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Middle Triassic Radiolarian Fauna from Lamphun, Northern Thailand

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ABSTRACT

An Anisian radiolarian assemblage has been recovered from thin-bedded siliceous rocks south of Lamphun, Northern Thailand. These sediments were formerly mapped as Permian strata. Twelve radiolarian species, which belong to eight genera, have been identified. The radiolarian assemblage can be correlated with the late Anisian *Triassocampe deweveri* zone in the Fang-Chiang Dao region and the Changning-Menglian belt of Yunnan. This result indicates that some part of the strata which are distributed between the Cenozoic Chiang Mai basin and the zone of granite and metamorphic rock located in the central part of Northern Thailand is younger than Permian. The stratigraphic sequence of this region is compared with the sequence of the eastern zone of the Changning-Menglian belt, Southwest Yunnan.

Key words: Triassic, Radiolarian, Lamphun, Northern Thailand.

INTRODUCTION

During the past ten years, Devonian to Triassic radiolarians have been discovered from Fang-Chiang Dao region north of Chiang Mai, Northern Thailand (Caridroit, 1993; Caridroit *et al.*, 1992; Sashida *et al.*, 2000). The cherty sequences bearing these radiolarian assemblages indicate that the region was part of the Paleotethyan pelagic basin and correlatable with the Changning-Menglian belt in Southwestern Yunnan (Caridroit *et al.*, 1992; Caridroit, 1993; Wu *et al.*, 1995; Zhong *et al.*, 2000). However, no evidence has been found up today, whether this pelagic basin extended farther to the south. As a consequence, the tectonic significance of this region was not understood.

During fieldwork in the autumn of 2000, a Middle Triassic radiolarian assemblage was discovered from strata formerly mapped as a Permian sequence, which is situated in the south of Chiang Mai, Northern Thailand. This result evidences the existence and evolution of deep basin of Triassic age. The following paper gives an account of the radiolarian assemblage, and discusses its geological significance.

GEOLOGIC BACKGROUND AND STRATIGRAPHY

On the 1: 1,000,000 geological map of Thailand, an obvious zone of granites and metamorphic rocks occurs in the central part of Northern Thailand. Extensive Carboniferous and few Permian strata crop out between the above-mentioned zone and the Cenozoic Chiang Mai basin. The metamorphic rocks are composed of phyllites, phyllitic schists, quartzofeldspatic schists with minor quartzites, phyllitic sandstone interbeds, which are divided to Silurian and Devonian in geological age. The Carboniferous strata mainly consist of greywackes, arkosic protoquartzites and orthoquartzites, quartzites and shales with quartz-veinlets. The Lower Permian includes phyllites, sandstones and siltstones, quartzites, quartzitic schists, agglomerates, and tuffs; and the Middle Permian is composed of massive limestones, shales, calcareous shales and sandstones with corals and crinoid stems (Charoenprawat *et al.*, 1994).

In autumn of 2000, fieldwork was carried out along the Highway 11 in order to study the stratigraphic sequence and sedimentary characters of the Carboniferous and Permian. A low hill, consisting of light grey, brown grey and thin-bedded siliceous rocks and siliceous shale, is situated in the east of the highway, approximately between 59.00-59.40km. Two samples (2000Stop28-1, 2) were collected for extracting radiolarians at 59.200km (18°30'16"N, 99°5'43"E) (Fig. 1). One sample (2000Stop28-1) contains abundant radiolarian tests, but only some radiolarians are identifiable to the species name as a result of poor preservation. Radiolarians from the other sample are few, and poorly preserved.

