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# Upper Permian to Middle Jurassic radiolarian assemblages of Busuanga and surrounding islands, Palawan, Philippines

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*Key words:* North Palawan Block, radiolarians, biostratigraphy, Triassic, Permian, Jurassic, East Asian accretion

ABSTRACT

The North Palawan Block is regarded as the southernmost continuation of a Late Mesozoic accretionary complex, which developed along the length of the East Asian margin. It records a long (up to ~ 100 My) period of pelagic deposition on an oceanic plate from Late Permian to Late Jurassic when subduction resulting in the disappearance of the plate by the Early Cretaceous began. Subduction-accretion resulted in the development of three lithotectonic belts. From thirteen localities within these belts, radiolarian investigations yielded 173 species belonging to 92 genera and 45 families. Most of the samples contain Middle to Upper Triassic faunas. Several sections containing upper Permian, Lower Jurassic, and Middle Jurassic assemblages were also found. The presence of benthonic and planktonic foraminifers at some localities indicates that portions of the Liminangcong Formation were deposited in environments above the carbonate compensation depth (CCD). Manganese deposits found in some areas (e.g. Busuanga and Dabatonay) suggest that parts of the depositional area experienced a very low average sedimentation rate. Examination of the North Palawan accretionary complex reveals the ghosted history of the Izanagi Plate and constrains the timing of subduction beneath the eastern margin of Asia.

## Introduction

Palawan is a NE-SW trending ridge located between the South China Sea and the Sulu Sea. The northern part of Palawan, together with the Calamian Island Group, Cuyo Island Group, Reed Bank, Spratly Islands, Dangerous Grounds, western Mindoro, Tablas and northwest Panay, is interpreted as a microcontinent, called the North Palawan Block (NPB) (Figure 1). The block is inferred to have rifted from the eastern margin of Eurasia as a result of the opening of the South China Sea at around 32 Ma (Hamilton 1979; Taylor & Hayes 1980; Holloway 1982; Briais et al. 1993; Almasco et al. 2000) and collided with the Philippine mobile belt during the middle Miocene (Hall 2002). Several investigations (e.g., Isozaki et al. 1988; Kojima 1989; Faure & Ishida 1990) considered the NPB as the southernmost continuation of the accretionary complex along the Eurasian margin that extends southwards from the Russian Far East, through NE China, NE and SW Japan and the Ryukyu islands.

In the last 30 years, radiolarian research has contributed tremendously in the deciphering and understanding of the pre-Cenozoic geology of the North Palawan Block. The Calamian Island Group is an integral part of this block and has been the subject of such investigations (Isozaki et al. 1988; Cheng 1989, 1992; Tumanda et al. 1990; Tumanda 1991a, 1991b, 1994; Yeh 1992; Yeh and Cheng 1996a, 1996b, 1998; Tumanda-Mateer et al. 1996; Zamoras & Matsuoka 2000, 2001 and Zamoras 2001). These studies produced radiolarian biostratigraphic zonations of the Middle Permian to Jurassic chert sequences. Zamoras (2001) and Zamoras & Matsuoka (2001) established that the chert-clastic succession youngs from north to south, and discriminated three different belts – the Northern Busuanga (NBB), Middle Busuanga (MBB) and Southern Busuanga (SBB) belts. They reported that the NBB accreted to the Asian margin in the late Middle Jurassic, whereas, the MBB and SBB accreted in Late Jurassic and Early Cretaceous, respectively.

The present research was undertaken in order to attempt to locate the Permo-Triassic boundary in the region and to expand the knowledge of the Triassic radiolarians in Southeast Asia, in particular those from the Calamian Island Group, in-

