5B. 12. *Kahlerosphaera* sp. D, ESN 148027, HZ-7, TR 6B. 13. *Kahlerosphaera* sp. A, ESN 148097, R-40, TR 5B. 14. *Kahlerosphaera* sp. B, ESN 148098, Q-18, TR 5B. 15. *Kahlerosphaera* sp. C, ESN 148099, Q-17, TR 5B. 16. *Ladinocampe* sp. A, ESN 148100, F-4, TR 3A. 17. *Laxtorum* (?) *carnicum* Sugiyama sp. nov., holotype, ESN 148028, R-22, TR 5B. 18. *Multimonilis japonicus* Sugiyama sp. nov., holotype, ESN 148032, N-5, TR 5B. 19, 20. *Muelleritortis cive* Sugiyama sp. nov. 19: Holotype, ESN 148031, R-15, TR 5A, 20: Paratype, ESN 148101, R-35, TR 5A. Scale bar=50 μm.

least two feet that do not fuse with the shell wall; feet vary from conical to rod-like. Length of thorax unknown as most specimens appear to be incomplete. is variable, which is probably due to preservation bias.

Remarks: Well preserved specimens have not been obtained yet, but the characteristic outline of the test permit the establishment of this new species. This species resembles *Dumitricaella* sp. 1 of De Wever (1982a) but their phylogenetic relationship is uncertain.

Dimensions (μm): Based on 15 specimens. Height of test including spine 90-145 (holotype 92); width of test including spine 70-140 (holotype 77).

Type material: ESN 148016 (Fig. 40-9), H-31, TR 8A.

Range: Norian (TR 7 to 8A).

Etymology: From the Latin *parvus* meaning small.

Genus *Enoplocampe* Sugiyama gen. nov.

Etymology: From the Greek *enoplos*, armed, and *kampe*, caterpillar, feminine gender.

Type species: *Enoplocampe yehae* Sugiyama sp. nov. (by monotypy).

Range: Carnian as far as known.

Definition: Multisegmented nassellarian whose test is composed of spherical to subspherical cephalis and barrel-shaped, porous post-cephalic segments which gradually increase in diameter. Apical spine conical and three-bladed. Three arms extending from thorax, proximally bladed and tapering distally to a point.

Remarks: This genus is similar to *Triassocampe* but it differs in having three arms attached to the thorax. It is distinguished from *Zevius*, especially *Z. peraramatus* Sugiyama, by having a stout bladed apical spine and arms. The upper ridges of the arms attached to collar are probably extensions of **D** and two **L**.

Enoplocampe yehae Sugiyama sp. nov.

Figs. 41-4, 5

Nassellaria indet. gen. B sp. A, Yeh, 1990, p. 30, pl. 8, figs. 11, 16, 17, pl. 10, fig. 13.

Description: Test as with genus; circumferential ridges absent and a single row of primary pores situated on the boundary between segments.

Remarks: Refer to the genus.

Dimensions (μm): Based on 32 specimens. Length of test 190-240 (holotype 215); width of test including arm 100-130 (holotype 105).

Type material: ESN 148022 (Fig. 41-5), Q-11, TR 5B.

Range: Upper Carnian (TR 5B to 6A).

Etymology: Named after Dr. Kuei-yu Yeh who first reported the occurrence of this species and contributed to the knowledge of Triassic radiolarians.

Genus *Farcus* Pessagno, Whalen and Yeh, 1986

Type species: *Farcus graylockensis* Pessagno, Whalen and Yeh, 1986.

Farcus sp. A

Fig. 40-12

Remarks: This specesis is similar to *Farcus kozuri* Yeh, but lacks transverse ridges on the thorax. Also, it differs from *F. lepidus* Yeh in having feet that are attached to the aperture.

Range: Sinemurian (JR 0B).

Genus *Foremanellina* Dumitrica, 1982b

Type species: *Foremanellina helenae* Dumitrica, 1982b.

Foremanellina sp. A

Figs. 41-8a, b

Zevius sp., Matsuoka *et al.*, 1994, pl. 1, fig. 10.

Remarks: This species is similar to *Foremanellina helenae* and *F. macrocephala* Dumitrica from which it is distinguished by its low-positioned **V** that is directed nearly horizontally, and also by the large and expanded thorax.

Range: Anisian (TR 2B to 2C).

Genus *Haeckelicyrtium* Kozur and Mostler, 1979

Type species: *Haeckelicyrtium austriacum* Kozur and Mostler, 1979.

Remarks: Kozur and Mostler (1979) established *Haeckelicyrtium* as a three-segmented, hat-shaped nassellarian genus. However, the type species is apparently two-segmented judging from the original illustration. Carter (1993) assigned Rhaetian three-segmented hat-shaped nassellarians to *Haeckelicyr-*

tium, whereas two-segmented ones to *Squinabolella* Pessagno, 1969. In this study, all hat-shaped Triassic nassellarians, which belong to neither *Deflandrecyrtium* nor *Dreyericyrtium*, are assigned to *Haeckelicyrtium*. Hori (1992) revealed that hat-shaped nassellarians disappear at the end of the Triassic, which is also confirmed by the present study. Recently, Yao (1997) illustrated more than 700 species from the Lower and Middle Jurassic maganese carbonate nodules which contain considerably well preserved and diverse radiolarian assemblages. However there are no hat-shaped nassellarians assignable to *Hackelicyrtium* or *Squinabolella* in Yao's (1977) materials. This supports the result of Hori (1992) and this stydy. Therefore, it is not appropriate phylogenetically to include Triassic hat-shaped nassellarians to *Squinabolella* whose type species is from the Upper Cretaceous. Morphologic similarities between Triassic hat-shaped nassellarians and *Squinabolella* must be considered as homeomorph. Pessagno (1969) mentioned that development of the thoracic velum is one of the important features of *Squinabolella*. However, this feature is not so important for genus level since taxa with flared final segment often have the velum as morphologic variation below genus level (e.g., Cenozoic theoperid *Cycladophora* Ehrenberg, 1872, and lophophaenid *Antarctissa* Petrushevskaya, 1967).

Haeckelicyrtium breviora Sugiyama sp. nov.
Figs. 42-5—8

Squinabolella (?) sp. C, Yao, 1982, pl. 3, fig. 8; Hori, 1990, p. 581, fig. 8-2.

Squinabolella sp. D, Carter, 1993, p. 103, pl. 17, fig. 8.

Description: Cephalis small, spherical, imperforate, with a rod-like apical spine in well preserved specimens. Thorax hemispherical, with a delicate velum at the base; pores mainly subhexagonal to hexagonal, regularly aligned in horizontal rows and quincuncially arranged in the lower thorax; bars relatively thick, forming hexagonal pore frames, often bearing nodes at the junctions especially in the upper part. Thoracic wall developed in a small scale beneath the skirt, extending as a velum at the base. The skirt relatively narrow, having one or rarely two rows of subcircular, subrectangular or subhexagonal pores. Triangular spines more or less developed laterally around the margin of the skirt.

Remarks: This species is distinguished from *Haeckelicyrtium takemurai* Yeh and Cheng by having a much narrower skirt.

Dimensions (μm): Based on 41 specimens. Length of test including spine 170-220 (holotype 210); width of skirt 210-430 (holotype 238).

Type material: ESN 148023 (Fig. 42-5), P-17, TR 8D.

Range: Rhaetian (TR 8D).

Etymology: From the Latin *brevis*, short, and, *ora*, a margin.

Haeckelicyrtium teren Sugiyama sp. nov.
Figs. 42-2—4, 9

Dreyericyrtium (?) sp. B. Yoshida, 1986, p. 18, pl. 8, figs. 3, 4.

Description: Cephalis small, spherical, imperforate, with a rod-like apical spine which is sometime long. Thorax hemispherical, commonly short; surface usually covered by microgranular silica especially in upper part; pores subhexagonal to subcircular enclosed by hexagonal pore frames, regularly aligned in horizontal rows and quincuncially arranged in the lower thorax; bars thin, oval in cross section. Development of thoracic velum not confirmed due to the preservation, but it appears the thoracic margin is present beneath the skirt which is flattened frustum from lateral view. There are more than four concentric rows of circular pores which are nearly same size. Margin of the skirt rimmed by a thick ring bounded by a single ridge.

Remarks: This species is distinguished from *Haeckelicyrtium takemurai* Yeh and Cheng by having a thick rim at the margin of the skirt. This species resembles *Haeckelicyrtium desrochersi* (Carter) from which it differs in having much smaller pores on the thoracic skirt that is rimmed by a thick ring bounded by a single ridge rather than double.

Dimensions (μm): Based on 15 specimens. Length of test including spine 100-160 (holotype 120); width of skirt 255-360 (holotype 255).

Type material: ESN 148025 (Fig. 42-2), H-68, TR 8A.

Range: Norian (TR 8A to 8B).

Etymology: From the Greek *teren* meaning smooth.

Haeckelicyrtium sp. A

Fig. 41-9

Squinablella (?) sp. A, Yao, 1982, pl. 2, fig. 19.

Unnamed nassellaria, Yeh and Cheng, 1996, pl. 11, figs. 1, 2, 12, 14, 15.

Remarks: There are no individuals possessing an apical spine. It is uncertain whether the absent is original or due to preservation.

Range: Carnian t Norian (6A).

Haeckelicyrtium sp. B

Fig. 42-1

Remarks: The general shape is similar to *Haeckelicyrtium teren* sp. nov., from which it differs in having much narrower skirt. This species lacks thoracic velum.

Range: Norian (TR 8A).

Genus *Hagiastrum* Haeckel, 1881,
emend. Baumgartner, 1980

Type species: *Hagiastrum plenum* Rüst, 1885.

Hagiastrum (?) *pacificum* Sugiyama sp. nov.

Figs. 43-1, 2

Pseudohagiastrum ? sp. A, Carter, 1993, p. 89, pl. 12, fig. 5.

Hagiastridae gen. et sp. indet A, Yeh and Cheng, 1996, p. 10, pl. 1, figs. 2, 6, 9.

Hagiastridae gen. et sp. indet B, Yeh and Cheng, 1996, p. 10, pl. 1, figs. 3, 4, 12, 13.

Description: Very large test consisteng of small central area and four coplanar rays. Length of the rays attains more than three times diameter of the central area. The rays keep an almost equal diameter, and the distal ends lack spines. Pores small and iiregularly arranged.

Remarks: Yeh and Cheng (1996) recognized two forms based on the arrangement of the pores. How-

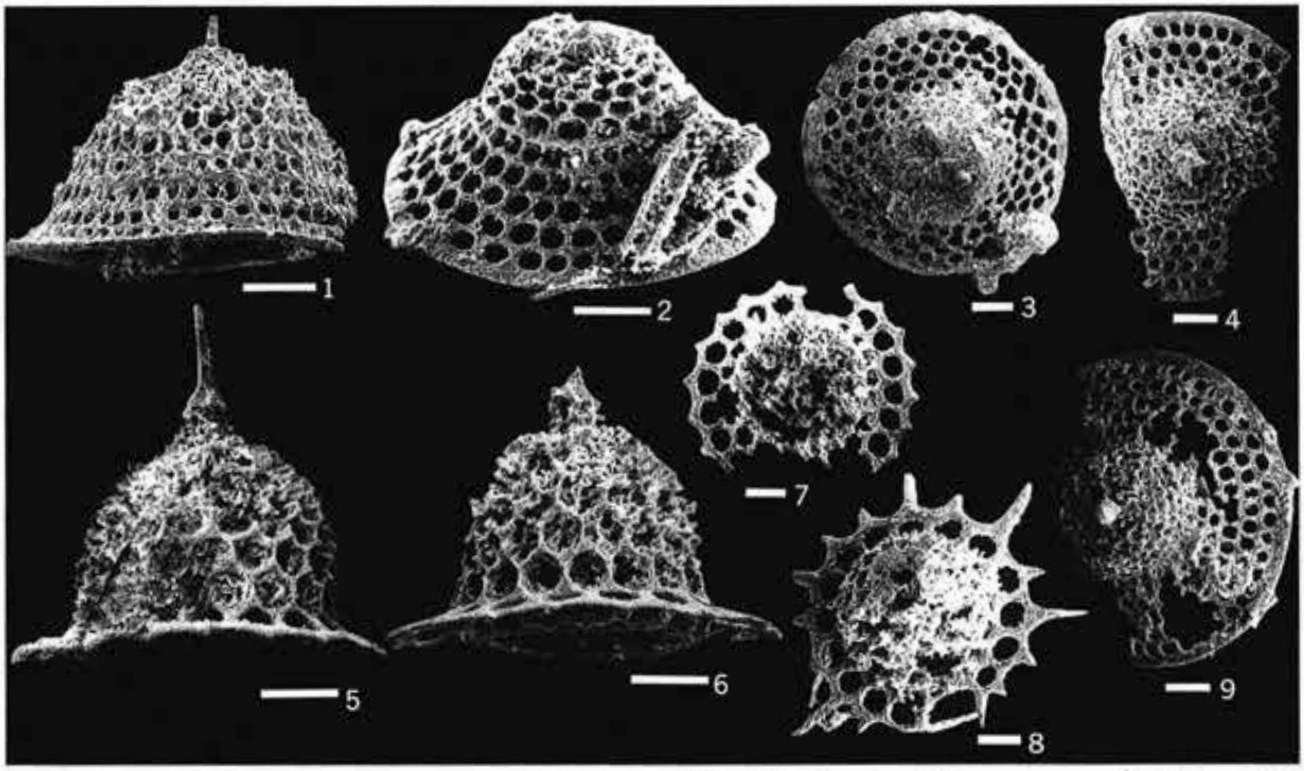


Fig. 42. 1. *Haeckelicyrtium* sp. B, ESN 148224, H-5, TR 8A. 2-4, 9. *Haeckelicyrtium teren* Sugiyama sp. nov. 2: Holotype, ESN 148025, H-68, TR 8A, 3: Paratype, ESN 148225, H-33, TR 8A, 4: Paratype, ESN 148226, H-33, TR 8A, 9: Paratype, ESN 148227, H-33, TR 8A. 5-8. *Haeckelicyrtium breviora* Sugiyama sp. nov. 5: Holotype, ESN 148023, P-17, TR 8D, 6: Paratype, ESN 148228, K-68, TR 8D, 7: Paratype, ESN 148229, K-68, TR 8D, 8: Paratype, ESN 148230, P-14, TR 8D. Scale bar=50 μm.

ever this is considered only as speceis variation. This species resembles *Pseudohagiastrum* ? *tasuense* Carter, from wihch it differs in lacking spines at the end of the rays.

Dimensions (μm): Based on 15 specimens. Length of rays up to 380 (holotype 378).

Type material: ESN 148232 (Fig. 43-2), K-47, TR 8C.

Range: Norian to Rhaetin (TR 8A to 8C).

Etymology: Based on the occurrences in the circum-Pacific region.

Genus *Hozmadia* Dumitrica, Kozur and Mostler, 1980

Type species: *H. reticulata* Dumitrica, Kozur and Mostler (by monotypy).

Hozmadia spinifera Sugiyama sp. nov.

Figs. 44-1, 2

Saitoum ? sp., Yao *et al.*, 1980, pl. 1, fig. 8.

Poulpus nakasekoi Sugiyama; Matsuoka *et al.*, 1994, pl. 1, fig. 13.

Description: Test as with genus but relatively small. Cephalis hemispherical to subhemispherical, having a three bladed apical spine bearing three branches within the interval between the proximal third and half. Each foot also has a verticil of three branches in the proximal part.

Remarks: This species is distinguished from other members of the genus in having branches on the apical spine and feet. This species resembles co-occuring *Neopylentonema nakasekoi* (Sugiyama), but is larger, has a thick rim at the base of the cephalis, and lacks protrusion of two **I** and **V** outside the cephalis.

Dimensions (μm): Based on 12 specimens. Length of apical spine 50-150 (holotype 100); of cephalis 85-105 (holotype 87); of feet 50-120 (holotype 67).

Type material: ESN 148026 (Fig. 44-2), C-2, TR 2C.

Range: Anisian (TR 2A to 3A).

Etymology: From the Latin *spinifer* for bearing thorns.

Hozmadia (?) sp. A

Fig. 41-11

Remarks: This species is similar to *Hozmadia koeveskallensis* group and *Poulpus* (?) *coronensis* (Yeh), but differs in having straight and longer feet. The position of the feet is higher than in the *H. koeveskallensis* group.

Range: Ladinian to Carnian (TR 4A to 5B).

Genus *Hungarosaturnalis* Kozur and Mostler, 1983

Type species: *Hungarosaturnalis multispinosus* Kozur and Mostler, 1983.

Hungarosaturnalis sp. A

Fig. 41-10

Remarks: There are 12 marginal spines which are very slender and have a sharp tip.

Range: Ladinian to Carnian (TR 4B to 5A).

Genus *Jacus* De Wever, 1982a

Type species: *Jacus coronatus* De Wever, 1982a.

Jacus sp. aff. *J. isa* De Wever

Fig. 38-2

aff. *Jacus isa* De Wever, 1982a, p. 212, pl. 12, figs. 10-14, pl. 13, figs. 1-4.

Remarks: This species is distinguished from *Jacus isa* by having a more robust apical horn. Presently the phylogenetic relationship with the Jurassic *Jacus* species is not well understood.

Range: Norian (TR 8A to 8B).

Genus *Kahlerosphaera* Kozur and Mostler, 1979

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

Kahlerosphaera sp. A

Fig. 41-13

Remarks: This species is similar to *Kahlerosphaera philippinensis* but differs in having the branches of the spines around the middle part rather than proximal, and also in lacking torsion on the spines.

Range: Carnian (TR 5A to 6A).

Kahlerosphaera sp. B

Fig. 41-14

Remarks: This species is similar to *Kahlerosphaera* sp. D but differs in havng prominent axial spines. It is distinguished from *K.* sp. A by having branches at the

species described by Blome (1984) but has narrower ridges.

Range: Norian (TR 8B).

Genus *Lysemelas* Sugiyama gen. nov.

Etymology: From a by-name of the Greek mithological goddess *Aphrodite*, feminine gender.

Type species: *Lysemelas olbia* Sugiyama sp. nov. (by monotypy).

Range: Norian as far as known.

Definition: Multisegmented test conical, long, with a very long, stout apical spine. Cephalis imperforate, completely hidden in proximal part of apical spine. Thorax perforated, having three arms. Abdomen and the subsequent segments short, frustum, possibly double-layered, perforated, and internally separated one another by thick septa; pores small, enclosed by frames that bearing small nodes at the junctions, with or without regular arrangement.

Remarks: This genus is somewhat similar to *Parahsuum* Yao, 1982, and *Droltus* Pessagno and Whalen, 1982, from which it differs in having three arms and a very stout apical spine. Phylogenetic relationships with othe genera are not known.

Lysemelas olbia Sugiyama sp. nov.
Figs. 28-1, 43-6—10b

Parahsuum (?) sp. A, Kojima and Mizutani, 1987, fig. 3-10.

Tetraspinocyrtis (?) sp., Bragin and Krylov, 1996, p. 135, pl. 2, figs. 8, 11.

Description: Test as with genus, gradually increasing in width but in some specimens the width decrease in the distal segments. Thoracic pores small, those on post-thoracic segments larger. Lumber stricture sometimes marked externally by a gentle change in contour, but other strictures are completely absent. Apical spine and arms never bladed. Development and divergent angle of arms are variable; some have rather short, conical arms extending nearly horizontally and the other posses thin, rod-like arms directed downward.

Remarks: Refer to the genus. Completely preserved specimens are very rare. Most individuals lack middle to distal part of the apical spine. This species has a relatively wide range of morphologic variation as described above, so a specimen with a forked apical spine (Fig. 43-7) is assigned to this species.