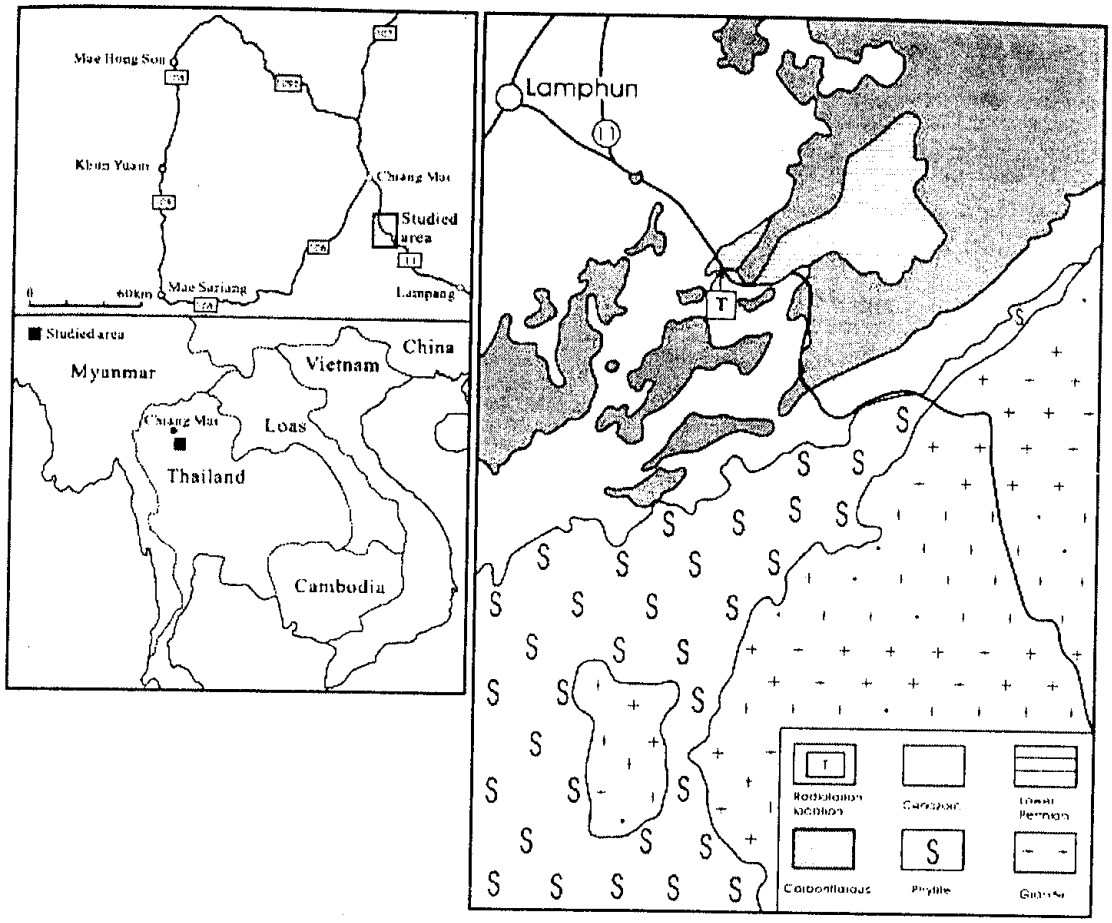

Figure 1 *Geological map of the studied area and the position of the fossil radiolarians reported (after Charoenprawat et al., 1994).*

RADIOLARIAN ASSEMBLAGE AND ITS AGE

The radiolarian assemblage is composed of 12 species which belong to 8 genera, including *Triassocampe deweveri* (Nakaseko and Nishimura), *Eptingium manfredi* Dumitrica, *Cryptostephanidium* sp. cf. *C. verrucosum* Dumitrica, *Parasepsagon asymmetricus praetetracanthus* Kozur and Mostler, *Pseudostylosphaera coccostylus* (Ruest), *Pseudostylosphaera longispinosa* Kozur and Mostler, *Parasepsagon variablis* (Nakaseko and Nishimura), *Paroertlispongus multispinosus* Kozur and Mostler, *Astrocentrus* sp. and others. It is characterized by the occurrence of abundant *Triassocampe deweveri* (Nakaseko and Nishimura), *Eptingium manfredi* Dumitrica, *Parasepsagon asymmetricus praetetracanthus* Kozur and Mostler, *Pseudostylosphaera coccostylus* (Ruest) and *Pseudostylosphaera longispinosa* Kozur and Mostler. It can be well correlated with the *Triassocampe deweveri* zone from the Mino terrane, Central Japan (Yao, 1982; Suguyama, 1997) and the *Triassocampe deweveri* zone from the Changning-Menglian belt, Southwestern Yunnan (Feng *et al.*, in press). Similar assemblages have also been discovered in the Philippines (Cheng, 1989; Tumanda *et al.*, 1990), the Far East of Russia (Bragin, 1991), and the European Tethys (Gorican and Buser, 1990; Kozur and Mostler, 1994). According to the radiolarian biostratigraphic data from Dumitrica (1982) and Lahm (1984) as well as to the conodont data from Mizutani and Koike (1982) and Sashida *et al.* (1993a), this zone is correlated to late Anisian (Sashida *et al.*, 1993a; Sugiyama, 1997; Feng *et al.*, 2001).