Dimensions (μm): Based on 15 specimens. Length of apical spine up to 180 (holotype 125); of test except apical spine 150-200 (holotype 160); width of test 90-130 (holotype 105).

Type material: ESN 148029 (Fig. 28-1), H-3, TR 7.

Range: Norian (TR 7 to 8C).

Etymology: From the Greek *olbios* meaning blessed.

Genus *Mesosaturnalis* Kozur and Mostler, 1981

Type species: Palaeosaturnalis levis Donofrio and Mostler, 1978.

Mesosaturnalis octospinus Sugiyama sp. nov.
Fig. 45-1

Description: Ring narrow, angular, having eight convex corners from which arise eight peripheral spines and two concave corners from which arise two peripolar spines.

Remarks: This species is distinguished from the other species of the genus by having an angular ring with eight peripheral spines. The number of peripheral spines is rarely reduced to seven.

Dimensions (μm): Based on 17 specimens. Maximum diameter of ring 130-180 (holotype 155); length of spine up to 50 (holotype 40).

Type material: ESN 148030 (Fig. 45-1), HZ-16, TR 7.

Range: Norian (TR 7 to 8A).

Etymology: From the Latin *octo*, eight, and *spina*, spine.

Mesosaturnalis sp. aff. *M. artus*
(Donofrio and Mostler)
Fig. 45-3

aff. *Paleosaturnalis artus* Donofrio and Mostler, 1978, p. 34, pl. 7, fig. 11.

Remarks: This species differs from *Mesosaturnalis artus* in having more than ten radial spines.

Range: Norian (TR 7 to 8A).

Mesosaturnalis sp. aff. *M. breviaculeatus*
(Donofrio and Mostler)
Fig. 45-4

aff. *Acanthocircus breviaculatus* Donofrio and Mostler, 1978, p. 26, pl. 1, fig. 9, pl. 3, figs. 12, 14.

Remarks: This species is distinguished from *Mesosaturnalis breviaculatus* by having asymmetrical arrangement of radial spines.

Range: Norian (TR 7).

Mesosaturnalis sp. aff. *M. octospinus* Sugiyama sp. nov.
Fig. 45-2

Remarks: Only two specimens were obtained. This species differs from *Mesosaturnalis octospinus* sp. nov. in having a rounded shaped ring rather than angular, but is a probably variation *M. octospinus*.

Range: Norian (TR 7 to 8A).

Genus *Muelleritortis* Kozur, 1988a

Type species: *Emiluvia* (?) *cochleata* Nakaseko and Nishimura, 1979.

Muelleritortis cive Sugiyama sp. nov.
Figs. 41-19, 20

Description: Cortical shell nodose, subspherical to subcylindrical, having four, coplanar spines crossing one another at right angles. The spines are three-bladed, widest at the middle, and tapering to a point. Ridges of the spines possess a series of small nodes.

Remarks: This species is distinguished from other species of the genus by having nodes on the ridges of the spines.

Dimensions (μm): Based on 15 specimens. Diameter of shell 90-130 (holotype 120); length of spine up to 180 (holotype 165).

Type material: ESN 148031 (Fig. 41-19), R-15, TR 5A.

Range: Ladinian to Carnian (TR 4B to 5B).

Etymology: Named by an arbitrary combination of letters (ICZN, 1985, p. 199, Appendix D, pt. V, Recommendation 26).

Genus *Multimonilis* Yeh, 1989

Type species: *Multimonilis pulcher* Yeh, 1989.

Multimonilis japonicus Sugiyama sp. nov.
Fig. 41-18

Description: Test as with genus. Cephalis large, conical, imperforate. Thorax and abdomen nearly cylindrical, short, wide or slightly wider than cephalis, with irregular small pores. Collar and lumber strictures marked by a gentle change in contour. The fourth and subsequent segments subtrapezoidal in outline, increasing in width distally, height almost constant. Circumferential ridges composed of a horizontal series of small nodes. Space between circumferential ridges wide and porous.

Remarks: This species is distinguished from other members of the genus in having circumferential ridges consisting of small nodes, which are widely spaced.

Dimensions (μm): Based on seven specimens. Length of test including spine 220-300 (holotype 240); maximum width of test 110-143 (holotype 143).

Type material: ESN 148032 (Fig. 41-18), N-5 , TR 5B.

Range: Carnian (TR 5A to 6A).

Etymology: According to the occurrence in Japan.

Multimonilis sp. A
Fig. 46-1

Remarks: This species is similar to *Multimonilis* sp. B, but the test is much smaller.

Range: Ladinian to Carnian (TR 4A to 5A).

Multimonilis sp. B
Fig. 46-2

Multimonilis sp. A, Yeh, 1989, p. 73, pl. 9, figs. 12, 22.

Multimonilis sp. cf. *M. splendidus* Yeh; Yeh, 1989, p. 73, pl. 9, fig. 16.

Remarks: This species is characterized by having a small apical spine on the spherical cephalis and also by possessing a wider space between two rows of circumferential ridge consisting of massive nodes.

Range: Carnian (TR 5A to 5B).

Genus *Neopylentonema* Kozur, 1984

Type species: *Neopylentonema messotriassica* Kozur, 1984.

Neopylentonema procera Sugiyama sp. nov.
Figs. 46-3a, b

Poulpus (?) sp. C, Yeh, 1989, p. 74, pl. 6, figs. 5, 10.

Description: Test as with genus, but arches are invisible owing to poor preservation of the materials. Apical spine and three feet prolonged from **D** and two **L** commonly have a verticil of three branches on their ridges, branches variable in length. Short spines prolonged from two **I** and **V** are short, sometimes wart-like, and extending from the lower half of the cephalis, usually slightly above the margin of cephalis.

Remarks: This species is distinguished from *Neopylentonema messotriassica* by its shorter feet and spine prolonged from two **I** and **V**. Moreover, feet of *N. procera* sp. nov. direct more downwardly than those of *N. messotriassica*. This species is also distinguished from *N. nakasekoi* (Sugiyama) by its thick, bladed apical spine and feet prolonged from **D** and two **L**.

Dimensions (*μm*): Based on 20 specimens. Length of apical spine 35-60 (holotype 47); of cephalis 40-55 (holotype 40); of feet 35-60 (holotype 40); width of cephalis 50-65 (holotype 60).

Type material: ESN 148033 (Figs. 46-3a, b), R-19, TR 5A.

Range: Carnian (TR 5A to 5B).

Etymology: From the Latin *procerus* meaning tall.

Genus *Orbiculiforma* Pessagno, 1973

Type species: *Orbiculiforma quadrata* Pessagno, 1973.

Orbiculiforma sp. aff. *O. trispina* Yeh

Figs. 43-11, 12

aff. *Orbiculiforma* (?) *trispina* Yeh, 1987, p. 42, pl. 9, figs. 2, 10.

Remarks: This species differs from *Orbiculiforma trispina* in having relatively thick three spines that are much shorter than those of the latter species.

Range: Hettangian to Sinemurian (JR 0A to 0B).

Orbiculiforma sp. A

Fig. 43-13

Remarks: This species is distinguished from *Orbiculiforma* sp. aff. *O. trispina* reported in this study by having four spines arranged at right angles.

Range: ? Sinemurian (TR 9B).

Genus *Palaeosaturnalis* Donofrio and Mostler, 1978, emend. Kozur and Mostler, 1981

Type species: *Spongosaturnalis triassicus* Kozur and Mostler, 1972.

Palaeosaturnalis (?) *incomptus* Sugiyama sp. nov.

Figs. 46-4, 5

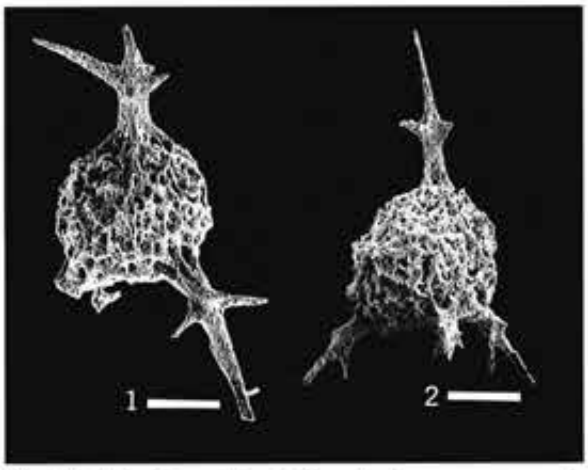
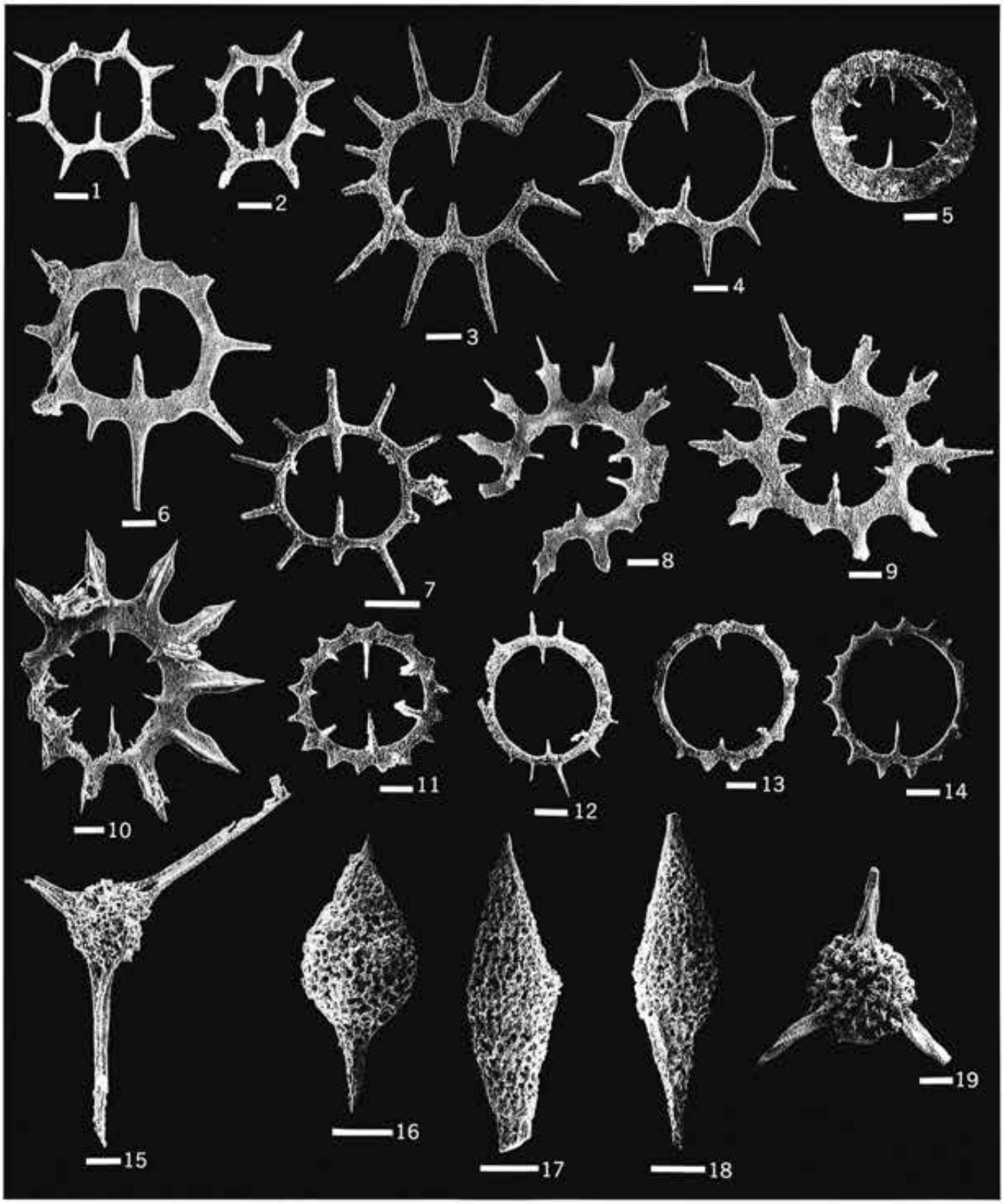
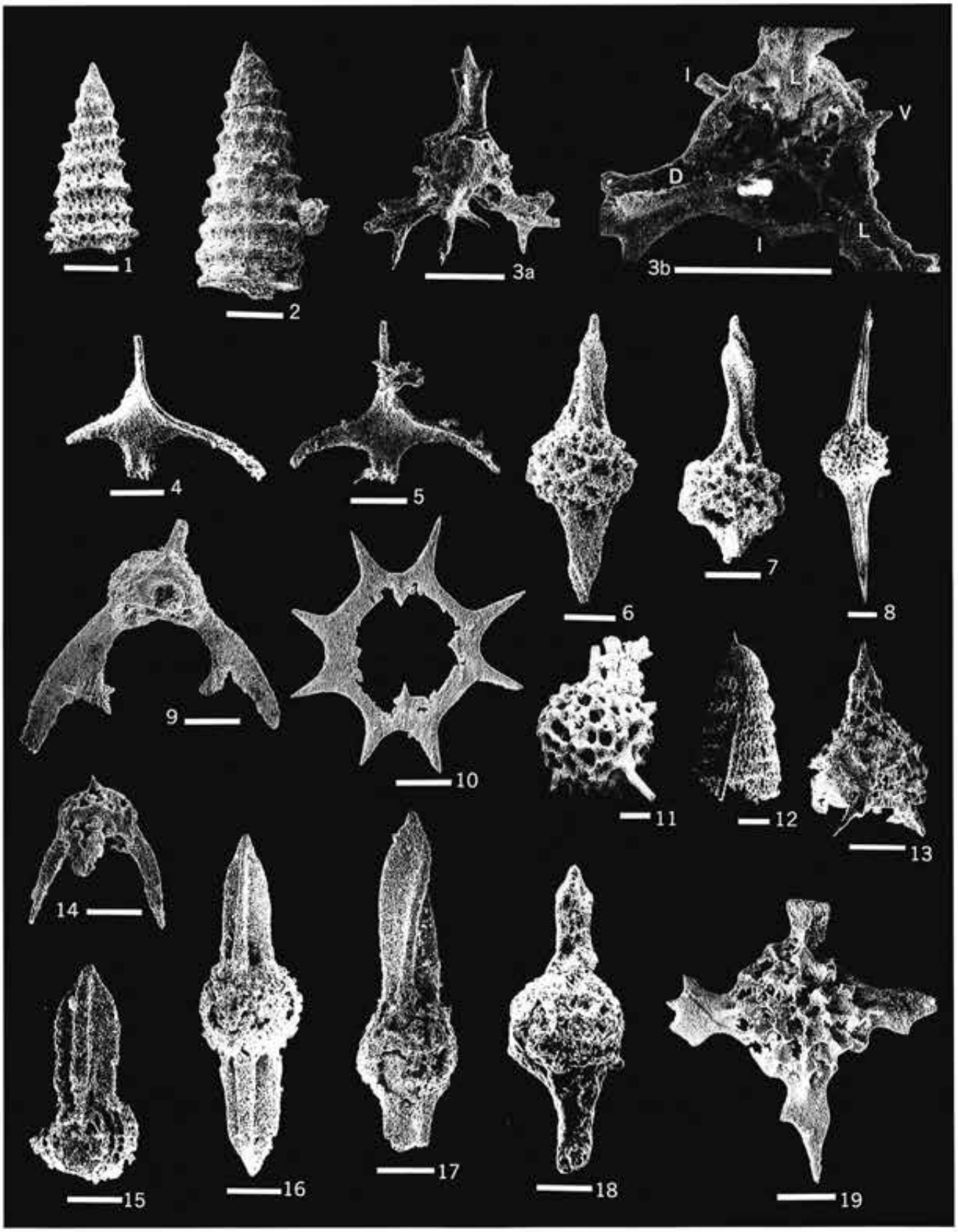


Fig. 44. 1, 2. *Hozmadia spinifera* Sugiyama sp. nov. 1: Paratype, ESN 148102, C-2, TR 2C, 2: Holotype, ESN 148026, C-2, TR 2C. All scale bar=50 μm.

Fig. 45. 1. *Mesosaturnalis octospinus* Sugiyama sp. nov., holotype, ESN 148030, HZ-16, TR 7. 2. *Mesosaturnalis* sp. aff. *M. octospinus* Sugiyama sp. nov., ESN 148250, HZ-22, TR 7. 3. *Mesosaturnalis* sp. aff. *M. artus* (Donofrio and Mostler), ESN 148251, HZ-24, TR 7. 4. *Mesosaturnalis* sp. aff. *M. breviaculeatus* (Donofrio and Mostler), ESN 148252, H-4, TR 7. 5. *Praeacanthocircus* (?) sp. A, ESN 148253, H-38, TR 8A. 6. *Paleosaturnalis* sp. aff. *P. dotti* (Blome), ESN 148254, HZ-21, TR 7. 7. *Paleosaturnalis* sp. aff. *P. harrisonensis* (Blome), ESN 148255, K-85, JR 0B. 8, 9. *Praemesosaturnalis pseudokahleri* Sugiyama sp. nov. 8: Paratype, ESN 148256, H-47, TR 8B, 9: Holotype, ESN 148037, H-83, TR 8B. 10. *Praemesosaturnalis* sp. A, ESN 148257, H-48, TR 8B. 11. *Praemesosaturnalis* sp. B, ESN 148258, K-49, TR 8C. 12. *Pseudacanthocircus* (?) sp. A, ESN 148259, H-31, TR 8A. 13. *Pseudacanthocircus* sp. B, ESN 148260, K-68, TR 8D. 14. *Pseudacanthocircus* sp. C, ESN 148261, K-83, JR 0A. 15. *Sarla* sp. A, ESN 148262, HZ-8, TR 6B. 16. *Syringocapsa* sp. A, ESN 148263, K-109, *Parahsuum simplum* Zone. 17, 18. *Syringocapsa* (?) sp. B. 17: ESN 148264, K-106, *Parahsuum simplum* Zone, 18: ESN 148265, K-106, *Parahsuum simplum* Zone. 19. *Xenorum* sp. A, ESN 148266, K-105, JR 0B. Scale bar=50 μm.


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Acanthocircus spp., Yoshida, 1986, pl. 17, figs. 7(?), 9.

Description: Whole shape is bilaterally asymmetrical. Stem flat and short. Root is not preserved in any available specimens. Axial spine is rod-like but more or less flat at the proximal part. Two lateral branches curved downward, abruptly twisted dextrally, so that the upper edge of the left lateral branch always faces to the opposite side and that of the right lateral branch looks out onto the front side of the spines in normal view.

Remarks: Descriptive terms of the genus *Baumgartneria* is herein used owing to the similarity. The generic assignment is quite tentative, thus it may belong to other genus such as *Angulocircus* Lahm.

Dimensions (μm): Based on 20 specimens. Length stem plus axial projection as far as preserved 100-140 (holotype 138).

Type material: ESN 148034 (Fig. 46-5), Q-6, TR 5B.

Range: Carnian to Norian (TR 5B to 6A).

Etymology: From the Latin *incomptus* meaning untrimmed.

Paleosaturnalis sp. aff. *P. dotti* (Blome)
Fig. 45-6

aff. *Acanthocircus dotti* Blome, 1984, p. 22, pl. 1, figs. 2, 3, 12.

Remarks: This species is distinguished from *Paleosaturnalis dotti* in having nine radial spines rather than ten, but the these may be the same species.

Range: Norian (TR 6B to 7).

Paleosaturnalis sp. aff. *P. harrisonensis* (Blome)
Fig. 45-7

aff. *Acanthocircus harrisonensis* Blome, 1984, p. 22, pl. 1, figs. 4, 5, 13.

Remarks: This species is distinguished from *Paleosaturnalis harrisonensis* in having 11 radial spines rather than 12, but the these may be the same species.

Range: Norian to Sinemurian (TR 6B to JR 0B).

Genus *Pantanellium* Pessagno, 1977

Type species: *Pantanellium riedeli* Pessagno, 1977.

Pantanellium sp. aff. *P. fosteri* Pessagno and Blome
Fig. 43-17

aff. *Pantanellium fosteri* Pessagno and Blome, 1980, p. 242, pl. 3, figs. 1, 8, 16.

Remarks: This species has a slightly more elongate test than *Pantanellium fosteri*.

Range: Norian to Rhaetian (TR 8C).

Pantanellium sp. aff. *P. kluense* Pessagno and Blome
Fig. 43-16

aff. *Pantanellium kluense* Pessagno and Blome, 1980, p. 243, pl. 4, figs. 1, 2, 13, 17, 21-24.

Remarks: The cortical shell is more elongated and the polar spines are relatively thicker than those of *Pantanellium kluense*.

Range: Hettangian to Sinemrian (JR 0A to 0B).

Pantanellium (?) sp. A
Fig. 46-6

Remarks: This species is distinguished from *Pantanellium* (?) *virgeum* Sashida in having twisted polar spines. It also distinguished from *Spongoxystris* (?) *slovenica* in its sinistral torsion on the spines rather than dextral.

Fig. 46. 1. *Multimonilis* sp. A, ESN 148103, B-3, TR 4A. 2. *Multimonilis* sp. B, ESN 148104, R-39, TR 5A. 3a, b. *Neopylentonema procea* Sugiyama sp. nov., holotype, ESN 148033, R-19, TR 5A. 3b: Basal view of aperture, showing skeletal structure. **D**=dorsal foot; **L**=primary lateral foot; **l**=secondary lateral spine; **V**=ventral spine. 4, 5. *Paleosaturnalis* (?) *incomptus* Sugiyama sp. nov. 4: Paratype, ESN 148105, Q-5, TR 5B, 5: Holotype, ESN 148034, Q-6, TR 5B. 6. *Pantanellium* (?) sp. A, ESN 148106, M-4, TR 2B. 7. *Pseudostylosphaera* (?) sp. B, ESN 148107, C-18, TR 3A. 8. *Pseudostylosphaera* sp. A, ESN 148108, E-1, TR 2A. 9. *Poulpus carcharus* Sugiyama sp. nov., paratype, ESN 148109, R-22, TR 5B. 10. *Praemesosaturnalis* (?) *ormites* Sugiyama sp. nov., holotype, ESN 148036, R-20, TR 5B. 11. *Pentactinorbis* (?) sp. A, ESN 148110, D-17, TR 2B. 12. *Spongosilicarmiger spelae* Sugiyama sp. nov., holotype, ESN 148038, D-9, TR 2B. 13. *Spongosilicarmiger* sp. A, ESN 148111, D-17, TR 2B. 14. *Poulpus* sp. A, ESN 148112, Q-2, TR 5A. 15, 16. *Spongoxystris hadra* Sugiyama gen. *et* sp. nov. 15: Paratype, ESN 148113, C-10, TR 2C, 16: Holotype, ESN 148039, C-18, TR 3A. 17. *Spongoxystris* sp. A, ESN 148114, C-12, TR 3A. 18. *Spongoxystris* sp. B, ESN 148115, C-10, TR 2C. 19. *Tiborella* sp. A, ESN 148116, R-11, TR 4A. Scale bar=50 μm.

Genus *Paronaella* Pessagno, 1971

Type species: *Paronaella solanoensis* Pessagno, 1971.

Paronaella (?) sp. A

Fig. 43-18

Remarks: The generic assignment is uncertain. This species is somewhat similar to *P.* (?) *beatrica* Carter, from which it differs in having a much expanded central region and diverse spines at the end of the three rays.

Range: Norian (TR 8B).

Genus *Parvibrachiale* Sugiyama gen. nov.

Etymology: From Latin *parvus*, small, and *brachiale*, an arm, neuter gender.

Type species: *Parvibrachiale yaoi* Sugiyama sp. nov. (by monotypy).

Range: Rhaetian as far as known.

Definition: Very small multisegmented test with two arms extending laterally from the imperforate cephalis, on which an apical spine is present or absent. The two arms curve downward and often bifurcated at the distal end. Arms sometimes with conical nodes on the upper edge. Post-cephalic segments are pierced by small pores, but they are often covered by secondary growth of silica. There are no prominent strictures on the test.

Remarks: This genus is somewhat similar to *Spinotriassocampe* Kozur, 1984, from which it is distinguished by its smaller size of the test. Presently, the ancestoral and descendant genera are not known.

Parvibrachiale yaoi Sugiyama sp. nov.

Figs. 43-14a—15, 19, 20

Triassocyrtium (?) sp. A, Yao, 1982, pl. 3, figs. 10, 11.

Description: Test as with genus, but lacking an apical spine.

Remarks: Yao (1982) illustrated two individuals of this species; one has an apical spine and the other lacks it. All of my available individuals belong to the latter form.

Demensions (*in μm*): Based on 18 specimens. Height of test as far as preserved 50-100 (holotype 52); maximum width of test up to 125 (holotype 117); width of the last segment as far as preserved up to 45 (holotype 35).

Type material: ESN 148244 (Figs. 43-14a, b), P-14, TR 8D.

Range: Rhaetian (TR 8C to 8D).

Etymology: This species is named after Prof. A. Yao who first discovered this species.

Genus *Pentactinorbis* Dumitrica, 1978b

Type species: *Pentactinorbis kozuri* Dumitrica, 1978b.

Pentactinorbis (?) sp. A

Fig. 46-11

Remarks: Includes forms with basal spines of *Pentactinocarpus* species inside the shell. The number of external spines is variable. This species is probably a direct ancestor of *Pentactinocarpus awaensis* group.

Range: Anisian (TR 2B to 2C).

Genus *Poulpus* De Wever, 1979

Type species: *Poulpus pyabyx* De Wever, 1979.

Poulpus carcharus Sugiyama sp. nov.

Figs. 27-14, 46-9

(?) *Poulpus piabyx* De Wever; Yeh, 1990, p. 27, pl. 8, figs. 3, 7, 9.

Description: Cephalis hemispherical to subhemispherical, surface lumpy, with or without tiny pores. Well preserved individuals have a short apical spine and thick peristome. Feet as with genus; the proximal part is tubular and sometimes has a ridge on the base, whereas the middle and distal parts are nearly flat. Mid-way down the inner edge of each foot is a triangular to spike-like projection.

Remarks: This species is distinguished from other members of the genus by its projections on the inner edges of the feet.

Dimensions (*μm*): Based on 19 specimens. Length of apical spine up to 50 (holotype 20); of cephalis 40-65 (holotype 57); of feet 100-180 (holotype 167); width of cephalis 63-85 (holotype 72).

Type material: ESN 148035 (Fig. 27-14), Q-12, TR 5B.

Range: Carnian (TR 5B to 6A).

Etymology: From the Greek *karcharos* meaning jagged.

Poulpus sp. A

Fig. 46-14

Remarks: This species is distinguished from *Poulpus carcharus* sp. nov. by lacking spike-like projections on the inner edges of the feet.

Range: Carnian (TR 5A to 5B).

Genus *Praeacanthocircus* Kozur and Mostler, 1983

Type species: *Praeacanthocircus carnicus* Kozur and Mostler, 1983.

Praeacanthocircus (?) sp. A

Fig. 45-5

Remarks: This species resembles *Praeacanthocircus spinosus* Kozur and Mostler from which it differs in having a wider ring without external spines. The generic assignment remains uncertain.

Range: Norian (TR 8A).

Genus *Praemesosaturnalis* Kozur and Mostler, 1981

Type species: *Spongosaturnalis bifidus* Kozur and Mostler, 1972.

Praemesosaturnalis (?) *ormites* Sugiyama sp. nov.

Fig. 46-10

Palaeosaturnalis sp. A, Yao, 1982, pl. 2, fig. 21.

Description: Ring modelately wide, flat, subcircular to suboctagonal in outline. There are eight peripheral spines; two in a peripolar position. Each peripolar spine flat, triangular, variable in length. Two polar and two auxiliary rays are same in length and thickness, and cross one another at right angles. No subsidiary rays are observed.

Remarks: Generic assignment is tentative because the occurrence is separated from other members of the genus. Moreover, this species is similar closely to species of the genus *Solisaturnalis* Mostler and Krainer, 1993. This species differs from *Solisaturnalis* species in lacking subsidiary rays.

Dimensions (μm): Based on 13 specimens. Diameter of ring 95-138 (holotype 135); length of spine up to 65 (holotype 52).

Type material: ESN 149036 (Fig. 46-10), R-20, TR 5B.

Range: Carnian (TR 5A to 5B).

Etymology: From the Greek *ormos* meaning a chain.

Praemesosaturnalis pseudokahleri Sugiyama sp. nov.

Figs. 28-3, 45-8, 9

Description: Ring moderately wide, circular to subcircular in outline. Inside the ring there are two polar rays and more than four auxiliary rays. Peripheral outer spines, displaying sinistral torsion, about ten in number. The spines flat in proximal part , abruptly becoming wide and bearing two, triangular, lateral branches at the middle, and needle-like in distal part.

Remarks: This species is distinguished from the other species of the genus in having lateral branches at the middle of each peripheral spines. It also differs from *Pseudoheliodiscus kahleri* (Kozur and Mostler) in having peripolar spines rather than polar spines. The number of auxiliary rays in this species is less than in *Pseudoheliodiscus kahleri*.

Dimensions (μm): Based on 23 specimens. Diameter of ring 205-260 (holotype 245); length of spine up to 140 (holotype 135).

Type material: ESN 148037 (Fig. 45-9), H-83, TR 8B.

Range: Norian (TR 8B to 8C).

Etymology: For the similarity to *Pseudoheliodiscus kahleri* (Kozur and Mostler).

Praemesosaturnalis sp. A

Fig. 45-10

Remarks: This species is distinguished from other species of the genus by having long, markedly bladed peripheral spines. This species is similar to *Saturnosphaera* sp. aff. *S. convertus* (Kozur and Mostler), but the relationship is uncertain.

Range: Norian (TR 8A to 8C).

Praemesosaturnalis sp. B

Fig. 45-11

Remarks: Included are forms with a nearly circular ring with 15-17 short outerspines. This species is possibly conspecific with *Praemesosaturnalis palawaensis* (Yeh) illustrated by Yang and Mizutani (1991).

Range: Rhaetian (TR 8C to 8D).

Genus *Pseudacanthocircus* Kozur and Mostler, 1990

Type species: *Pseudacanthocircus mediospinosus* Kozur and Mostler, 1990.

Pseudacanthocircus (?) sp. A

Fig. 45-12

Remarks: Included are forms with a circular, relatively wide ring with thin, needle-like outer spines. The generic assignment is uncertain.

Range: Norian (8A).

Pseudacanthocircus sp. B

Fig. 45-13

Remarks: Included are forms with a subcircular ring having short 10-14 outer spines. The spines are in many cases vestigial. This species resembles *Pseudacanthocircus troegeri* Kozur and Mostler, 1990, but differs in having lesser nuber of spines.

Range: Norian to Sinemurian (TR 8A to JR 0B).

Pseudacanthocircus sp. C

Fig. 45-14

Remarks: Included are forms with a subcircular ring having short 14-16 outer spines. This species may be conspecific to *Pseudacanthocircus* sp. B.

Range: Norian to Sinemurian (TR 7 to JR 0A).

Genus *Pseudostylosphaera* Kozur and Mostler, 1981

Type species: *Pseudostylosphaera gracilis* Kozur and Mostler, 1981.

Pseudostylosphaera sp. A

Fig. 46-8

Pseudostylosphaera sp. A, Sugiyama, 1992, p. 1209, figs. 14-1, 2.

Remarks: This species differs from other species of the genus in having obliquely directed polar spines.

Range: Anisian (TR 2A to 2B).

Pseudostylosphaera (?) sp. B

Fig. 46-7

Remarks: This species is similar to *Psuudostylosphaera graculis* in having sinistral torsion on the spines. However, the cortex is nearly spherical rather than ellipsoidal.

Range: Anisian to Ladinian (TR 2B to 3A).

Genus *Sarla* Pessagno, 1979

Type species: *Sarla prietoensis* Pessagno, 1979.

Sarla sp. A

Fig. 45-15

Remarks: This species has very long, slender spines; spines usually straight or may exhibit slight dextral torsion. *Sarla hadrecaena* (De Wever) also displays dextral torsion of spines but they are much shorter than those of this species.

Range: Norian (TR 6A to 7).

Genus *Spongosilicarmiger* Kozur, 1984

Type species: *Spongosilicarmiger italicus* Kozur, 1984.

Spongosilicarmiger spelae Sugiyama sp. nov.

Fig. 46-12

Description: Test as with genus but lacks a tubular apical spine characteristic of other *Spongosilicarmiger* species. Instead there is a thin and short, rod-like apical spine.

Remarks: This species is distinguished from other species of the genus by lacking a tubular apical spine.

Dimensions (μm): Based on five specimens. Length of test 270-330 (hootype 275); maximum width of test as far as preserved 145-190 (holotype 145).

Type material: ESN 148038 (Fig. 46-12), D-9, TR 2B.

Range: Anisian (TR 2B to 2C).

Etymology: This species is named after Dr. Spela Goricăn who kindly provide me referential samples from the Slovenian Triassic.

Spongosilicarmiger sp. A

Fig. 46-13

Remarks: This species is characterized by having an apical spine similar to that of *Spongosilicarmiger scabiturritus* Sugiyama, but lacks long postcephalic segments. The cephalis is porous and rugged. Therefore the outline of the lower test is somewhat similar to *Hozmadia* species.

Range: Anisian (TR 2B to 2C).

Genus *Spongoxystris* Sugiyama gen. nov.

Etymology: From the Greek *spongos*, a sponge, and *xystris*, a scraper, feminine gender.

Type species: *Spongoxystris hadra* Sugiyama sp. nov.

Range: Anisian to Ladinian as far as known.

Definition: Shell ellipsoidal, consisting of more than five, thin concentric layers; its surface thick, spongy, pierceed by very small pores; the innermost structure is not known. Two opposed spines aligned in the major axis of the shell, variable in their characters-straight, twisted, bladed and tubular.

Remarks: This new genus includes *Cromyostylus* ? *koppi* Lahm, 1984, *Spongopallium* ? sp. A and B described by Goricăn and Buser, 1990, and *Spongopallium* ? *tetrapterum* Ramvos and Goricăn, 1995, as well as the type species. *Pseudostylosphaera slovenica* Kolar-Jurkovsek, 1989, *Spongostylus tortilis* Kozur and Mostler, 1979, and *Spongostylus carnicus* Kozur and Mostler, 1979, are probably included to this new genus, but the detailed internal structures are not knwon. This genus may have evolved from *Pegoxystris* Sugiyama from which it differs in having an ellipsoidal shell without by-spines. This genus also resembles *Pseudostylosphaera*, but the inner shell structures are quite different.

Spongoxystris hadra Sugiyama sp. nov.

Figs. 46-15, 16

Spongopallium ? sp. Ramovs and Goricăn, 1995, pl. 1, figs. 6, 7.

Description: Test as with genus; two spines are stout, straight, three-bladed, and equal in width through the most part, and abruptly tapering to a point at the distal end.

Remarks: This species is distinguished from other members of the genus by having straight and stout three-bladed spines.

Dimensions (μm): Based on 17 specimens. Major diameter of shell 80-100 (holotype 85); length of spine 100-140 (holotype 110).

Type material: ESN 148039 (Fig. 46-16), C-18, TR 3A.

Range: Anisian (TR 2C to 3A).

Etymology: From the Greek *hadros* meaning thick.

Spongoxystris sp. A

Fig. 46-17

Remarks: The spines display dextral torsion as observed in *Spongoxystris* (?) *slovenica* (Kolar-Jurkovsek), but the torsion is gentle and the thick spines retain same width except for the tip.

Range: Anisian (TR 2C to 3A).

Spongoxystris sp. B

Fig. 46-18

Spumellaria gen et sp. indet. with tubular spines, Dumitrica and Mello, 1982, pl. 2, fig. 13.

Spongopallium ? sp. B, Goricăn and Buser, 1990, p. 158, pl. 4, fig. 6.

Remarks: This species is characterized by having tubular spines whose tips are grooved and rapidly tapered to a point.

Range: Anisian (TR 2C).

Genus *Syringocapsa* Neviani, 1990

Type species: *Theosyringium robustum* Vinassa de Regny, 1990.

Syringocapsa sp. A

Fig. 45-16

Remarks: This specis differs from *Syringocapsa batoes* in having porous proximal segments and a thinner tube at the base. This species is similar to *Globolaxtorum hullae*, but the proximal segments are much more inflated than those of *G. hullae*.

Range: Senemurian (JR 0B).

Syringocapsa (?) sp. B

Figs. 45-17, 18

(?) Eucyrtid gen. and sp. indet., Carter, 1993, p. 114, pl. 20, figs. 15, 16, 19.

Remarks: The generic assignment is tentative. It probably belongs to a new genus together with gen. et sp. indet. 1, 2 and 3 described by De Wever (1982a).

Genus *Tiborella* Dumitrica, Kozur and Mostler, 1980

Type species: *Tiborella magnidentata* Dumitrica, Kozur and Mostler, 1980.

Tiborella sp. A

Fig. 46-19

Spumellaria indet. gen. D sp. A, Yeh, 1992, p. 64, pl. 8, fig. 12.

Remarks: Four coplanar spines are flat, bearing triangular projections at the middle part, and rod-like in the distal part. This species is a possible ancestor of species of *Hungarosaturnalis* and *Praeheliostaurus*.

Genus *Trialatus* Yeh, 1990

Type species: *Trialatus megacornutus* Yeh, 1990.

Remarks: Yeh (1990) defined *Trialatus* a multisegmented nassellarian genus. However, it seems likely that the genus includes two-segmented species as well. This genus comprises an evolutional lineage from *Trialatus* (?) sp. A or *T. pristinus* sp. nov. to *T. robustus* (Nakaseko and Nishimura).

Trialatus praerobustus Sugiyama sp. nov.

Figs. 47-1, 2

Description: Test composed of three segments, but the third segment is always vestigial. Cephalis imperforate, hidden in the proximal part of the tubular apical spine. The apical spine has two or three poers in the middle position and three strong ridges which terminate in a single narrow spine.

Remarks: This species is distinguished from *Trialatus robustus* in lacking triangular projections on the distal ridges of the apical spine. The vestigial third segment is also characteristic of this species.

Dimensions (μm): Based on seven specimens. Length of cephalothorax plus apical spine 140-168 (holotype 152); of feet up to 60 (holotype 47).

Type material: ESN 148040 (Fig. 47-1), Q-20, TR 5B.

Range: Carnian (TR 5B to 6A)

Etymology: For the precedent occurrence for *T. robustus*.

Trialatus pristinus Sugiyama sp. nov.

Figs. 47-3, 4

Lithomelissa (?) sp. A, Yao, 1982, p. 67, pl. 2, fig. 13.

Description: Test as with genus, three-segmented, but the apical spine is three-bladed and tapers distally. **V** sometimes present outside shell wall.

Remarks: This species is similar to *Trialatus longicornutus* Yeh from which it is distinguished by having a simple apical spine rather than a distally furcate one.

Dimensions (μm): Based on 17 specimens. Length of apical spine 50-125 (holotype 62); of test except apical spine as far as preserved 100-145 (holotype 120); of feet up to 80 (holotype 62).

Type material: ESN 148041 (Fig. 47-4), R-19, TR 5A.

Range: Carnian (TR 5A to 5B).

Etymology: From the Latin *pristinus* meaning primitive.