STRATIGRAPHIC IMPLICATION

The age of the discribed radiolarian fauna is important in as such as the stratigraphic units in this area were formerly dated on the basis of a few fossil locations and petrological similarities. However, strata in the studied area are possibly not continuous in stratigraphic sequence, but consist of some stratigraphic slices. Fossil age from any stratigraphic slice indicates only the geological age of this slice, and adjacent stratigraphic slices are often different in geological age. In the Fang-Chiang Dao region or the Lamphun area, radiolarian biostratigraphy supports this result (Caridroit, 1993; Caridroit *et al.*, 1992; Sashida et al., 2000). Some parts of the strata formerly mapped as Carboniferous and Permian stratigraphic units should be younger. In other words, except Carboniferous-Permian clastic rocks, shales and siliceous rock sequences there are early-middle Triassic fine-grain clastic rock and siliceous rocks sequences distributed in the studied area, which imply that the Middle Triassic deep basin in the Fang-Chiang Dao region must have extended southward to the Lamphun area.

CORRELATION WITH THE CHANGNING-MENGLIAN BELT

In southwestern Yunnan, the stratigraphic sequence of the eastern zone of the Changning-Menglian belt consists of the Lower Carboniferous Nanduan Formation and the Upper Carboniferous-Permian Laba Group (Liu *et al.*, 1991, 1993), and is closely similar to the one of the studied area near Lamphun. The Lower Carboniferous Nanduan Formation is a clastic sequence, and comprises low maturity arkose sandstones, quartz greywacke as well as quartz sandstones with a high maturity of its content but a low maturity of its texture (Jia, 1994), which contains the early Namurian ammonite *Stenopronorites* sp., *Prolecanites* sp. and others (Feng *et al.*, 1996). The Laba Group, formerly assigned only to Lower Permian (Bureau of Geology and Mineral Resources of Yunnan Province, 1982), varies in thickness between 900-1200m, and is subdivided into the lower clastic rock member, the siliceous rock-limestone-shale member, the upper clastic rock member, the siliceous rock-mudstone member, and the tuff member. The lower clastic rock member is characterized by purplish-red thin-bedded sandstone and mudstone. Fusunilids *Triticites* sp., *Schwagerina* sp. and radiolarians were discovered from the siliceous rock-limestone-shale member. Three Late Permian radiolarian assemblage zones, named *Follicucullus scholasticus* m. II, *Neoalbaillella optima*, and *Neoalbaillella ornithoformis* assemblage zones, were identified from the siliceous rock-mudstone member (Feng *et al.*, 1993, 1996). In addition, Middle-Upper Permian and Triassic radiolarian faunas were found from the strata that were mapped as the Laba Group, and the youngest radiolarian zone is *Triassocampe deweveri* zone as well (Feng, 1992; Feng *et al.*, 1993, 2001; Yao *et al.*, 1999).

These data clearly indicate that the Carboniferous to Middle Triassic sequences in the studied area can be correlated to those of the eastern zone of the Changning-Menglian belt. The Nanduan Formation resembles the Carboniferous clastic rocks extensively distributed in the north (e.g. northeast of Mae Hong Son) and east of the Chiang Mai Basin (Fig.1) not only in petrological characters, but also in sedimentary character and fossil assemblages. The Laba Group is similar to the Permian strata in the studied area. Therefore, the central zone of the Changning-Menglian belt should correlate to the west of the extensive Carboniferous to Triassic strata in the central part of Northwestern Thailand, and not to the Nan-Uttaradit belt.

Studies of radiolarians are vital in order to understand the tectonic evolution of Northern Thailand. A lot of strata, which has been mapped as Carboniferous and Permian, are distributed in the north and east of the Chiang Mai Basin (Fig.1). Future work on radiolarian biostratigraphy will result in an improved understanding on the geotectonic evolution of this complex geological unit.

SYSTEMATIC PALEONTOLOGY

Order **Polycystina** Ehrenberg, 1838
Suborder **Nassellaria** Ehrenberg, 1875

Family ***Triassocampidae*** Kozur and Mostler, 1981
Genus ***Triassocampe*** Dumitrica, Kozur and Mostler, 1980

Type species: *Triassocampe scalaris* Dumitrica, Kozur and Mostler, 1980

Triassocampe deweveri (Nakaseko and Nishimura), 1979
(Plate 1, Figs.1-5)

1979 *Dictyomitrella deweveri* sp. nov. Nakaseko and Nishimura: 77, pl.10, figs.8, 9.
1982 *Triassocampe deweveri* (Nakaseko and Nishimura).-Yao, pl.1, figs.1-3.
1986 *Triassocampe deweveri* (Nakaseko and Nishimura).-Kozur and Reti, 288, fig.5-E.
1989 *Triassocampe deweveri* (Nakaseko and Nishimura).-Cheng, 148, pl.6, figs.13, 14; pl.7, figs.10, 11.
1990 *Triassocampe deweveri* (Nakaseko and Nishimura).-Yeh, 28, pl. 7, figs.7, 18, 20; pl. 11, figs. 2-3, 7-8, 13-14.
1993 *Triassocampe deweveri* (Nakaseko and Nishimura).-Feng and Liu, 547, pl. 3, figs.1-4.

Remarks: The species is characterized by 2-3 rows of pores beneath each circumferential ridge. Specimens figured here are closely similar to this species.

Triassocampe? sp.
(Plate 1, Fig.6)

Description: Test tower-shaped with numerous segments. Cephalis and thorax not preserved. Post-abdominal segment with strong circumferential ridge. Constriction between adjacent two segments deep, smooth. Three rows of pores located on ridge, and pore large.

Remarks: Specimen is similar to *Triassocampe exilis* Yeh (1989) and *Tr. myterocorys* Sugiyama (1992) in the shape of post-abdominal segments and in the arrangement of pores, but because its cephalis was not preserved it is tentatively assigned to this genus.

Suborder **SPUMELLARIA** Ehrenberg, 1875
Family **Eptingiidae** Dumitrica, 1978
Genus ***Eptingium*** Dumitrica, 1978

Type species: *Eptingium manfredi* Dumitrica, 1978

Eptingium manfredi Dumitrica, 1978
(Plate 1, Figs. 7-10; Plate 2, Fig.8)

1978 *Eptingium manfredi* sp. nov. Dumitrica, 33-34, pl. 3, figs. 3,4; pl. 4, figs. 1, 2, 5, 6.
1990 *Eptingium manfredi* Dumitrica.-Gorican and Buser, 144, pl.8, figs.7, 8.
1991 *Eptingium manfredi* Dumitrica.-Bragin, 108-109, pl.2, figs.12,13.
1993 *Eptingium manfredi* Dumitrica.-Feng and Liu, 544-545, pl. 1, figs. 14, 15.
1995 *Eptingium manfredi* Dumitrica.-Ramovs and Gorican, 184, pl. 5, figs. 6-8.