Trialatus (?) sp. A

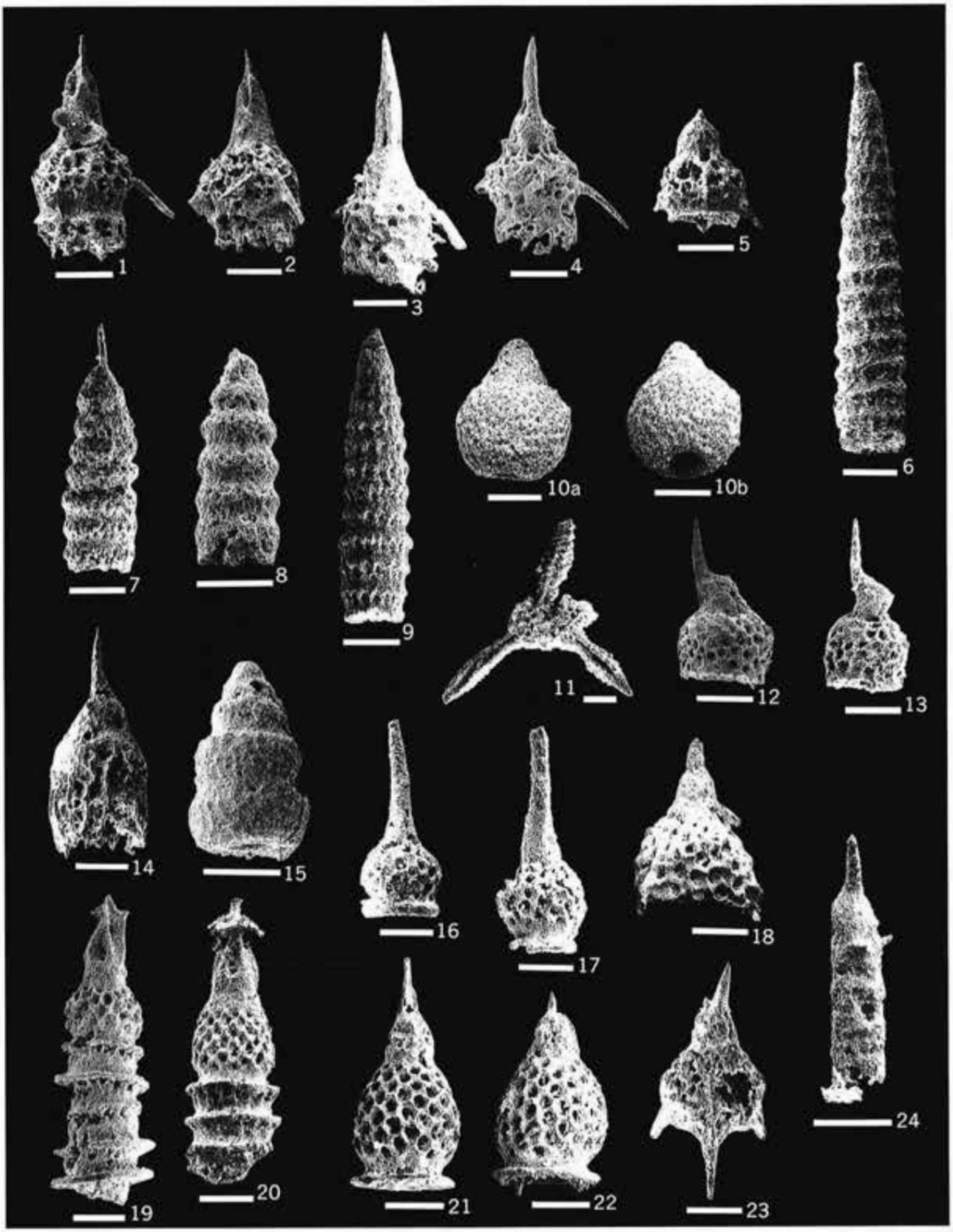
Fig. 47-5

Remarks: The test is composed of an imperforated cephalis and barrel-shaped thorax. The apical spine and three arms are short.

Range: Carnian (TR 5A).

Genus *Triassocampe* Dumitrica, Kozur and Mostler, 1980

Fig. 47. 1, 2. *Trialatus praerobstus* Sugiyama sp. nov. 1: Holotype, ESN 148040, Q-20, TR 5B, 2. Paratype, ESN 148117, Q-20, TR 5B. 3, 4. *Trialatus pristinus* Sugiyama sp. nov. 3: Paratype, ESN 148118, R-19, TR 5A, 4: Holotype, ESN 148041, R-19, TR 5A. 5. *Trialatus* (?) sp. A, ESN 148119, R-20, TR 5B. 6. *Triassocampe* sp. A, ESN 148120, M-7, TR 2B. 7, 8. *Triassocampe eruca* Sugiyama sp. nov. 7: Paratype, ESN 148121, E-10, TR 2A, 8: Holotype, ESN 148044, E-1, TR 2A. 9. *Triassocampe* sp. B, ESN 148122, D-4, TR 2B. 10a, b. *Tricolocapsa* (?) *lacrima* Sugiyama sp. nov., holotype, ESN 148046, R-14, TR 4B. 11. *Tritortis* sp. A, ESN 148123, R-14, TR 4B. 12, 13. *Veles vulgaris* Sugiyama gen. et sp. nov. 12, Holotype, ESN 148047, R-22, TR 5B, 13: Paratype, ESN 148124, R-22, TR 5B. 14. *Veles* sp. A, ESN 148125, R-15, TR 5A. 15. *Xipha nodosa* Sugiyama sp. nov., holotype, ESN 148048, G-36, TR 6A. 16, 17. *Yeharaia cornigera* Sugiyama sp. nov. 16: Holotype, ESN 148050, A-3, TR 3B, 17: Paratype, ESN 148126, L-14, TR 3A. 18, 23. *Yeharaia* (?) sp. A. 18: ESN 148127, A-11, TR 3B, 23: ESN 148128, A-4, TR 3B. 19, 20. *Yeharaia compsa* Sugiyama sp. nov. 19: Paratype, ESN 148129, B-5, TR 4A, 20: Holotype, ESN 148049, B-5, TR 4A. 21, 22. *Yeharaia mascula* Sugiyama sp. nov. 21: Holotype, ESN 148051, A-13, TR 3B, 22: Paratype, ESN 148130, A-13, TR 3B. 24. *Zevius* (?) sp. aff. *Z. perarmatus* Sugiyama, ESN 148131, M-9, TR 2B. Scale bar=50 μm.


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Type species: *Triassocampe scalaris* Dumitrica, Kozur and Mostler, 1980 (a junior objective synonym of *Dictyomitrella deweveri* Nakaseko and Nishimura, 1979).

Triassocampe eruca Sugiyama sp. nov.
Figs. 47-7, 8

Triassocampe (?) sp. A, Sugiyama, 1992, p. 1199, figs. 11-4, 9.

Description: Test composed of a small cephalis and relatively large rounded subsequent segments. Cephalis imperforate, often asymmetrical in lateral view and bearing a rod-like apical spine. Collar and the subsequent strictures distinct. Thorax and subsequent segments nearly equal in shape and width; circumferential ridges absent; small pores are scattered on the shell surface, especially at the center of segments.

Remarks: This species may represent a transitional form from *Zevius* to *Triassocampe*. It is included in the latter because the development of the apical spine is weak and strictures between segments are clearer than in *Zevius* species.

Dimensions (μm): Based on 13 specimens. Length of test except apical spine as far as preserved 110-250 (holotype 135); of cephalothorax 33-40 (holotype 33); maximum width of test 55-70 (holotype 57).

Type material: ESN 148044 (Fig. 47-8), E-1, TR 2A.

Range: Anisian (TR 2A to 2B).

Etymology: From the Latin *eruca* meaning a caterpillar.

Triassocampe sp. A
Fig. 47-6

Remarks: The test is slender and there is a relatively thick apical spine on the cephalis. The general shape is somewhat similar to *Triassocampe coronata* Bragin with an apical spine. However this species does not have a single row of pores just beneath the circumferential ridges. The details of the distribution of the pores are not known due to the preservation, but it appears to be irregular.

Range: Anisian (TR 2B).

Triassocampe sp. B
Fig. 47-9

Remarks: This species does not have prominent circumferential ridges. The cephalis is poreless, but the subsequent segments are porous. Especially below the thorax, the pores are large and deeply set in the pore frames, so that longitudinal pore frames become prominet and look like discontinuous ridges.

Range: Anisian (TR 2B).

Genus *Tricolocapsa* Haeckel, 1881

Type species: *Tricolocapsa theophrasti* Haeckel, 1887, designated by Campbell (1954).

Tricolocapsa (?) *lacrima* Sugiyama sp. nov.
Figs. 47-25a, b

Description: Test small, covered by microgranular silica, pierced by very small pores, circular aperture at the base. The upper part is conical, composed possibly of a cephalis and thorax; lower part large, subspherical, possibly the abdomen.

Remarks: The internal structure has not been observed yet, so generic assignment is tentative based exclusively on the external morphology. This species is similar to *Siphocampium* (?) sp. A illustrated by Yao (1982), from which it differs in lacking a basal peristome and having smaller pores.

Dimensions (μm): Based on six specimens. Length of test 120-145 (holotype 120); maximum width of test 93-105 (holotype 100).

Type material: ESN 148046 (Fig. 47-25a, b), R-14, TR 4B.

Range: Carnian (TR 4B to 5A).

Etymology: From the Greek *lacrima* meaning tears.

Genus *Tritortis* Kozur, 1988b

Type species: *Sarla ? kretaensis* Kozur and Krahl, 1984.

Tritortis sp. A
Fig. 47-11

Remarks: This species is distinguished from other species of the genus by having nodose spines.

Range: Carnian (TR 5A).

Genus *Veghia* Kozur and Mostler, 1981

Type species: *Veghia goestlingensis* Kozur and Mostler, 1981.

Veghia sp. A

Figs. 38-3, 4

Remarks: This species is distinguished from the type species and *Veghia sulovensis* Kozur and Mostler by having much nore flattened, hemispherical cephalis.

Range: Norian (TR 8B).

Genus *Veles* Sugiyama gen. nov.

Etymology: From the Latin *veles* meaning a skirmisher, masculine gender.

Type species: *Veles vulgaris* Sugiyama sp. nov. (by monotypy).

Range: Carnian as far as known.

Definition: Test small, composed of hemispherical to subhemispherical cephalis, and cylindrical thorax. Abdomen present or absent. Apical spine situated on the dorsal side of cephalis.

Remarks: This genus is somewhat similar to *Zevius*, but differs in lacking post-abdominal segments and ventral spine on the cephalis.

Veles vulgaris Sugiyama sp. nov.

Figs. 47-12, 13

Description: Test as with genus, lacking abdomen. Cephalis with or without small pores. Apical spine circular in cross section, extending obliquely upward in the proximal part, and more or less curved ventrally at the middle part. Collar stricture expressed especially in the dorsal side. Thorax pierced by circular to subcircular pores; its margin with teeth or tubercles.

Remarks: This species is compared with *Veles* sp. A under the latter species.

Dimensions (μm): Based on 25 specimens. Length of apical spine 40-60 (holotype 52); of cephalothorax 85-110 (holotype 90); maximum width of test 75-90 (holotype 87).

Type material: ESN 148047 (Fig. 47-12), R-22, TR 5B.

Range: Carnian (TR 5A to 5B).

Etymology: From the Latin *vulgaris* meaning ordinary.

Veles sp. A

Fig. 47-14

Remarks: This species is distinguished from *Veles vulgaris* sp. nov. in having an abdomen with more or less developed longitudinal ridges.

Range: Carnian (TR 5A).

Genus *Xenorum* Blome, 1984

Type species: *Xenorum largum* Blome, 1984.

Xenorum sp. A

Fig. 45-19

Xenorum sp. A, Hori, 1990, p. 581, fig. 8-9.

Remarks: This species is characterized by having prominent nodes on the cortex. The spines exhibit dextral torsion in the middle to distal part.

Range: Sinemurian (JR 0B).

Genus *Xipha* Blome, 1984

Type species: *Dictyomitra pessagnoi* Nakaseko and Nishimura, 1979.

Remarks: This genus has had an unsolved taxonomic problem. Prior to Blome's (1984) study, Kozur (1984) established a genus *Nakaseoellus* with the type species *Stichophormis polita* Hinde. He then regarded *Dictyomitrella pessagnoi* as a junior synonym of *S. polita*. Because it is difficult to judge whether *D. pessagnoi* and *S. polita* are synonymous or not, I prefer to use the generic name *Xipha* rather than *Nakaseoellus*. In order to avoid taxonomic confusion, the latter should be regarded as *nomen dubium*.

Xipha nodosa Sugiyama sp. nov.

Fig. 47-15

Description: Test as with genus but lacks longitudinal costae. Weak nodes are distributed on the post-thoracic segments. No pores are not observed.

Remarks: This species differs from *Xipha pessagnoi* (Nakaeko and Nishimura) and *X. striata* Blome in lacking longitudinal costae.

Dimensions (μm): Based on five specimens. Length of test 98-125 (holotype 120); maximum width of test 70-83 (holotype 80).

Type material: ESN 148048 (Fig. 47-15), G-36, TR 6A.

Range: Carnian (TR 5B to 6A).

Etymology: From the Latin *nodosus* meaning

Capnuchosphaera parawaensis Yeh, 1990, p. 9, pl. 2, fig. 1, pl. 10, figs. 5, 6.

Capnuchosphaera silviensis Blome group (Fig. 49-18)

Capnuchosphaera silviensis Blome, 1983, p. 16, pl. 1, figs. 5, 11, 13, 19, pl. 11, fig. 3.

Capnuchosphaera sockensis Blome, 1983, p. 17, pl. 2, figs. 2, 13, 14, 16.

Remarks: The above two species are tentatively grouped for the same reason mentioned in the remarks of *C. colemani* group.

Capnuchosphaera theroides De Wever *in* De Wever *et al.*, 1979, p. 83, pl. 3, figs. 10-13.

Capnuchosphaera triassica De Wever *in* De Wever *et al.*, 1979, p. 84, pl. 3, figs. 14-19.

Capnuchosphaera tricornis De Wever *in* De Wever *et al.*, 1979, p. 85, pl. 4, figs. 6-10.

Cenosphaera clathrata Parona, 1890, p. 19, pl. 1, fig. 5.

Citriduma asteroides Carter, 1993, p. 97, pl. 15, figs. 3, 5, 8, 9. (Fig. 50-8)

Remarks: Illustrated specimen has a greater number of radial tubes than the typicl morphotype, so it may be conspecific with *Citriduma* sp. A of Carter (1993) rather than *C. asteroides*.

Corum regium Blome (Fig. 49-4)

Triassocampe (?) sp. E, Yao, 1982, pl. 2, fig. 12 (*non* fig. 11).

Whalenella arrecta (Hinde); Kozur, 1984, p. 71, pl. 2, fig. 3 (illustrated specimen is from Yao, 1982).

Corum regium Blome, 1984, p. 51, pl. 13, figs. 3, 8, 15.

Corum aff. *perfectum* Blome; Matsuoka *et al.*, 1994, pl. 3, fig. 12 (*non* fig. 11) (illustrated specimen is from Yao, 1982).

Cryptostephanidium cornigeum Dumitrica, 1978a, p. 31, pl. 1, figs. 1-4, pl. 4, fig. 4.

Cryptostephanidium japonicum (Nakaseko and Nishimura) group

Trilonche japonica Nakaseko and Nishimura, 1979, p. 72, pl. 4, figs. 8, 10.

Cryptostephamidium ? japonicum (Nakaseko and Nishimura); Goricăn and Buser, 1990, p. 142, pl. 8, fig. 5.

Spongostephanidium longispinosum Sashida, 1991, p. 694, figs. 7-1—8.

Cryptostephanidium longispinosum (Sashida); Sugiyama, 1992, p. 1205, figs. 13-1, 2.

Divatella austriaca Kozur and Mostler, 1981, p. 76, pl. 63, figs. 1a, 1b.

Droltus euraciaticus Kozur and Mostler (Fig. 50-4)

Parahsuum (?) sp. A, Yao, 1982, pl. 3, fig. 6.

Parahsuum aff. *longiconicum* Sashida; Hori, 1990, p. 581, fig. 8-14.

Droltus euraciaticus Kozur and Mostler, 1990, p. 223, pl. 17, figs. 3, 4.

Entactinia morii Sugiyama, 1992, p. 1205, figs. 12-8, 9.

Eptingium japonicum (Nakaseko and Nishimura)

Tripocyclina japonica Nakaseko and Nishimura, 1979, p. 73, pl. 4, figs. 4-6.

Eptingium manfredi japonicum (Nakaseko and Nishimura); Kozur and Mostler, 1994, p. 42, pl. 1, fig. 4.

Eptingium manfredi Dumitrica, 1978a, p. 33, pl. 3, figs. 3, 4, pl. 4, figs. 1, 2, 5-7.

Eptingium nakasekoi Kozur and Mostler (Figs. 27-4, 5)

Tripocyclina cf. *acythus* De Wever; Nakaseko and Nishimura, 1979, p. 72, pl. 4, figs. 1, 2, 4.

Cryptostephanidium sp. cf. *C. verrucosum* Dumitrica; Sugiyama, 1992, p. 1207, fig. 13-3.

Eptingium nakasekoi Kozur and Mostler, 1994, p. 43, pl. 1, fig. 5.

Remarks: Younger morphotypes have weakly developed grooves on the spines as illustrated in Sugiyama (1992).