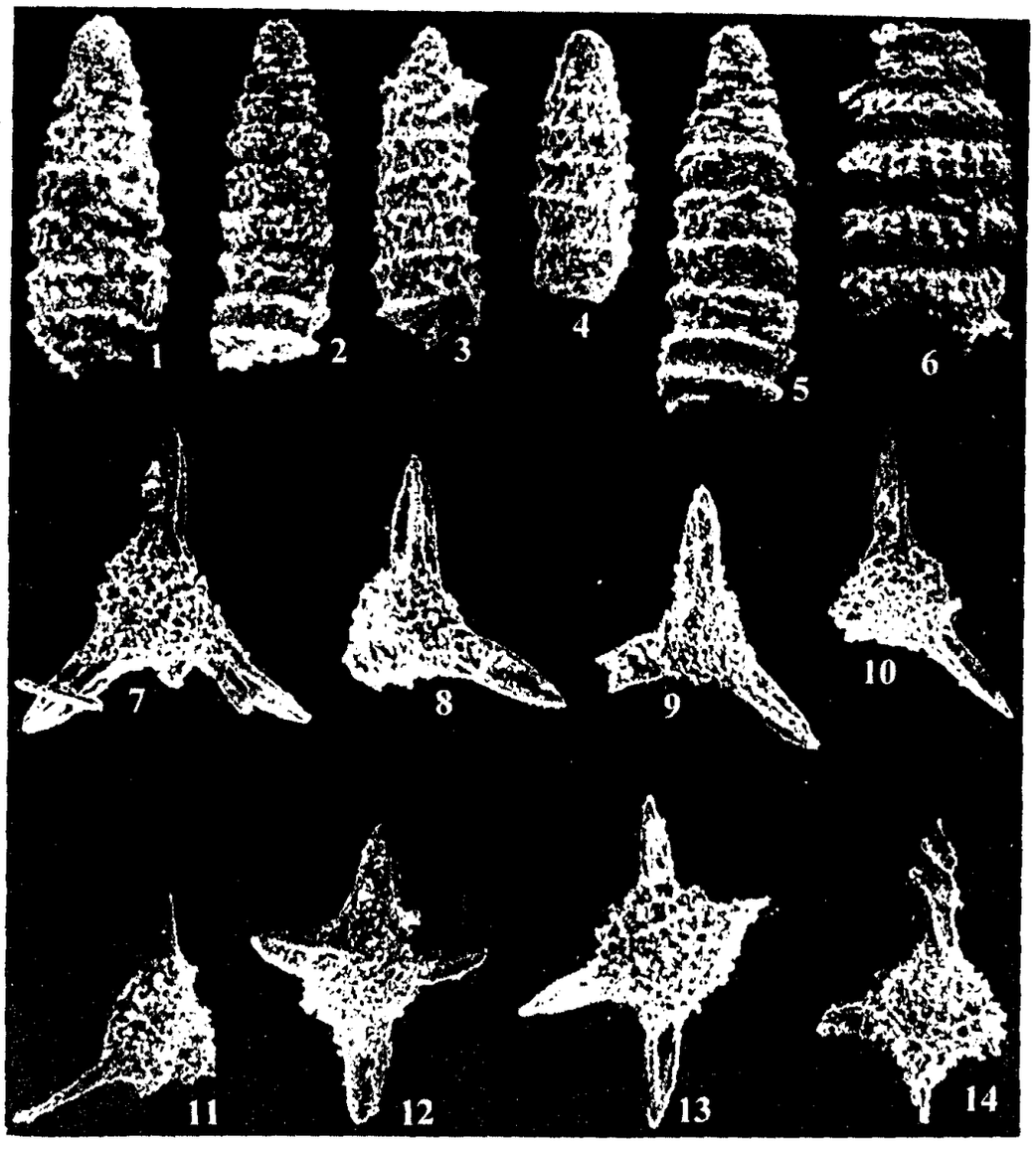

Plate 1 All figures are from 2000Stop28-1 from the south of Lamphum, Northern Thailand.
Figure 1-5. *Triassocampe deweveri* (Nakaseko and Nishimura), 1: 4472, x270; 2: 4477, x220; 3: 4474, x210; 4: 4475, x200; 5: 4476, x280.
Figure 6. *Triassocampe*? sp., 4478, x300.
Figure 7-10. *Eptingium manfredi* Dumitrica, 7: 4440, x140; 8: 4484, x130; 9: 4599, x115; 10: 4587, x130.
Figure 11. *Cryptostephanidium* sp. cf. *C. verrucosum* Dumitrica, 4574, x175.
Figure 12. *Parasepsagon variabilis* Nakaseko and Nishimura, 4492, x140.
Figure 13. *Parasepsagon asymmetricus praetetracanthus* Kozur and Mostler, 4595, x210.
Figure 14 *Stauracontium*? *granulosum* Dumitrica, Kozur and Mostler, 4483, x140.

1999 *Eptingium manfredi* Dumitrica.- Sashida, Kamata, Adachi and Munasri, 773, figs.6.16, 6.17.
1980 *Eptingium manfredi manfredi* subsp. nov. Dumitrica.-Dumitrica Kozur and Mostler, 19, pl. 3, figs. 1-3; pl. 6, figs.5-7.
1994 *Eptingium manfredi manfredi* Dumitrica.-Kozur and Mostler, 42, pl.1, figs.3.
1996 *Eptingium manfredi manfredi* Dumitrica.-Kozur, Krainer and Mostler, 204-205, pl.10, figs. 1-4, 6, 10.

Remarks: Specimens figured here are characterized by three main spines with secondary grooves, and with some transverse bridges between the adjacent ridges. It closely agrees with the description and illustration of *Eptingium manfredi* Dumitrica given by many authors.

Genus ***Cryptostephanidium*** Dumitrica, 1978

Type species: Cryptostephanidium cornigerum *Dumitrica, 1978*

Cryptostephanidium sp. cf. *C. verrucosum* Dumitrica, 1978
(Plate 1, Fig.11)

Cf. 1978 *Cryptostephanidium verrucosum* Dumitrica, 31, pl.1, figs. 7,8; pl.4, fig. 8.

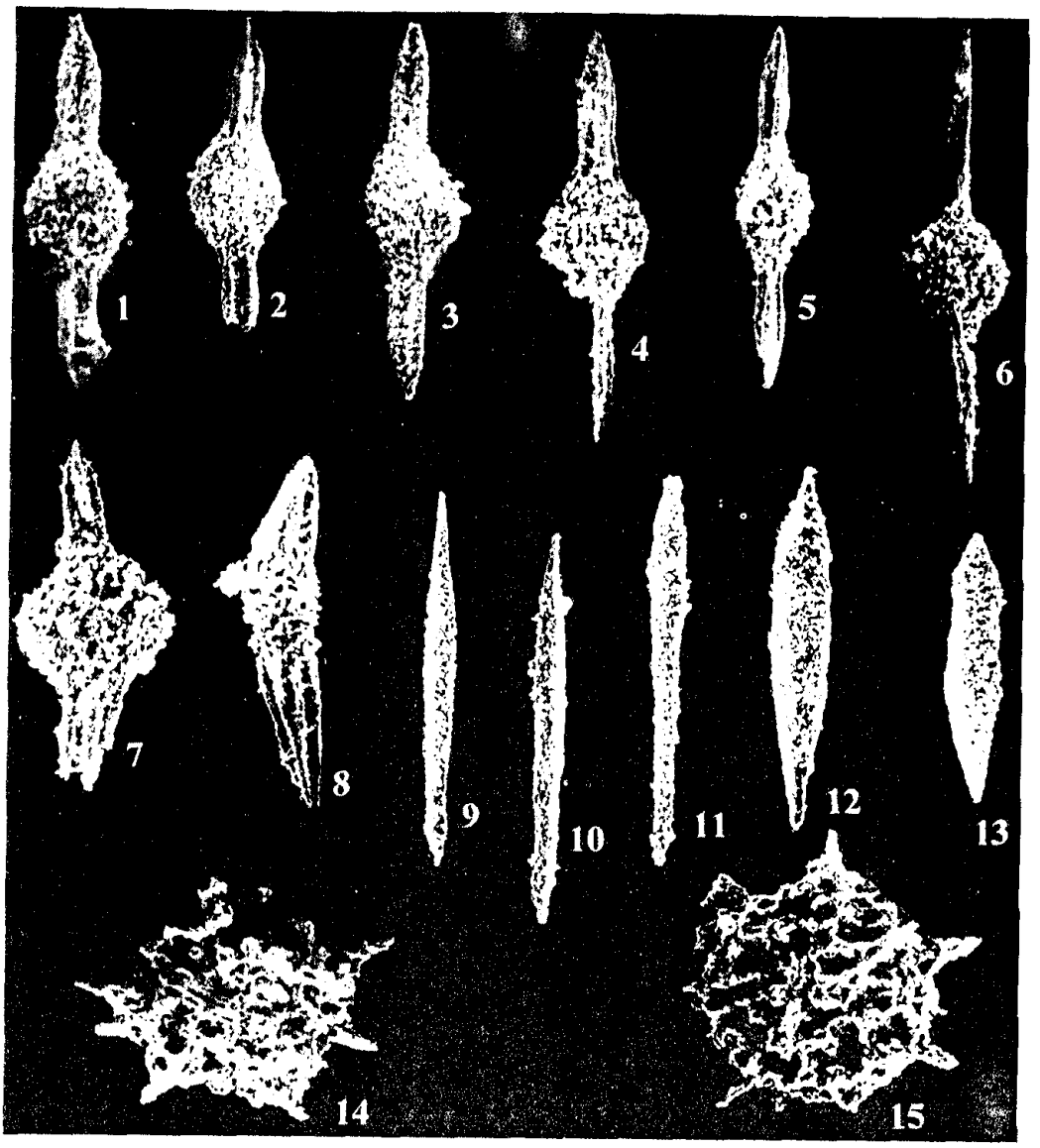

Plate 2 All figures are from 2000Stop28-1 from the south of Lamphum, Northern Thailand.
Figure 1-5 *Pseudostylosphaera coccostylus* (Ruest), 1: 4499, x160; 2: 4480, x130; 3: 4495, x160; 4: 4491, x140; 5: 4572, x115.
Figure 6. *Pseudostylosphaera longispinosa* Kozur and Mostler, 4593, x150.
Figure 7. *Pseudostylosphaera* sp., 4594, x210.
Figure 8. *Eptingium manfredi* Dumitrica, 4473, x140.
Figure 9-11. *Paroertlispongus multispinosus* Kozur and Mostler, 9: 4582, x150; 10: 4580, x115; 11: 4579, x115.
Figure 12,13 Genus and species indetermined, 12: 4581, x218; 13: 4576, x250.
Figure 14,15. *Astrocentrus* sp., 14: 4583, x180; 15: 4590, x200.

1992 *Cryptostephanidium* sp. cf. *C. verrucosum* Sugiyama, 1207, figs.13-3.

Description: Test small, subspherical, with three main spines. Pore small and dense. Spine is different in length, rod-like, and circular in cross-section.

Remarks: Specimen illustrated in this paper is different from *Cryptostephanidium verrucosum* Dumitrica by the fact that one of three main spines is relatively longer than other two spines, but they can be correlated to *Cryptostephanidium* sp. cf. *C. verrucosum* Sugiyama.

Family **Hindeosphaeridae** Kozur and Mostler, 1981
Genus ***Pseudostylosphaera*** Kozur and Mostler, 1981