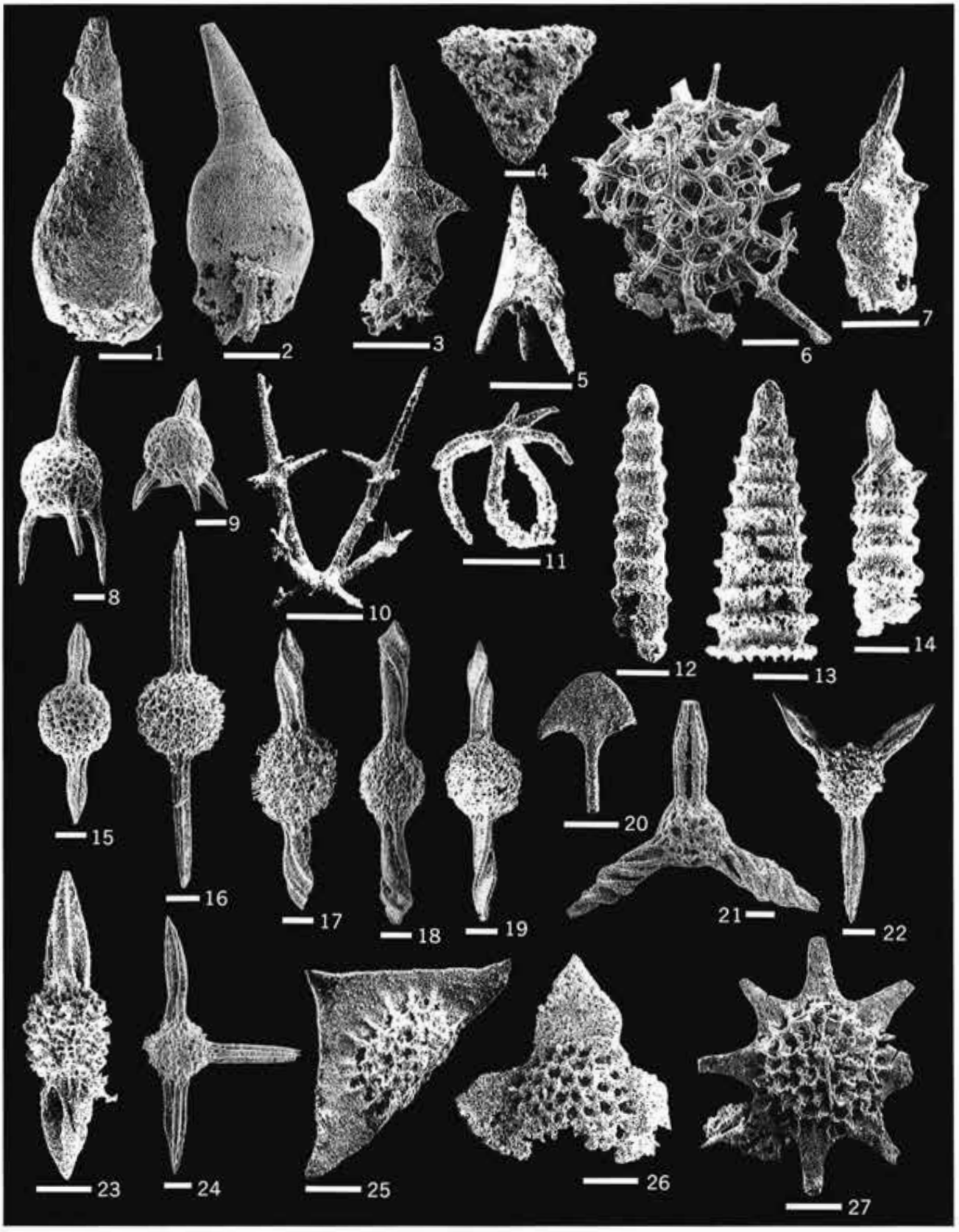
Falcispongus calcaneum Dumitrica, 1982a, p. 65, pl. 1, fig. 1, pl. 2, figs. 2, 4-6, 8. (Fig. 49-14)

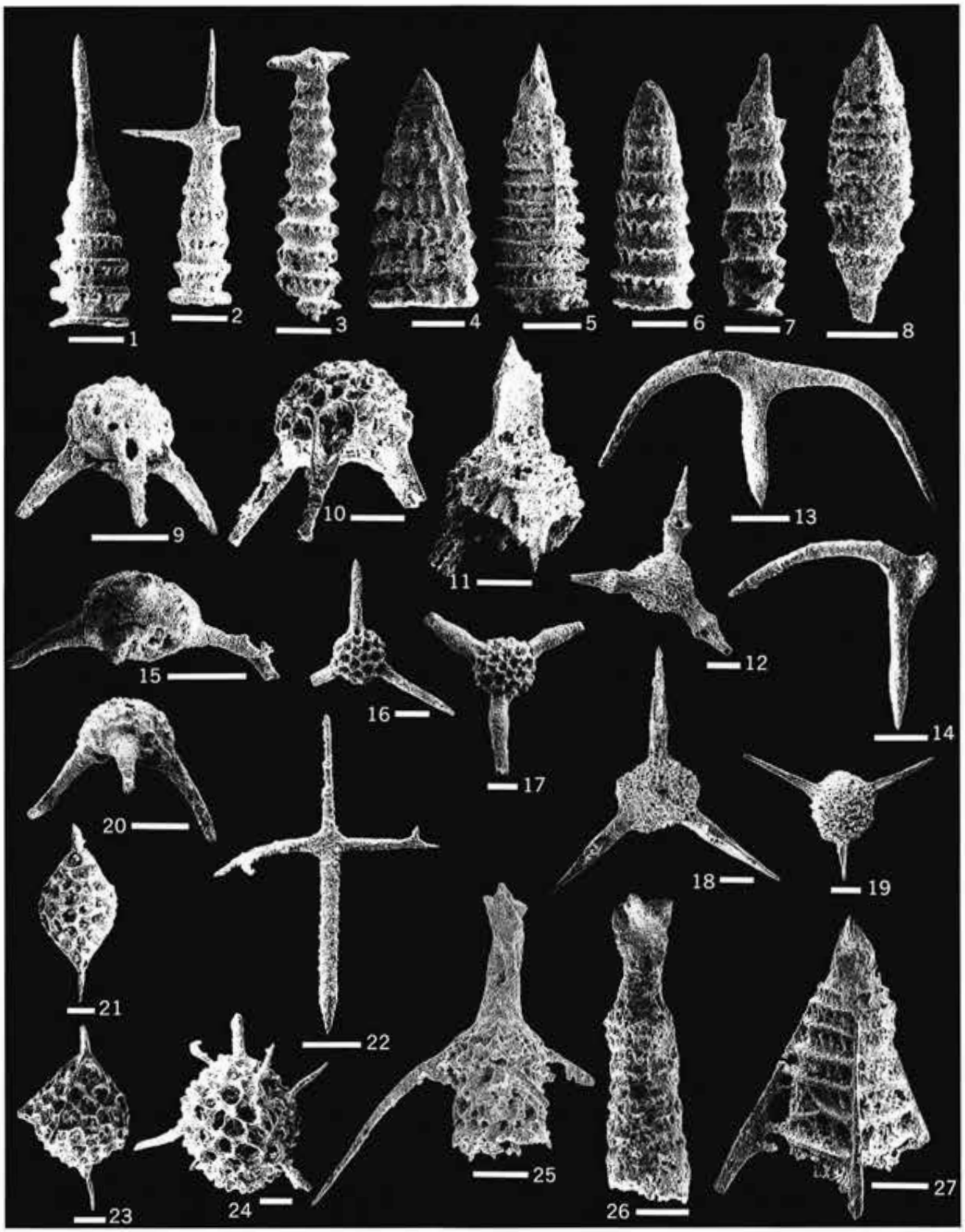
Falcispongus curvispinus (Dumitrica) comb. nov. (Fig. 49-13)

Baumgartneria curvispina Dumitrica, 1982c, p. 71, pl. 12, figs. 1, 2, 4.

Remarks: It is apparent from the stratigraphic evidence revealed by this study that this species evolved from *Falcispongus calcaneum* by elongation of external wing, and that there is

Fig. 48. 1. *Follicucullus monacanthus* Ishiga and Imoto, ESN 148157, T-19, TR 0. 2. *Follicucullus ventricosus* Ormistone and Babcock group, ESN 148158, T-56, TR 0. 3. *Pseudoalbaillella* sp. , ESN 148159, KIN-85, TR 0. 4. *Ruzencevispongus* sp. cf. *R. uraricus* Kozur, ESN 148160, KIN-86, TR 0. 5. Nassellaria gen. *et* sp. indet. A, ESN 148161, KIN-95, TR 1. 6. Spumellaria gen. *et* sp. indet. K, ESN 148162, T-56, TR 0. 7. *Planispinocyrtis* sp. cf. *P. baloghi* Kozur and Mostler, ESN 148163, M-13, TR 2A. 8. *Hozmadia gifuensis* Sugiyama, ESN 148164, E-1, TR 2A. 9. *Hozmadia reticulata* Dumitrica, Kozur and Mostler, ESN 148165, C-7, TR 2C. 10. *Tandarnia recoarensis* Dumitrica, ESN 148166, M-13, TR 2A. 11. *Archaeosemantis pterostephanus* Dumitrica, ESN 148167, F-3, TR 3A. 12. *Triassocampe campanilis* (Kozur and Mostler), ESN 148168, M-3, TR 2B. 13. *Triassocampe postdeweveri* Kozur and Mostler, ESN 148169, A-16, TR 3B. 14. *Planispinocyrtis praecursor* Kozur and Mostler, ESN 148170, F-4, TR 3A. 15. *Pseudostylosphaera japonica* (Nakaseko and Nishimura) group, ESN 148171, C-20, TR 3A. 16. *Pseudostylosphaera longispinosa* Kozur and Mostler group, ESN 147172, R-19, TR 5A. 17. *Pseudostylosphaera nazarovi* (Kozur and Mostler), ESN 148173, B-4, TR 3B. 18. *Pseudostylosphaera gracilis* Kozur and Mock, ESN 148174, R-15, TR 5A. 19. *Pseudostylosphaera goestlingensis* (Kozur and Mostler), ESN 148175, B-6, TR 4A. 20. *Falcispongus rostatus* Dumitrica, ESN 148176, A-1, TR 3B. 21. *Tritortis Kretaensis* (Kozur and Krahl), ESN 148177, R-14, TR 4B. 22. *Tritortis integrita* Cordey, De Wever, Dumitrica, Danelian, Kito and Vrielynk, ESN 148178, A-13, TR 3B. 23. *Pseudostylosphaera magnispinosa* Yeh, ESN 148179, O-5, TR 3B. 24. *Muelleritortis* sp. cf. *M. noblis* Dosztály, ESN 148180, B-2, TR 4A. 25. *Praeheliostaurus levis* Kozur and Mostler, ESN 148181, R-15, TR 5A. 26. *Praeheliostaurus ingridae* Mostler and Krainer, ESN 148182, R-13, TR 4B. 27. *Hungarosaturnalis piletus* (Nakaseko and Nishimura), ESN 148183, R-15, TR 5A. Scale bar=50 μm.


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no direct phylogenetic relationship with the type species of *Baumgartneria, B. retorospina*. This is well represented by the fact that *F. curvispinus* lacks axial spine characteristic of *Baumgartneria* species.

Falcispongus dumitricae (Dosztály) comb. nov.

Baumgartneria sp., Dumitrica, 1982a, p. 72, pl. 12, fig. 5.

Baumgartneria dumitricae Dosztály, 1991, p. 344, pl. 1, fig. 1.

Remarks: This species is evolved from *Falcispongus curvispinus* listed above. The species name should be *dumitricai* according to the ICZN (1985).

Falcispongus falciformis Dumitrica, 1982a, p. 66, pl. 1, fig. 5, pl. 2, figs. 1, 3, 7, pl. 3, figs. 2, 3, 5, 6.

Falcispongus rostratus Dumitrica, 1982a, p. 66, pl. 3, figs. 8, 9, pl. 4, figs. 2, 3, 5, 6, pl. 5, figs. 2, 4. (Fig. 48-20)

Follicucullus monacanthus Ishiga and Imoto *in* Ishiga *et al.*, 1982, p. 276, pl. 4, figs. 11-15. (Fig. 48-1)

Follicucullus scholasticus Ormiston and Babcock, 1979, p. 333, pl. 1, figs. 1-5. (Fig. 27-1)

Follicucullus ventricosus Ormiston and Babcock group (Fig. 48-2)

Follicucullus ventricosus Ormiston and Babcock, 1979, p. 332, pl. 1, figs. 6-14.

Follicucullus dilatatus Rudenko *in* Beljanskij *et al.*, 1984, p. 54, pl. 8, figs. 6, 7.

Follicucullus porrectus Rudenko *in* Beljanskij *et al.*, 1984, p. 55, pl. 8, figs. 3, 10.

Follicucullus japonicus Ishiga, 1991, p. 108, pl. 1, figs. 1-22, pl. 2, fig. 1.

Follicucullus bispinosus Kozur, 1993, p. 105, pl. 3, figs. 10, 11.

Foremanellina sp. cf. *F. hellenae* Dumitrica

cf. *Foremanellina hellenae* Dumitrica, 1982b, p. 79, pl. 1, figs. 4, 5.

Foremanellina sp. cf. *F. macrocephala* Dumitrica

cf. *Foremannelina macrocephala* Dumitrica, 1982b, p. 78, fig. 2, pl. 3, figs. 1-4.

Globolaxtorum hullae (Yeh and Cheng) comb. nov. (Fig. 50-21)

Syringocapsa sp. A, Yao, 1982, pl. 3, fig. 12.

Syringocapsa sp. C, Yoshida, 1986, pl. 6, figs. 13, 14.

Katroma hullae Yeh and Cheng, 1996, p. 14, pl. 8, figs. 1, 2, 6, 7, 12, 13.

Gorgansium sp. aff. *G. gongyloideum* Kishida and Hisada

aff. *Gorgansium gongyloideum* Kishida and Hisada, 1985, p. 116, pl. 1, figs. 21, 22.

Justium cf. *novum* Blome; Yoshida, 1986, pl. 14, figs. 6, 7.

aff. *Gorgansium alpinum* Kozur and Mostler, 1990, p. 216, pl. 16, fig. 12.

Haeckelicyrtium karcharos Carter, 1993, p. 96, pl. 14, figs. 5, 6. (Fig. 50-9)

Heliosaturnalis sp. cf. *H. transitus* Kozur and Mostler

cf. *Heliosaturnalis transitus* Kozur and Mostler, 1972, p. 29, pl. 2, fig. 7, pl. 4, fig. 6.

Heptacladus crassispinus Dumitrica, Kozur and Mostler, 1980, p. 3, pl. 5, fig. 3, pl. 13, figs. 1-3, 5.

Hinedorcus alatus Dumitrica, Kozur and Mostler, 1980, p. 24, pl. 9, figs. 2, 8, pl. 15, fig. 4.

Hindeosphaera bispinosa Kozur and Mostler

Hindeosphaera ? bispinosa Kozur and Mostler, 1979, p. 63, pl. 2, fig. 6.

Hindeosphaera bispinosa Kozur and Mostler, 1981, p. 29, pl. 67, fig. 1.

Hindeosphaera spinulosa (Nakaseko and Nishimura)

Archaeospongoprunum spinulosum Nakaseko and Nishimura, 1979, p. 69, pl. 2, figs. 3, 4, 6.

Pseudostylosphaera sp. cf. *P. spinulosa* (Nakaseko and Nishimura); Cheng, 1989, p. 143, pl. 6, fig. 2, pl. 7, figs. 8, 9.

Pseudostylosphaera spinilosa (Nakaseko and Nishimura); Yeh, 1990, p. 15, p. 4, fig. 14.

"Stylosphaera" spinulosa (Nakaseko and Nishimura); Bragin, 1991, p. 91, pl. 3, figs. 4, 5, 9.

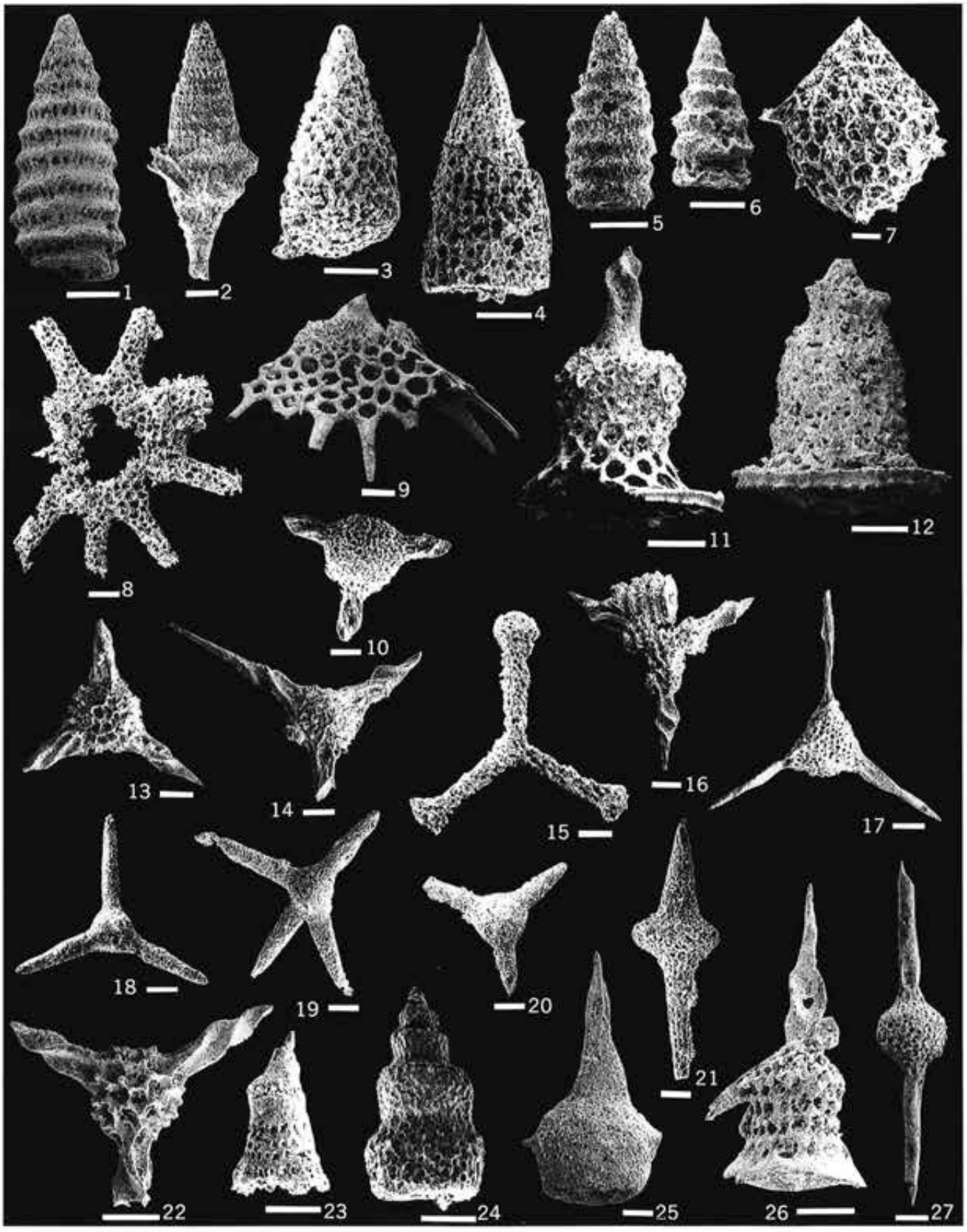
Hindeosphaera ? spinulosa (Nakaseko and Nishimura); Ramovs and Goricăn, 1995, p. 185, pl. 3, figs. 6-8.

Remarks: Included are forms with a straight major spine, which is a different character from other species of the genus.

Hozmadia gifuensis Sugiyama, 1992, p. 1194, figs. 9-6-8. (Fig. 48-8)

Remarks: Included are forms with expanded, subspherical cephalis with well developed apical spine whose proximal part is bladed and length is usually longer than cephalic height.

Fig. 49. 1. *Spinotriassocampe annulata* (Nakaseko and Nishimura) group, ESN 148132, A-8, TR 3B. 2. *Spinotriassocampe hungarica* Kozur group, ESN 148133, A-1, TR 3B. 3. *Spinotriassocampe carnica* Kozur and Mostler group, ESN 148134, B-4, TR 4A. 4. *Corum regium* Blome, ESN 148135, HZ-7, TR 7 (Section HZ is described in the part 2 of this study). 5. *Ladinocampe japonica* (Nakaseko and Nishimura), ESN 148136, L-23, TR 3B. 6. *Triassocampe baldii* (Kozur), ESN 148137, R-20, TR 5B. 7. *Planispinocyrtis* (?) *gabiolaensis* Kozur and Mostler, ESN 148138, R-10, TR 4A. 8. *Tubotriassocyrtis annulata* Kozur and Mostler, ESN 148139, A-1, TR 3B. 9. *Poulpus* sp. cf. *P. curvispinosus* Dumitrica, Kozur and Mostler, ESN 148140, R-10, TR 4A. 10, 11. *Hozmadia koeveskallensis* Kozur and Mostler group. 10: ESN 148141, A-18, TR-3B, 11: A-15, TR 3B. 12. *Capnuchosphaera colemani* Blome group, ESN 148142, Q-8, TR 5B. 13. *Falcispongus curvispinosus* (Dumitrica), ESN 148143, R-10, TR 4A. 14. *Falcispongus calcaneum* Dumitrica, ESN 148144, A-8, TR 3B. 15. *Poulpus piabyx* De Wever, ESN 148145, Q-23, TR 6A. 16. *Capnodoce sarisa* De Wever, ESN 148146, H-16, TR 6B (Section H is described in the part 2 of this study). 17. *Capnodoce crystallina* Pessagno group, ESN 148147, Q-25, TR 6A. 18. *Capnuchosphaera silviensis* Blome group, ESN 148148, Q-1, TR 5A. 19. *Sarla* (?) *externa* Blome, ESN 148149, R-39, TR 5A. 20. *Poulpus phasmatodes* De Wever, ESN 148150, R-39, TR 5A. 21. *Pentactinocarpus fusiformis* Dumitrica, ESN 148151, L-22, TR 3B. 22. *Baumgartneria bifurcata* Dumitrica, ESN 148152, F-5, TR 3A. 23. *Pentactinocarpus tetracanthus* Dumitrica, ESN 148152, A-13, TR 3B. 24, *Pentactinocarpus awaensis* (Nakaseko and Nishimura) group, ESN 148153, L-40, TR 2C. 25. *Trialatus longicornutus* Yeh, ESN 148154, Q-6, TR 5B. 26. *Trialatus megacornutus* Yeh, ESN 148155, Q-8, TR 5B. 27. *Silicarmiger latus* Kozur and Mostler, ESN 148156, B-2, TR 4A. Scale bar=50 μm.