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

Pseudostylosphaera coccostylus (Ruest, 1892)
(Plate 2, Figs.1-5)

1892 *Spongotructus coccostylus* sp. nov. Ruest, 160, pl.21, fig. 8.
1981 *Pseudostylosphaera coccostyla* (Ruest).-Kozur and Mostler, 33, pl.47, fig.5.

1993b *Pseudostylosphaera coccostyla* (Ruest).-Sashida, Igo, Hisada, Nakornsri and Ampornmaha, pl.2, figs.15-18.
1994 *Pseudostylosphaera coccostyla* (Ruest).-Kozur and Mostler, 44, pl.1, fig.8.
1995 *Pseudostylosphaera coccostyla* (Ruest).-Kellic and De Wever, 157, pl.4, figs.11, 12.
1995 *Pseudostylosphaera coccostyla* (Ruest).-Ramovs and Gorican, 190, pl.3, figs. 3, 4.
1997 *Pseudostylosphaera coccostyla* (Ruest).-Sashida, Igo, Adachi, Nakornsri and Ampornmaha, 9, figs. 6: 7-11.

Remarks: Test is characterized by elliptic spongy shell and straight three-bladed spine. The proximal part of spine is invariable, but terminal part rapidly decreasing in width. They can be correlated with *Pseudostylosphaera coccostyla* (Ruest).

Pseudostylosphaera longispinosa Kozur and Mostler, 1981
(Plate 2, Fig. 6)

1981 *Pseudostylosphaera longispinosa* Kozur and Mostler, 32, pl.1, fig.6.
1990 *Pseudostylosphaera longispinosa* Kozur and Mostler.-Yeh, 15, pl.4, fig.2.
1990 *Pseudostylosphaera longispinosa* Kozur and Mostler.-Goric an and Buser, 155, pl.5, figs. 3-5.

Remarks: Test is characterized by subspherical shell with two fine, long polar spines.

Pseudostylosphaera sp.
(Plate 2, Fig.7)

Description: Test subspherical, spongy, with two massive polar spines. Pore small and dense. Spine three-bladed in cross-section and two polar spines are not in a straight line.

Remarks: Specimen illustrated here is similar to *P.* sp. A figured by Yeh (1992, pl.8, fig.8) in the shape of shell and in having massive polar spines, but differs from the latter by the fact that two polar spines are not in a straight line.