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Hozmadia koeveskallensis Kozur and Mostler group (Figs. 49-10, 11)

Poulpus aff. *curvispinosus* Dumitrica, Kozur and Mostler; Yao, 1992, pl. 1, fig. 18.

Hozmadia koeveskallensis Kozur and Mostler, 1994, p. 115, p. 115, pl. 31, fig. 3.

Hozmadia ozawai Sugiyama, 1992, p. 1194, figs. 9-4a-5.

Remarks: This species is distinguished from co-occured *Hozmadia gifuensis* by its smaller size of the test and the rod-like apical spine.

Hozmadia sp. cf. *H. pyramidalis* Goricăn

cf. *Hozmadia pyramidalis* Goricăn *in* Goricăn and Buser, 1990, p. 146, pl. 9, figs. 4-7b.

Hozmadia reticulata Dumitrica, Kozur and Mostler, 1980, p. 21, pl. 9, figs. 9, 10. (Fig. 48-9)

Remarks: The cephalic size becomes smaller stratigraphically upward.

Hozmadia rotunda (Nakasko and Nishimura)

Tripilidium rotundum Nakaseko and Nishimura, 1979, p. 81, pl. 8, figs. 1-3.

Hozmadia rotunda (Nakaseko and Nishimura); Sugiyama, 1992, p. 1194.

Remarks: Included are forms with relatively shorter feet and a long apical spine that is completely bladed and usually longer than cephalis.

Hungarosaturnalis pileatus (Nakaseko and Nishimura) (Fig. 48-27)

Saturnosphaera pileata Nakaseko and Nishimura, 1979, p. 74, pl. 5, figs. 3a, b.

Saturnosphaera triassica Nakaseko and Nishimura, 1979, p. 74, pl. 5, figs. 4, 5, pl. 12, fig. 1.

Hungarosaturnalis pileatus (Nakaseko and Nishimura); Kozur and Mostler, 1983, p. 7.

Hungarosaturnalis triassicus (Nakaseko and Nishimura); Kozur and Mostler, 1983, p. 7.

Hungarosaturnalis longobardica Kozur and Mostler (*sic*), 1983, p. 8, pl. 4, fig. 3, pl. 5, fig. 4.

Remarks: The holotype of *Hungarosaturnalis triassicus* is similar to a well preserved individual of *H. pileatus*. The priority is herein given to the latter species. *H. longobardicus* is also regarded as a junior synonym of *H. pileatus* since it represents only morphologic variation of *H. pileatus*.

Japonocampe nova (Yao) (Fig. 50-1)

Dictyomitrella sp. B, Yao *et al*., 1980, pl. 3, figs. 1-3.

Triassocampe nova Yao, 1982, p. 59, pl. 2, figs. 1-4.

Japonocampe nova (Yao); Kozur, 1984, p. 72.

Latium mandum Blome, 1984, p. 55, figs. 1, 7, 13.

Remarks: The genus *Latium* Blome, 1984, is a junior objective synonym of *Japonocampe* Kozur, 1984. This genus certainly comprises *Japonocampe nova* (Yao) and *L. longulum* Blome, 1984 (type species of *Latium*). *L. paucum* Blome, 1984, may be a junior synonym of *L. longulum*. It is difficult to determine the generic assignment of this species. However this spece is has morphologic similarities much closer to *L. longulum* rather than *Triassocampe* spece is, so the original generic assignment by Yao (1982) is changed.

Kahlerosphaera norica Kozur and Mock group

Kahlerosphaera norica Kozur and Mock *in* Kozur and Mostler, 1981, p. 36, pl. 15, fig. 4.

Remarks: Included are forms with an axial spine and three branches arising from the middle to distal part of each spine lacking torsion. The length and direction of the branches are quite variable.

Kahlerosphaera philippinensis Yeh, 1990, p. 11, pl. 6, figs. 11, 12, pl. 10, fig. 2.

Katorella bifurcata Kozur and Mostler, 1981, p. 51, pl. 3, figs. 4, 5, pl. 60, fig. 2.

Katroma sp. cf. *K. bicornus* De Wever

cf. *Katroma bicornus* De Wever 1982a, p. 193, pl. 3, figs. 1-4.

Ladinocampe japonica (Nakaseko and NIshimura) comb. nov. (Fig. 49-5)

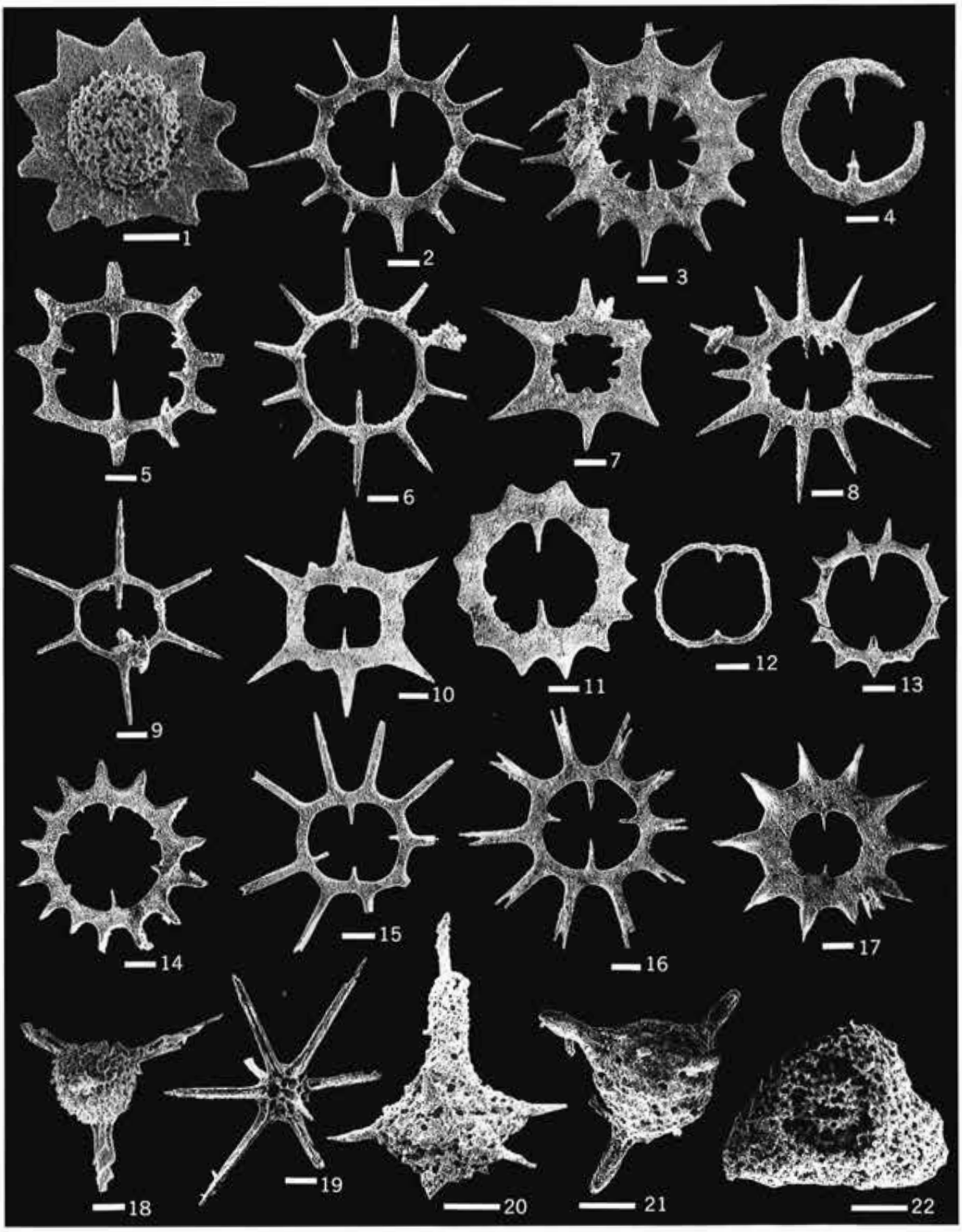
Yeharaia japonica Nakaseko and Nishimura, 1979, p. 83, pl. 10, figs. 6, 10, pl. 12, fig. 9.

Triassocampe (?) *japonica* (Nakaseko and Nishimura); Yao, 1982, pl. 1, fig. 12.

Remarks: Some individuals have a vertical projection extending from collar stricture, which indicates phylogenetic relationships between this species and *Ladinocampe multiperforata* Kozur.

Laxtorum sp. cf. *L. capitaneum* Carter (Fig. 50-2)

Fig. 50. 1. *Japonocampe nova* (Yao), ESN 148267, H-3, TR 7. 2. *Laxtorum* sp. cf. *L. capitaneum* Carter, ESN 148268, P-13, TR 8C. 3. Nassellaria gen. et sp. indet. E, ESN 148269, K-86, TR 9B. 4. *Droltus euraciaticus* Kozur and Mostler, ESN 148270, K-109, *Parahsuum simplum* Zone. 5. *Canoptum rhaeticum* Kozur and Mostler group, ESN 148271, K-70, TR 8D. 6. *Pachus firmus* Blome, ESN 148272, H-12, TR 6A. 7. *Pentactinocarpus sevaticus* Kozur and Mostler, ESN 148273, N-18, TR 7. 8. *Citriduma asteroides* Carter, ESN 148274, H-38, TR 8A. 9. *Haeckelicyrtium karcharos* Carter, ESN 148275, P-5, TR 8C. 10. *Sarla vetusta* Pessagno, ESN 148276, H-28, TR 8A. 11. *Dreyericyrtium carterae* (Yeh and Cheng), ESN 148277, K-47, TR 8C. 12. *Squinabolella* (?) *trispinosa* Carter, ESN 148278, P-14, TR 8D. 13. *Sarla prietoensis* Pessagno group, ESN 148279, HZ-4, TR 6B. 14. *Sarla hadrecaena* (De Wever), ESN 148280, HZ-2, TR 6B. 15. *Paronaella pacofiensis* Carter, ESN 148281, K-53, TR 8C. 16. *Risella tledoensis* Carter, ESN 148282, K-68, TR 8D. 17. *Bipedis acrostylus* Bragin, ESN 148283, K-47, TR 8C. 18, 19. *Livarella valida* Yoshida group. 18: ESN 148284, K-48, TR 8C, 19: Odd specimen having four rays, ESN 148285, P-5, TR 8C. 20. *Livarella densiporata* Kozur and Mostler, ESN 148286, K-25, TR 8B. 21. *Globolaxtorum hullae* (Yeh and Cheng), ESN 148287, P-3, TR 8C. 22. *Betraccium deweveri* Pessagno and Blome, ESN 148288, H-37, TR 8A. 23. Nassellaria gen. *et* sp. indet. B, ESN 148289, H-16, TR 6B. 24. Nassellaria gen. *et* sp. indet. A, ESN 148290, H-16, TR 6B. 25. Nassellaria gen. *et* sp. indet. C, ESN 148291, K-4, TR 8A. 26. Nassellaria gen. et sp. indet. F, ESN 148292, HZ-7, TR 6B. 27. *Xiphosphaera fistulata* Carter, ESN 148293, HZ-3, TR 6B. Scale bar=50 μm.


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cf. *Laxtorum capitaneum* Carter, 1993, p. 112, pl. 19, figs. 6-8.
Laxtorum sp. cf. *L. hidei* Blome
cf. *Laxtorum hidei* Blome, 1984, p. 56, pl. 15, figs. 4, 10, 17, 18.
Livarella densioirata Kozur and Mostler, 1981, p. 115, pl. 9, figs. 1a, b. (Fig. 50-20)
Livarella valida Yoshida group (Figs. 50-18, 19)
Livarella validus Yoshida (*sic*), 1986, p. 14, pl. 3, figs. 1-3.
Livarella longus Yoshida (*sic*), 1986, p. 14, pl. 2, figs. 3-5.
Livarella gifuensis Yoshida, 1986, p. 2, figs. 6-10.
Remarks: Yoshida (1986) discriminated three species of *Livarella* based on the development of a node on the center of the cortex, and the length of arms. In my opinion, these are not species characters but represent only morphologic variation of one and the same species. In younger assemblage the arms are slightly curved to a side comprising a node on the shell. The original species name *longus* is changed to *longa* in accordance with the International Code of Zoological Nomenclature (ICZN, 1985), Articles 31 and 32.
Mesosaturnalis artus (Donofrio and Mostler) group
Palaeosaturnalis artus Donofrio and Mostler, 1978, p. 34, pl. 7, fig. 11.
Mesosaturnalis artus (Donofrio and Mostler); Kozur and Mostler, 1981, p. 58.
Monicasterix prisca Kozur and Mostler, 1994, p. 89, pl. 20, figs. 8, 10-12.
Muelleritortis cochleta (Nakaseko and Nishimura) (Fig. 27-11)
Emiluvia (?) *cochleta* Nakaseko and Nishimura, 1979, p. 70, pl. 3, figs. 2-4, 6.
Staurocontium minoense Nakaseko and Nishimura, 1979, p. 71, pl. 2, figs. 7, 9, 10, pl. 12, fig. 4.
Plafkerium cochletum (Nakaseko and Nishimura); Cordey *et al*., 1988, p. 31.
Muelleritortis cochleata (Nakazawa and Nishimura) (*sic*); Kozur, 1988a, p. 52, pl. 1, figs. 1-8, pl. 2, figs. 1, 2, pl. 3, figs. 2-4, 6.
Remarks: The holotype of *Staurocontium minoense* is referred to a well preserved individual of *Muelleritortis cochleta*.
Muelleritortis sp. cf. *M. noblis* Dosztály (Fig. 48-24)
cf. *Muelleritortis noblis* Dosztály, 1991, p. 345, pl. 5, figs. 4, 5.
Neopaurinella sevatica Kozur and Mostler, 1981, p. 45, pl. 48, fig. 6, pl. 49, figs. 1, 4.
Neopylentonema nakasekoi (Sugiyama) comb. nov.
Poulpus nakasekoi Sugiyama, 1992, p. 1196, figs. 10-3a, b.
Nofrema sp. cf. *N. trispinosa* Dumitrica, Kozur and Mostler
cf. *Nofrema trispinosa* Dumitrica, Kozur and Mostler, 1980, p. 25, pl. 9, fig. 1, pl. 15, fig. 3.
Oertlispongus diacanthus Sugiyama
Oertlispongus diacanthus Sugiyama, 1992, p. 1217, figs. 17-10—12.
? *Palaeoencyrtis elongata* Feng, 1992, pl. 2, figs. 13, 14; Feng and Liu, 1993, p. 548, pl. 2, figs. 1-4, 26.
? *Palaeoencyrtis fusina* Feng, 1992, pl. 2, figs. 15, 16; Feng, 1993, p. 548, pl. 2, figs. 5-8.
Remarks: Feng (1992) illustrated *Palaeoencyrtis elongata* and *P. fusina* as new nassellarians without systematic descriptions. Later Feng and Liu (1993) briefly described them in Chinese. It is obvious judging from their illustrations that *P. elongata* and *P. fusina* are not nassellarians but only detached spines of oertlispongids. Based on their straight shape, they are included in Spine A1 defined in the former chapter.
Pachus firmus Blome, 1984, p. 49, pl. 12, figs. 3, 4, 8, 9, 15, 17, pl. 17, fig. 8. (Fig. 50-6)
Pachus (?) *indistinctus* Blome, 1984, p. 49, pl. 12, figs. 5, 10, 18, 19.
Palaeosaturnalis dotti (Blome) group comb. nov. (Fig. 51-6)
Acanthocircus dotti Blome, 1984, p. 22, pl. 1, figs. 2, 3, 12.
Acanthocircus laxus Blome, 1984, p. 23, pl. 1, figs. 9, 17.
Palaeosaturnalis harrisonensis (Blome) group comb. nov. (Fig. 51-2)
Acanthocircus harrisonensis Blome, 1984, p. 22, pl. 1, figs. 4, 5, 13.
Acanthocircus supleensis Blome, 1984, p. 25, pl. 2, figs. 7, 17.
Acanthocircus usilatus Blome, 1984, p. 25, pl. 2, figs. 8, 18.
Palaeosaturnalis largus (Blome) group comb. nov.
Acanthocircus largus Blome, 1984, p. 23, pl. 1, figs. 7, 8, 15, 16.
Acanthocircus lupheri Blome, 1984, p. 23, pl. 1, figs. 10, 18.
Acanthocircus ochocoensis Blome, p. 24, pl. 2, figs. 2, 13.
Acanthocircus prinevillensis Blome, 1984, p. 24, pl. 2, figs. 3, 14.
? *Acanthocircus burnsensis* Blome, 1984, p. 21, pl. 1, figs. 1, 11.
? *Acanthocircus izeensis* Blome, 1984, p. 22, pl. 1, figs. 6, 14.
? *Acanthocircus macoyensis* Blome, 1984, p. 24, pl. 2, figs. 1, 12.

Fig. 51. 1. *Praemesosaturnalis multidentatus* (Kozur and Mostler) group, ESN 148294, H-33, TR 8A. 2. *Paleosaturnalis harrisonensis* (Blome) group, ESN 148295, N-18, TR 7. 3. *Pseudoheliodiscus finchi* Pessagno group, ESN 148296, HZ-12, TR 7. 4. Saturnalidae gen. *et* sp. indet., ESN 148297, HZ-13, TR 7. 5. *Pseudoheliodiscus robustospinus* Kozur and Mostler, ESN 148298, K-85, TR 9B. 6. *Paleosaturnalis dotti* (Blome) group, ESN 149299, HZ-21, TR 7. 7. *Pseudoheliodiscus huangi* Yeh group, ESN 148300, HZ-27, TR 8A. 8. *Pseudoheliodiscus heisseli* Kozur and Mostler group, ESN 148301, HZ-23, TR 7. 9, 10. *Praehexasaturnalis tenuispinosus* (Kozur and Mostler) group. 9: ESN 148302, HZ-21, TR 7. 10. ESN 148303, HZ-27, TR 8A. 11. *Praemesosaturnalis sandspitensis* (Blome), ESN 148304, HZ-13, TR 7. 12. *Pseudacanthocircus pseudosimplex* Kozur and Mostler, ESN 148305, K-83, JR 0A. 13. *Paleosaturnalis zapfei*, ESN 148306, HZ-8, TR 6B. 14. *Praemesosaturnalis decilobum* (Carter), ESN 148307, H-72, TR 8A. 15. *Praemesosaturnalis gracilis* (Kozur and Mostler), ESN 148308, H-71, TR 8A. 16. *Praemesosaturnalis heilongjiangensis* Yang and Mizutani group, ESN 148309, K-4, TR 8A. 17. *Praemesosaturnalis rugosus* (Yeh) group, ESN 148310, H-65, TR 8A. 18. Spumellaria gen. *et* sp. indet. F, ESN 148311, K-56, TR 8C. 19. *Pentaspongodiscus dihexacanthus* Carter, ESN 148312, K-100, JR 0B. 20. Spumellaria gen. *et* sp. indet. D., ESN 148313, H-28, TR 8A. 21. Spumellaria gen. *et* sp. indet. E, ESN 148314, H-21, TR 7. 22. *Paratriassoastrum* sp. cf. *P. crassum* Carter, ESN 148315, K-71, TR 8D. Scale bar=50 μm.

? *Acanthocircus silverensis* Blome, 1984, p. 25, pl. 2, figs. 6, 16.

Palaeosaturnalis zapfei (Kozur and Mostler) (Fig. 51-13)

Spongosaturnalis zapfei Kozur and Mostler, 1972, p. 41, pl. 1, fig. 2.

Palaeosaturnalis zapfei (Kozur and Mostler); Kozur and Mostler, 1981, p. 56.

Paleosaturnalis sp. aff. *P. radidenticulatus* Kozur and Mostler

aff. *Paleosaturnalis radidenticulatus* Kozur and Mostler, 1982, p. 56, pl. 61, fig. 5.

aff. *Acanthocircus rotundus* Blome, 1984, p. 24, pl. 2, figs. 4, 5, 15.

Pantanellium (?) *virgeum* Sashida group

Pantanellium (?) *virgeum* Sashida, 1991, p. 691, figs. 7-9—14.

Remarks: Thickness of the polar spines is quite variable. Moreover, some have completely rod-like spines and others possess proximally bladed spines.

Pantanellium sp. cf. *P. newkluense* Carter

cf. *Pantanellium newkluense* Carter, 1993, p. 65, pl. 7, figs. 5-7, 13, 14.

Parahsuum ovale Hori and Yao

Parahsuum (?) sp. C, Yao, 1982, pl. 4, figs. 9-11.

Parahsuum ovale Hori and Yao, 1988, p. 51, pl. 1, figs. 3a-e, 4a-c, 6-8, 9a, b.

Parahsuum simplum Yao (Fig. 28-8)

Archaeodictyomitra sp. A, Yao, Matsuda and Isozaki, 1980, pl. 3, figs. 7-9.

Parahsuum simplum Yao, 1982, p. 61, pl. 4, figs. 1-8.

Parasepsagon (?) *antiquus* (Sugiyama) comb. nov.

Plafkerium (?) *antiquum* Sugiyama, 1992, p. 1218, figs. 18-4—6.

Remarks: This species may be related to the *Parasepsagon* species rather than *Plafkerium* as mentioned by Ramvos and Goricăn (1995). It is better to restrict the usage of the generic name *Plafkerium* to an evolutional lineage including *Plafkerium abbotti*, the type species of the genus. Therefore, *Plafkerium* (?) *confluens* Dumitrica, Kozur and Mostler and *Plafkerium* (?) *muelleri* Dumitrica, Kozur and Mostler listed below should be separated to another genus or other genera.

Parasepsagon tetracanthus Dumitrica, Kozur and Mostler, 1980, p. 13, pl. 1, fig. 8, pl. 2, fig. 7.

Parasepsagon variabilis (Nakaseko and Nishimura)

Staurodoras variabilis Nakaseko and Nishimura, 1979, p. 71, pl. 3, figs. 5, 8.

Parasepsagon variabilis (Nakaseko and Nishimura); Yeh, 1989, p. 63, pl. 1, figs. 16, 19.

Paratriassoastrum sp. cf. *P. crassum* Carter (Fig. 51-22)

cf. *Paratriassoastrum crassum* Carter, 1993, p. 77, pl. 11, figs. 1, 2, 5, 6.

Parentactinia inermis Dumitrica

Parentactinia inerme Dumitrica (*sic*), 1978b, p. 51, pl. 5, figs. 4-6.

Parentactinia nakatsugawaensis Sashida group (Figs. 27-2, 3)

Parentactinia nakatsugawaensis Sashida, 1983, p. 172, pl. 37, figs. 1-9.

Parentactinia virgata Sashida, 1991, p. 689, fig. 6-7.

Pactarentinia koikei Sashida, 1991, p. 691, figs. 6-2, 8-12.

Polyentactinia ? phatthalungensis Sashida and Igo, 1992, p. 1304, figs. 5-1—15.

Remarks: The species concept follows Sugiyama (1992).

Parentactinia okuchichibuensis (Sashida)

Archaeothamnulus okuchichibuensis Sashida, 1991, p. 687, figs. 5-10-14.

Parentactinia okuchichibuensis (Sashida); Sugiyama, 1992, p. 1213, figs. 16-2a, b.

Parentactinia pugnax Dumitrica, 1978b, p. 50, pl. 4, figs. 4, 5, pl. 5, figs. 1-3.

Paronaella pacofiensis Carter (Fig. 50-15)

Sontanella sp. A, Yeh, 1992, p. 62, pl. 2, fig. 8.

Paronaella pacofiensis Carter, 1993, p. 81, pl. 10, fig. 5.

Paronaella trammeri (Kozur and Mostler)

Rhopalodictyum trammeri Kozur and Mostler, 1978, p. 152, pl. 1, figs. 3, 8, pl. 3. figs. 8-11, 16.

Paronaella trammeri (Kozur and Mostler); Kozur and Mostler, 1981, p. 61.

Paronaella (?) sp. cf. *P.* (?) *beatrica* Carter

cf. *Paronaella* (?) *beatrica* Carter, 1993, p. 80, pl. 10, figs. 7, 8, 15, 16.

Pegoxystris mizutanii Sugiyama, 1992, p. 1218, figs. 17-7, 8.

Pentactinocarpus awaensis (Nakaseko and Nishimura) group comb. nov. (Fig. 49-24)

Acanthosphaera awaensis Nakaseko and Nishimura, 1979, p. 67, pl. 1, figs. 1, 5, 6.

Remarks: Included are forms having four basal spines incompletely incorporated with latticed shell wall, and lacking antapical spine. The basal spines deviate inside from the shell wall especially in the middle to distal part, so that the extensions of the basal spines arise always from the lower hemisphere of the shell. Additional spines are very often present.

Pentactinocarpus fusiformis Dumitrica, 1978b, p. 44, pl. 2, fig. 2. (Fig. 49-21)

Pentactinocarpus sevaticus Kozur and Mostler, 1981, p. 21, pl. 52, fig. 3, pl. 53, figs. 2, 5, pl. 55, fig. 1. (Fig. 16-7)

Pentactinocarpus tetracanthus Dumitrica, 1978b, p. 44, pl. 2, fig. 1. (Fig. 49-23)

Pentaspongodiscus (?) *dihexacanthus* Carter, 1993, p. 87, pl. 13, figs. 1-3. (Fig. 51-19)

Pentaspongodiscus mesotriassicus Dumitrica, Kozur and Mostler, 1980, p. 10, pl. 8, fig. 7.

Plafkerium (?) *confluens* Dumitrica, Kozur and Mostler, 1980, p. 13, pl. 1, fig. 1.

Plafkerium (?) *muelleri* Dumitrica, Kozur and Mostler, 1980, p. 14, pl. 1, fig. 3.

Plafkerium sp. cf. *P. abbotti* Pessagno

cf. *Plafkerium abbotti* Pessagno *in* Pessagno *et al.*, 1979, p. 179, pl. 9, figs. 6, 10, 14.

Planispinocyrtis (?) *gabiolaensis* Kozur and Mostler, 1994, p. 95, pl. 23, fig. 13. (Fig. 49-7)

Planispinocyrtis baloghi Kozur and Mostler, 1981, p. 111, pl. 10, fig. 2.

Planispinocyrtis multiporata Kozur and Mostler, 1994, p. 98, pl. 25, figs. 1, 3, 5, 6, 9.

Planispinocyrtis praecursor Kozur and Mostler, 1994, p. 103, pl. 25, figs. 7, ?13, 14. (Fig. 48-14)

Poulpus sp. cf. *P. curvispinosus* Dumitrica, Kozur and Mostler (Fig. 49-9)

cf. *Poulpus curvispinosus* Dumitrica, Kozur and Mostler, 1980, p. 22, pl. 2, fig. 1, pl. 15, figs. 5, 6.

Poulpus (?) *coronensis* (Yeh) comb. nov.

Parapoulpus coronensis Yeh, 1990, p. 26, pl. 8, figs. 8, 10.

Remarks: Kozur and Mostler (1981) redefined the genus

Parapoulpus Kozur and Mostler, 1979, as a two-segmented form. Therefore one-segmented forms with three feet arising above the rim of cephalis should be assigned to *Annulopoulpus* Kozur and Mostler, 1981. Most individuals of this species however have three feet whose lower edges attached to the rim of cephalis. This species is thus questionably assigned to *Poulpus*.

Poulpus phasmatodes De Wever *in* De Wever *et al.*, 1979, p. 96, pl. 7, figs. 10, 11. (Fig. 49-20)

Poulpus piabyx De Wever *in* De Wever *et al.*, 1979, p. 98, pl. 7, figs. 12, 13. (Fig. 49-15)

Praeheliostaurus ingridae (Mostler and Krainer) (Fig. 48-26)

Ornatisaturnalis ingridae Mostler and Krainer, 1993, p. 103, pl. 10, figs. 1-5.

Praeheliostaurus levis Kozur and Mostler, 1972, p. 26, pl. 2, fig. 11. (Fig. 48-25)

Praehexasaturnalis tenuispinosus (Donofrio and Mostler) group (Figs. 51-9, 10)

Palaeosaturnalis tenuispinosus Donofrio and Mostler, 1978, p. 37, pl. 7, figs. 1-3, 8.

Spongosaturnalis sp. cf. *S. elegans* Kozur and Mostler; De Wever in De Wever *et al.*, 1979, p. 81, pl. 2, figs. 3, 4.

Palaeosaturnalis aff. *tenuispinosus* Donofrio and Mostler; Yao, 1982, pl. 3, fig. 17.

Praehexasaturnalis tenuispinosus (Donofrio and Mostler); Kozur and Mostler, 1983, p. 29.

Acanthocircus vigrassi Blome, 1984, p. 24, pl. 2, figs. 9, 10.

Acanthocircus cf. *A. elegans* Kozur and Mostler (*sic*); Yoshida, 1986, pl. 15, figs. 8, 9.

Kozurastrum aff. *tenuispinosus* (Donofrio and Mostler); Matsuoka *et al.*, 1994, pl. 4, fig. 16 (illustrated is the same specimen to Yao, 1982).

Remarks: Shape and thickness of the ring are more or less inconstant among individuals.

Praehexasaturnalis sp. cf. *P. elegans* (Kozur and Mostler)

cf. *Spongosaturnalis elegans* Kozur and Mostler, 1972, p. 34, pl. 1, fig. 4.

Praemesosaturnalis bifidus (Kozur and Mostler)

Spongosaturnalis bifidus Kozur and Mostler, 1972, p. 31, pl. 2, fig. 18.

Praemesosaturnalis bifidus (Kozur and Mostler); Kozur and Mostler, 1981, p. 58.

Praemesosaturnalis decilobum (Carter) comb. nov. (Fig. 51-14)

Kozurastum decilobum Carter, 1993, p. 53, pl. 4, fig. 1.

Pseudoheliodiscus decilobum (Carter); Yeh and Cheng, 1996, p. 9, pl. 3, fig. 13.

Remarks: Spine features are variable. Illustrated specimen has shorter and more acute spines than the holotype.

Praemesosaturnalis gracilis (Kozur and Mostler) (Fig. 51-15)

Spongosaturnalis gracilis Kozur and Mostler, 1972, p. 35, pl. 1, fig. 17.

Praemesosaturnalis gracilis (Kozur and Mostler); Kozur and Mostler, 1983, p. 25.

Praemesosaturnalis heilongjiangensis Yang and Mizutani group (Fig. 51-16)

Palaeosaturnalis bifidus (Kozur and Mostler); Yao, 1982, pl. 3, fig. 17.

Acanthocircus sp., Yoshida, 1986, pl. 16, fig. 12.

Praemesosaturnalis heilongjiangensis Yang and Mizutani, 1991, p. 67, pl. 1, figs. 3, 4, 6, 10, 12, 13.

Kozurastum bifidus (Kozur and Mostler) (*sic*); Matsuoka *et al.*, 1994, pl. 4, fig. 17 (illustrated is the same specimen to Yao, 1982).

Remarks: Most individuals do not retain completely preserved spines, which results in apparent bifurcation as mentioned by Yang and Mizutani (1992). The spines are often subparallel to the ring, but they are never twisted.

Praemesosaturnalis multidentatus (Kozur and Mostler) group (Figs. 28-2, 51-1)

Spongosaturnalis multidentatus Kozur and Mostler, 1972, p. 38, pl. 1, fig. 20.

Palaeosaturnalis validus Donofrio and Mostler, 1978, p. 38, pl. 7, figs. 4-6, 10.

Praemesosaturnalis multidentatus (Kozur and Mostler); Kozur and Mostler, 1981, p. 58.

Palaeosaturnalis sp. G, Kishida and Sugano, 1982, pl. 3, figs. 17-19.

Palaeosaturnalis sp. H, Kishida and Sugano, 1982, pl. 3, figs. 20, 21.

Palaeosaturnalis multidentatus (Kozur and Mostler); Kishida and Hisada, 1985, pl. 1, fig. 1.

? *Acanthocircus heisseli* Kozur and Mostler (*sic*); Yoshida, 1986, pl. 15, fig. 1.

Acanthocircus sp., Yoshida, 1986, pl. 16, figs. 1-5.

Pseudoheliodiscus sp. aff. *P. multidentatus* (Kozur and Mostler); Yeh, 1990, p. 18, pl. 12, fig. 13; pl. 15, 7, 9-11.

Pseudoheliodiscus sp. cf. *P. multidentatus* (Kozur and Mostler); Yeh, 1990, p. 18, pl. 15, fig. 12.

Remarks: This species is characterized by possessing a broad ring with relatively low, more or less triangular-shaped, flattened spines. The peripolar spines are short and thin, and the auxiliary spines are also tiny. Therefore those spines, especially the latter, are considerably susceptible to dissolutional effect resulted from diagenesis or extracting procedure of individuals. It seems to be one of reason why the generic assignment is different among investigators. Moreover, the number and shape of spines in this species are very inconstant in an assemblage. Even if we picked those two forms from a residue, which seem to belong to different species at a glance, a few intermediate forms between such two forms could always be found by subsequent reserch. Stratigraphic change of the morphology may be present, but it is in the present state of knowledge impossible to separate this species group into some species by clear diagnoses.

Praemesosaturnalis rugosus (Yeh) group comb. nov. (Fig. 51-17)

Palaeosaturnalis sp. F, Kishida and Sugano, 1982, pl. 3, figs. 14, 15 (? fig. 16).

Acanthocircus convertus Kozur and Mostler (*sic*); Yoshida, 1986, pl. 15, figs. 4-6.

Pseudoheliodiscus rugosus Yeh, 1990, p. 19, pl. 12, figs. 10, 14, pl. 13, fig. 12.

Pseudoheliodiscus sp. aff. *P. rugosus* Yeh; Yeh, 1990, p. 19, pl. 12, figs. 3, 6.

Remarks: The spines exhibit more or less sinistral torsion. Shape of the spines is variable from narrow to wide.

Praemesosaturnalis sandspitensis (Blome) comb. nov. (Fig. 51-11)

Pseudoheliodiscus sandspitensis Blome, 1984, p. 27, pl. 3, figs. 6, 7.

Praemesosaturnalis shengi Yang and Mizutani, 1991, p. 71, pl. 1, figs. 1, 2, 9.
Praemesosaturnalis zhangi Yang and Mizutani, 1991, p. 71, pl. 1, figs. 5, 7, 8, 14, 15.
Pseudacanthocircus laevis Kozur and Mostler, 1990, p. 208, pl. 2, fig. 2, pl. 11, fig. 8.
Pseudoacanthocircus sp. cf. *teminospinosus* Kozur and Mostler
cf. *Pseudoacanthocircus terminospinosus* Kozur and Mostler, 1990, p. 209, pl. 10, fig. 2, pl. 11, figs. 1, 4.
Pseudacanthocircus pseudosimplex Kozur and Mostler, 1990, p. 209, pl. 11, fig. 2. (Fig. 51-12)
Pseudoheliodiscus finchi Pessagno group (Fig. 51-3)
Pseudoheliodiscus finchi Pessagno *in* Pessagno *et al*., 1979, p. 170, pl. 5, figs. 9, 10.
Pseudoheliodiscus heisseli (Kozur and Mostler) group (Fig. 51-8)
Spongosaturnalis heisseli Kozur and Mostler, 1972, p. 36, pl. 1, figs. 15, 16.
Pessagnosaturnalis heisseli (Kozur and Mostler); Kozur, 1979, p. 670.
Pseudoheliodiscus heisseli (Kozur and Mostler); Kozur and Mostler, 1983, p. 21.
Pseudoheliodiscus huangi Yeh group (Fig. 51-7)
Pseudoheliodiscus huangi Yeh, 1990, p. 17, pl. 12, fig. 2, pl. 13, fig. 5.
Pseudoheliodiscus sp. aff. *P. huangi* Yeh; Yeh, 1990, p. 18, pl. 12, fig. 1.
Remarks: The width and shape of the ring is variable among individuals.
Pseudoheliodiscus robustspinosus Kozur and Mostler, 1990, p. 190, pl. 2, figs. 3, 8, pl. 4, figs. 8-11, pl. 5, fig. 10. (Fig. 17-5)
Pseudoheliodiscus sp. cf. *P. alpinus* Kozur and Mostler
cf. *Pseudoheliodiscus alpinus* Kozur and Mostler, 1990, p. 189, pl. 5, figs. 1, 3, 5-9, 11, 12.
Pseudostylosphaera cocostyla (Rüst)
Spongatractus cocostylus Rüst, 1892, p. 160, pl. 21, fig. 8.
Pseudostylosphaera cocostyla (Rüst); Kozur and Mostler, 1979, p. 31, pl. 15, fig. 3, pl. 46, fig. 5.
Pseudostylosphaera goestlingensis (Kozur and Mostler) (Fig. 48-19)
Stylosphaera ? goestlingensis Kozur and Mostler, 1979, p. 54, pl. 17, fig. 5; pl. 18, fig. 1.
Archaeospongoprunum helicatum Nakaseko and Nishimura, 1979, p. 68, pl. 2, figs. 1, 2; pl. 12, fig. 3.
Pseudostylosphaera goestlingensis (Kozur and Mostler); Kozur and Mostler, 1981, p. 31.
Remarks: This species is distinguished from *Pseudostylosphaera hellenica* (De Wever) by having relatively gentle dextral torsion on the whole spines. *P. nazarovi* somewhat resembles this species, but the former species differs from the latter in having sinistral torsion on the spines.
Pseudostylosphaera gracilis Kozur and Mock *in* Kozur and Mostler, 1981, p. 32, pl. 66, fig. 1. (Fig. 48-18)
Remarks: This species is distinguished from *Pseudostylosphaera hellenica* by having sinistral torsion on the spines rather than dextral torsion.
Pseudostylosphaera hellenica (De Wever)
Archaeospongoprunum (?) *hellenicum* De Wever *in* De Wever *et al*., 1979, p. 78, pl. 1, fig. 8.
Pseudostylosphaera hellenica (De Wever); Kozur and Mostler, 1981, p. 31.
Remarks: This species is characterized by possessing strong dextral torsion in the middle to distal part of the spines.
Pseudostylosphaera japonica (Nakaseko and Nishimura) group (Fig. 48-15)
Archaeospongoprunum japnicum Nakaseko and Nishimura, 1979, p. 67, pl. 1, figs. 2, 4, 9.
Archaeospongoprunum compactum Nakaseko and Nishimura, 1979, p. 68, pl. 1, figs. 3, 7.
Pseudostylosphaera japonica (Nakaseko and Nishimura); Kozur and Mostler, 1981, p. 31.
Remarks: Most individuals exhibit intermediate forms between *Pseudostylosphaera japonica* and *P. compacta*.
Pseudostylosphaera kozuri Sugiyama, 1992, p. 1208, figs. 13-7, 8.
Pseudostylosphaera longispinosa Kozur and Mostler group (Fig. 48-16)
Pseudostylosphaera longispinosa Kozur and Mostler, 1981, p. 32, pl. 1, fig. 6.
Pseudostylosphaera longobardica Kozur and Mostler, 1981, p. 33, pl. 49, fig. 3.
Remarks: The species concept follows Goricăn and Buser (1990).
Pseudostylosphaera magnispinosa Yeh, 1989, p. 63, pl. 1, figs. 1, 2, 11, 18. (Fig. 48-23)
Pseudostylosphaera nazarovi (Kozur and Mostler) (Fig. 48-17)
Stylosphaera ? nazarovi Kozur and Mostler, 1979, p. 55, pl. 1, fig. 5, pl. 14, figs. 4, 6.
Pseudostylosphaera nazarovi (Kozur and Mostler); Kozur and Mostler, 1981, p. 31.
Remarks: This species is characterized by possessing gentle sinistral torsion on the spines.
Pseudostylosphaera tenuis (Nakaseko and Nishimura)
Archaeospongosprunum tenue Nakaseko and Nishimura, 1979, p. 68, pl. 1, figs. 8. 10.
Pylostephanidium clavator Dumitrica, 1978a, p. 34, pl. 2, figs. 6, 7.
Renzium sp. cf. *R. adversum* Blome
cf. *Renzium adversum* Blome, 1983, p. 40, pl. 10, figs. 1, 6, 7, 12.
Risella tledoensis Carter (Fig. 50-16)
Gen. nov. C sp., 1, Carter, 1990, pl. 2, fig. 1.
Hagiastrum (?) sp., Bragin, 1991, pl. 7, fig. 2.
Paronaella sp. B, Yeh, 1992, p. 62, pl. 2, fig. 12.
Risella tledoensis Carter, 1993, p. 75, pl. 9, figs. 10, 11, 13.
Ruzencevispongus sp. cf. *R. uraricus* Kozur (Fig. 48-4)
cf. *Ruzencevispongus uraricus* Kozur, 1980, p. 237, pl. 1, figs. 1-3.
Sarla delicata Blome, 1983, p. 18, pl. 3, figs. 1, 6, 14.
Sarla (?) *externa* Blome (Fig. 49-19)
Sarla (?) *externa* Blome, 1983, p. 18, p. 3, figs. 2, 8, 9, 15.
Tripocyclina sp., Yoshida, 1986, pl. 14, fig. 2 (*non* fig. 3).
Sarla hadrecaena (De Wever) (Fig. 50-14)
Tripocyclina (?) *hadrecaena* De Wever *in* De Wever *et al*., 1979, p. 87, pl. 5, figs. 1, 2.
Sarla hadrecaena (De Wever); De Wever, 1982b, p. 167, pl. 8, figs. 5-8, pl. 9, fig. 1.
Sarla prietoensis Pessagno group
Sarla prietoensis Pessagno *in* Pessagno *et al*., 1979, p. 174, pl. 7, figs. 4, 6, 7, 13, 14. (Fig. 50-13)
Sarla transita (Kozur and Mock) comb. nov.
Vinassaspongus transitus Kozur and Mock *in* Kozur and