Family **Oertlispongidae** Kozur and Mostler, 1980
Genus ***Paroertlispongus*** Kozur and Mostler, 1981

Type species: *Paroertlispongus multispinosus* Kozur and Mostler, 1981

Paroertlispongus multispinosus Kozur and Mostler, 1981
(Plate 2, Figs.9-11)

1981 *Paroertlispongus multispinosus* sp. nov. Kozur and Mostler, 48, pl.44, fig.2; pl.45, fig.1.
1994 *Paroertlispongus multispinosus* Kozur and Mostler.-Kozur and Mostler, 69, pl.12, fig.10; pl.13, fig.4, 11.
1996 *Paroertlispongus multispinosus* Kozur and Mostler.-Kozur, 291, pl.1, fig.1.

Remarks: Specimens illustrated here are polar spines of *Paroertlispongus multispinosus* Kozur and Mostler.

Family **Intermediellidae** Lahm, 1984
Genus and species indetermined
(Plate 2, Figs.12, 13)

Remarks: Specimens are common in the examined material, but complete specimen was not discovered. They are similar to main spines of some genera of this family, such as *Paurinella* Kozur and Mostler.

Family **Sepasagonidae** Kozur and Mostler, 1981
Genus ***Parasepsagon*** Dumitrica, Kozur and Mostler, 1980

Type species: *Parasepsagon tetracanthus* Dumitrica, Kozur and Mostler, 1980

Parasepsagon asymmetricus praetetracanthus Kozur and Mostler, 1994
(Plate 1, Fig.13)

1981 *Parasepsagon asymmetricus* sp. nov. Kozur and Mostler, 35, pl.5, figs. 2-4.
1994 *Parasepsagon asymmetricus praetetracanthus* subsp. nov. Kozur and Mostler, 49-50, pl.5, fig.3.

Remarks: Test is slightly different from holotype of *Parasepsagon asymmetricus praetetracanthus* Kozur and Mostler in having shorter main spines.

Parasepsagon variabilis Nakaseko and Nishimura 1979
(Plate 1, Fig.12)

1979 *Staurodoras dercourti* sp. nov. De Wever, Sanfillipo, Riedel, Gruber, 79, pl.1, figs.11, 12.
1979 *Staurodoras variabilis* sp. nov. Nakaseko and Nishimura, 71-72, pl.3, figs. 5, 8.
1989 *Parasepsagon variablis* (Nakaseko and Nishimura).-Yeh, 63, pl.1, figs.16, 19.
1995 *Parasepsagon variablis* (Nakaseko and Nishimura).-Ramovs and Gorican, 187, pl.3, fig.5.
1996 *Parasepsagon variablis* (Nakaseko and Nishimura).-Kozur, Krainer and Mostler, 217, pl.4, figs.2, 3, 7, 9.

Remarks: Test is characterized by having four three-bladed main spines, which are straight, and no torsions.

Family **Multiarcusellidae** Kozur and Mostler, 1979
Genus ***Stauracontium*** Haeckel 1882, emend. Kozur and Mostler, 1979

Type species: *Stauracontium cruciferum* Haeckel, 1887

Stauracontium? granulosum Dumitrica, Kozur and Mostler, 1980
(Plate 1, Fig.14)

1980 *Stauracontium*? *granulosum* Dumitrica, Kozur and Mostler, 16-17, pl.1, fig.7; pl.11, fig.5.
1984 *Stauracontium*? *granulosum* Dumitrica, Kozur and Mostler.-Lahm, 76-77, pl.13, fig. 9.
1990 *Stauracontium*? *granulosum* Dumitrica, Kozur and Mostler.-Gorican and Buser, 158, pl.1, fig.1.

Remarks: Although specimen figured here is incomplete, it can be correlated with *Stauracontium*? *granulosum* Dumitrica, Kozur and Mostler (1980) in outline of shell, arrange of pore, and shape of main spine.

Family **Centrolonchidae** Campbell, 1954,
emend. Kozur and Mostler, 1979
Genus ***Astrocentrus*** Kozur and Mostler, 1979

Type species: *Astrocentrus pulcher* Kozur and Mostler, 1979

Astrocentrus sp.
(Plate 2, Figs.14, 15)

Description: Specimen is common in our material. Test large, subspherical. Pore large, irregular in form. Spine short, conical, and circular in cross-section.

Remarks: They are similar to *Astrocentrus* sp. cf. *A. pulcher* (Kozur and Mostler)(Nakaseko and Nishimura, 1979), but poorly preserved.

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