Mostler, 1981, p. 69, pl. 64, fig. 1.
Sarla vetusta Pessagno *in* Pessagno *et al*., 1979, p. 174, pl. 7, figs. 4, 6, 7, 13, 14. (Fig. 50-10)
Stauracanthocircus quadratus Kozur and Mostler, 1990, p. 199, pl. 3, figs. 4, 6, pl. 8, figs. 2, 3, 5.
Saturacanthocircus sp. cf. *S. asymmetricus* Kozur and Mostler
cf. *Saturacanthocircus asymmetricus* Kozur and Mostler, 1990, p. 197, pl. 2, fig. 9, pl. 8, figs. 7-10, pl. 9, figs. 1-5, 7, 10, 12.
Silicarmiger costatus Dumitrica, Kozur and Mostler, 1980, p. 23, pl. 7, figs. 1-6, pl. 14. fig. 4.
Silicarmiger latus Kozur and Mostler (Fig. 49-27)
Stichopterium (?) sp. A, Nakaseko and Nishimura, 1979, p. 80, pl. 11, figs. 1, 3, 4.
Silicarmiger aff. *costatus* Dumitrica, Kozur and Mostler; Gori cãn and Buser, 1990, p. 156, pl. 10, fig. 9.
Silicarmiger latus Kozur and Mostler, 1994, p. 119, pl. 34, figs. 1-4, 9, pl. 35, figs. 1, 2, 4, 5.
Spinopoulpus noricus Kozur and Mock
Saitoum (?) sp. A, Pessagno *in* Pessagno *et al*., 1979, p. 186, pl. 4, fig. 1.
Poulpus (?) sp., Nakaseko and Nishimura, 1979, p. 78, pl. 11, fig. 7 (*non*. figs. 6, 7, 9).
Spinopoulpus noricus Kozur and Mock *in* Kozur and Mostler, 1981, p. 86, pl. 30, fig. 4.
Spinotriassocampe annulata (Nakaseko and Nishimura) group comb. nov. (Fig. 49-1)
Yeharaia annulata Nakaseko and Nishimura, 1979, p. 82, pl. 10, fig. 1, 7; pl. 12, fig. 5.
Triassocampe (?) *annulata* (Nakaseko and Nishimura); Yao, 1982, pl. 1, fig. 11.
Triassocampe (?) sp. A., Cheng, 1989, p. 148, pl. 7, fig. 17.
Triassocampe annulata (Nakaseko and Nishimura); Yeh, 1990, p. 28, pl. 7, figs. 1, 6, 4, pl. 10, fig. 10, pl. 11, fig. 9.
Triassocampe sp. aff. *T. annulata* (Nakaseko and Nishimura); Yeh, 1990, p. 28, pl. 7, fig. 22.
Remarks: The length of the apical spine is variable. In older assemblages a morphotype identical to Cheng's (1989) illustration predominates over long-spined morphotype.
Spinotriassocampe carnica Kozur and Mostler group (Fig. 49-3)
Triassocampe (?) sp. F, Yao, 1982, pl. 1, fig. 10.
Spinotriassocampe carnica Kozur and Mostler, 1994, p. 105, pl. 26, fig. 7.
Spinotriassocampe longobardica Kozur and Mostler, 1994, p. 106, pl. 26, figs. 8, 11, 12, pl. 27, figs. 4, 6, 8.
Spinotriassocampe hungarica Kozur group (Fig. 49-2)
Stichopilium sp. A, Nakaseko and Nishimura, 1979, p. 79, pl. 9, figs. 6-8, pl. 12, fig. 8.
Spinotriassocampe hungarica Kozur, 1984, p. 74, pl. 4, fig. 2.
Spinotriassocampe mesofassanica Kozur and Mostler, 1994, p. 107, pl. 26, fig. 13, pl. 27, figs. 1, 2, 5, 9.
Spinotriassocampe eofassanica Kozur and Mostler, 1994, p. 105, pl. 27, fig. 3.
Spinotriassocampe transita Kozur and Mostler, 1994, p. 107, pl. 27, fig. 27.
Spongoserrula dehli Cordey, De Wever, Dumitrica, Danelian, Kito and Vrielynck, 1988, p. 31, pl. 1, figs. 1-5. (Fig. 27-12)
Spongosilicarmiger italicus Kozur
Stichopterium (?) sp. B, Nakaseko and Nishimura, 1979, p. 80, pl. 11, figs. 2, 5.
Spongosilicarmiger italicus Kozur, 1984, p. 64, pl. 6, fig. 2, pl. 7, fig. 1.
Spongosilicarmiger nakasekoi Yeh, 1990, p. 25, pl. 5, figs. 3, 16, pl. 8, figs. 4, 5, pl. 9, figs. 7, 8, 14, pl. 11, fig. 20.
Spongosilicarmiger gigantoceras (Sugiyama) comb. nov.
Nofrema (?) *gigantoceras* Sugiyama, 1992, p. 1201, figs. 12-1-3.
Spongosilicarmiger holdsworthi (Sugiyama) comb. nov.
Hinedorcus holdsworthi Sugiyama, 1992, p. 1201, figs. 12-5a, b.
Spongosilicarmiger mostleri Sugiyama
Spongosilicarmiger mostleri Sugiyama, 1992, p. 1199, figs. 11-13, 14.
Spongosilicarmiger gabiolaensis Kozur and Mostler, 1994, p. 121, pl. 35, figs. 3, 6, 8, 9, 11, pl. 36, figs. 1, 4, 5, 7, 8, 10, pl. 37, figs. 2-4, 7, 8.
Spongostylus carnicus Kozur and Mostler, 1979, p. 56, pl. 9, figs. 5, 6, 8.
Spongostylus tortilis Kozur and Mostler, 1979, p. 56, pl. 4, fig. 2, pl. 11. fig. 6, pl. 18, fig. 2.
Spongoxystris (?) *slovenica* (Kolar-Jurkovsek) comb. nov.
Pseudostylosphaera slovenica Kolar-Jurkovsek, 1989, p. 158, pl. 2, figs. 2, 3.
? *Spongopallium* ? sp. A., Goricăn and Buser, 1990, p. 157, pl. 4, fig. 5.
Remarks: This species is tentatively referred to *Spongoxystris* gen. nov., but further reserch is necessary to determine the generic asignment.
Spongoxystris sp. cf. *S. koppi* (Larm) comb. nov.
cf. *Cromyostylus ? koppi* Lahm, 1984, p. 68, pl. 12, figs. 1, 2.
cf. *Spongopallium* n. sp., Kozur and Rĕti, 1986, fig. 6H.
cf. *Spongopallium ? koppi* (Lahm); Goricăn and Buser, 1990, p. 157, pl. 4, fig. 1.
Squinabolella (?) *trispinosa* Carter (Fig. 50-12)
Squinabolella ? trispinosa Carter, 1993, p. 102, pl. 17, figs. 3, 4.
Squinabolella (?) sp. cf. *S.* (?) *trispinosa* Carter; Yeh and Cheng, 1996, p. 14, pl. 5, figs. 1, 2, 6, 15, 16.
Stauracontium (?) *trispinosum* (Kozur and Mostler)
Staurosphaera trispinosa Kozur and Mostler, 1979, p. 58, pl. 21, fig. 3.
Staurosphaera triloba Nakaseko and Nishimura, 1979, p. 72, pl. 5, figs. 1, 2.
Stauracontium ? trispinosum ladinicum Dumitrica, Kozur and Mostler, 1980, p. 17, pl. 1, fig. 5 (?), pl. 2, fig. 4, pl. 3, figs. 6, 7, pl. 5, fig. 4, pl. 14, fig. 5.
Syringocapsa batodes De Wever
Syringocapsa batodes De Wever *in* De Wever *et al*., 1979, p. 91, pl. 6, figs. 10-12.
Syringocapsa turgida Blome, 1984, p. 53, pl. 14, figs. 2, 6, 7, 16.
Syringocapsa coliforme Hori
Syringocapsa sp. C, Yao, 1982, pl. 4, fig. 16.
Syringocapsa coriforme Hori, 1988, p. 556, figs. 8-1-10.
Tandarnia recoarensis Dumitrica (Fig. 48-10)
Tandarnia recoarense Dumitrica (*sic*), 1982c, p. 415, pl. 3. figs. 6-10.
Tetraporobrachia composita Carter, 1993, p. 90, pl. 12, figs. 7, 11.
Tetraporobrachia haeckeli Kozur and Mostler, 1979, p. 79, pl. 4, fig. 6, pl. 5, figs. 1, 2.
Tetrarchiplagia arborescens Dumitrica, 1982c, p. 412, pl. 2, figs. 1-4.
Tetrarchiplagia simplex Sugiyama, 1992, p. 1191, figs. 9-1a, 1b.
Tetraspinocyrtis annuloporata Kozur and Mostler, 1994, p. 130,

pl. 40, figs. 2, 3, 8.
Tiborella agria Sugiyama, 1992, p. 1220, figs. 18-1-3.
Tiborella florida (Nakaseko and Nishimura)
Cecrops floridus Nakaseko and Nishimura, 1979, p. 69, pl. 2, figs. 5, 8.
Tiborella floria (Nakaseko and Nishimura); Kozur and Mostler, 1994, p. 52.
Trialatus longicornutus Yeh, 1990, p. 27, pl. 8, figs. 2, 6. (Fig. 49-25)
Trialatus megacornutus Yeh, 1990, p. 28, pl. 8, figs. 1, 15, 18, 19, pl. 10, fig. 12. (Fig. 49-26)
Trialatus robustus (Nakaseko and Nishimura) comb. nov. (Fig. 27-16)
Napora robusta Nakaseko and Nishimura, 1979, p. 78, pl. 8, figs. 4-6.
Triassobipedis balatonica Kozur, 1984, p. 69, pl. 4, figs. 4a, b.
Triassocampe baldii (Kozur) (Fig. 49-6)
Annulotriassocampe baldii Kozur *in* Kozur and Mostler, 1994, p. 249, pl. 1A, fig. 13.
Triassocampe campanilis (Kozur and Mostler) (Fig. 48-12)
Annulotriassocampe campanilis Kozur and Mostler, 1994, p. 132, pl. 41, figs. 1-4, 7, 9-11, 13-18.
Triassocampe coronata Bragin group (Figs. 27-6, 7)
Dictiomitrella sp. A, Yao, Matsuda and Isozaki, 1980, pl. 1, fig. 10 (*non* figs. 9, 11).
Triassocampe coronata Bragin, 1991, p. 99, pl. 1, fig. 15.
Triassocampe sp. aff. *T. coronata* Bragin; Matsuoka *et al.*, 1994, pl. 1, figs. 4, 5.
? *Yeharaia transita* Kozur and Mostler, 1994, p 148, pl. 46, figs. 1-4, 12.

Remarks: As mentioned by Sugiyama (1992) some individuals have a short spine on the cephalis, whereas older individuals sometimes have a two-spined cephalis. One of the spines extending vertically is probably prolonged from **A**, and the other extending obliquely is from **V**. It is impossible to distinguish non-, one- and two-spined forms as separate species with time since the transition is quite smooth.

Triassocampe deweveri (Nakaseko and Nishimura) (Fig. 27-8)
Dictyomitrella deweveri Nakaseko and Nishimura, 1979, p. 77, pl. 10, figs. 8, 9.
Dictiomitrella sp. A, Yao, Matsuda and Isozaki, 1980, pl. 1, figs. 9, 11 (*non* fig. 10).
Triassocampe scalaris Dumitrica, Kozur and Mostler, 1980, p. 26, pl. 9, figs. 5, 6, 11, pl. 14, fig. 2.
Triassocampe deweveri (Nakaseko and Nishimura); Yao, 1982, pl. 1, figs. 1-3.
Triassocampe myterocorys Sugiyama, 1992, p. 1198, figs. 11-1—3b.
Triassocampe nodosoannulata (Kozur and Mostler)
Striatotriassocampe nodosoannulata Kozur and Mostler, 1994, p. 138, pl. 43, figs. 4, 10.
Triassocampe postdeweveri Kozur and Mostler, 1994, p. 144, pl. 42, fig. 2. (Fig. 48-13)
Triassocampe propria Blome
Triassocampe proprium Blome (*sic*), 1984, p. 59, pl. 16, figs. 4, 11, 14.
Triassocampe (?) *pulchra* Kozur and Mostler, 1981, p. 98, pl. 12, fig. 3.
Triassocampe sp. aff. *T. sulovensis* Kozur and Mock
aff. *Triassocampe sulovensis* Kozur and Mock *in* Kozur and Mostler, 1981, p. 99, pl. 13, fig. 3.
Triassocampe sp. cf. *T. illyrica* Kozur and Mostler
cf. *Triassocampe illyrica* Kozur and Mostler, 1981, p. 98, pl. 15, fig. 2.
Triassothumnus verticilatus (Dumitrica)
Palacantholithus (?) *verticilatus* Dumitrica, 1978b, p. 42, pl. 1, fig. 1, pl. 2, fig. 5.
Triassothumnus verticilatus Kozur and Mostler, 1981, p. 5.
Archaeothumnulus verticilatus (Dumitrica); Dumitrica, 1982c, p. 418, pl. 5, figs. 3, 4, pl. 7, fig. 4.
Tritortis integrita (Cordey, De Wever, Dumitrica, Danelian, Kito and Verielynck) comb. nov. (Fig. 48-22)
Sarla integrita Cordey, De Wever, Dumitrica, Danelian, Kito and Verielynck, 1988, p. 33, pl. 2, fig. 2.
Tritortis kretaensis (Kozur and Krahl) (Fig. 48-21)
Sarla? kretaensis Kozur and Krahl, 1984, p. 401, pl. 1, figs. 3, 4.
Sarla dispiralis Bragin, 1986, p. 67, pl. 1, fig. 15.
Sarla kretaensis Kozur and Krahl; Cordey *et al.*, 1988, p. 34, pl. 2, figs. 7, 9-11.
Tritortis kretaensis (Kozur and Mostler); Kozur, 1988b, p. 98, pl. 4, figs. 3-6, 8.
Supmellaria gen. et. sp. indet., Sashida *et al.*, 1993, p. 93, figs. 8-9-12 (non 7).
Tritortis sp. cf. *T. ariana* (Cordey, De Wever, Dumitrica, Danelian, Kito and Vrielynck) comb. nov.
cf. *Sarla ariana* Cordey, De Wever, Dumitrica, Danelian, Kito and Vrielynck, 1988, p. 32, pl. 1, figs. 8-11.
Tubortiassocyrtis annulata Kozur and Mostler, 1994, p. 90, pl. 21, figs. 9, 11. (Fig. 49-8)
Vinassaspongus subsphaericus Kozur and Mostler, 1979, p. 66, pl. 6, figs. 5-7, pl. 5, fig. 5.
Xipha pessagnoi (Nakaseko and Nishimura)
Dictyomitra pessagnoi Nakaseko and Nishimura, 1979, p. 77, pl. 9, figs. 2-4.
Nakasekoellus polita (Hinde) (*sic*); Kozur, 1984 (January), p. 60, pl. 3, fig. 4.
Xipha pessagnoi (Nakaseko and Nishimura); Blome, 1984 (April), p. 59, pl. 16, figs. 6, 9, 17.
? *Xipha striata* Blome, 1984, p. 60, pl. 16, figs. 5, 15, 16, pl. 17, fig. 18.
Xiphosphaera fistulata Carter, 1991, p. 200, pl. 1, figs. 4, 5, 7, 8, 9, 10. (Fig. 50-27)
Xiphotheca karpenissionensis De Wever
Xiphotheca karpenissionensis De Wever *in* De Wever *et al.*, 1979, p. 93, pl. 7, figs. 1-4 (non fig. 5).
Xiphotheca longa Kozur and Mock *in* Kozur and Mostler, 1981, p. 113, pl. 41, fig. 2.
Yeharaia elegans Nakaseko and Nishimura group (Figs. 27-9, 10)
Yeharaia elegans Nakaseko and Nishimura, 1979, p. 82, pl. 10, figs. 2-5, pl. 12, figs. 2, 6.

Remarks: In the younger morphotypes this species is represented by a form with shorter test and subspherical thorax, whereas taller test having rugby ball shaped thorax is predominant in later time of the range.

Zamolxis corona Dumitrica, 1982c, p. 407, pl. 1, figs. 1-4.
Zamolxis tardus Dumitrica, 1982c, p. 407, pl. 1, figs. 5, 6.
Zevius perarmatus Sugiyama, 1992, p. 1204, figs. 6a, b.
Zevius yaoi Sugiyama, 1992, p. 1204, figs. 12-4, 7.

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