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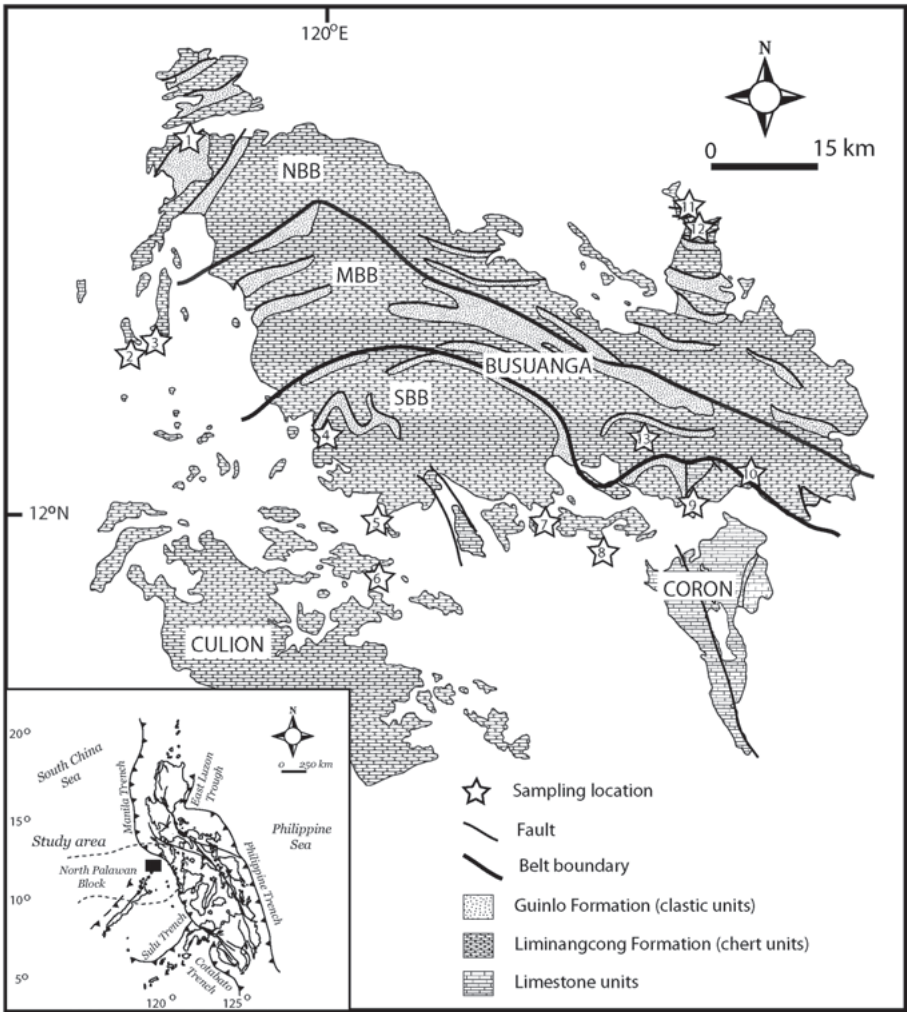


Fig.1. Geologic map of Busuanga and surrounding islands modified after Zamoras (2001). SBB = Southern Busuanga Belt, MBB = Middle Busuanga Belt, NBB = Northern Busuanga Belt. Locations of the sections where the cherts belonging to the Liminangcong Formation were collected are indicated. Numbers refer to the following areas: 1. Calauit-Illultuk Bay, 2. Dabatonay, 3. Mapadolo, 4. Dipuyay-Decalangwang River, 5. Lusong, 6. Marily, 7. Mayanpayan, 8. Dimanglet, 9. Road cut, township of Coron, 10. Calindo, 11. Sitio Tingil, 12. Mabudyen, 13. Mabintangin River.

cluding Busuanga and surrounding islands. Results presented herein provide information from many new localities, which complement the previous works in the description of Upper Permian and Middle Jurassic radiolarians. The data presented herein help to constrain the age of the oceanic materials accreted along the eastern margin of Eurasia during the Late Mesozoic.

## Geologic Background

Busuanga is the largest island in the Calamian Island Group (Figure 1). As with the rest of the group, the island is part of a Late Mesozoic subduction complex that extended from the Russian Far East southwards at least as far as the north Palawan mainland. The subduction complex mainly consists of accreted limestones and cherts intercalated with trench-fill clastic sediments. The location of the sampling sites and a geologic map of the study area are given in Figure 1.

Various authors have proposed different stratigraphic subdivisions. Isozaki et al. (1988) interpreted the rock suite comprising the islands together with the north Palawan mainland to be a subduction-related complex and named this suite the North Palawan Complex. Faure & Ishida (1990) considered these rocks to be olistostromes. Zamoras (2001) and Zamoras & Matsuoka (2001) referred to the accretionary complex on Busuanga as the Malampaya Sound Group.

Several investigators considered the chert as part of the Liminancong Formation (Hashimoto & Sato 1973; Bureau of Mines and Geosciences 1984; Wolfart et al. 1986; Zamoras 2001; Zamoras & Matsuoka 2001) and assigned various ages: Middle Triassic (Hashimoto & Sato 1973; Fontaine 1979; Wolfart 1984); Lower to Middle Jurassic (Bureau of Mines and Geosciences 1984) and Middle-Upper Permian to Upper Jurassic (Wolfart et al. 1986; Isozaki et al. 1988; Tumanda 1991a; 1991b; Zamoras 2001; Zamoras and Matsuoka 2001). Japan International Cooperation Agency-Metal Mining Agency of Japan (1990) subdivided the chert into Liminangcong Chert (Triassic) and Busuanga Chert (Jurassic). Wolfart et al. (1986) adopted the name Bacuit Formation for the Permian sequence of chert, clastic rocks and limestone.

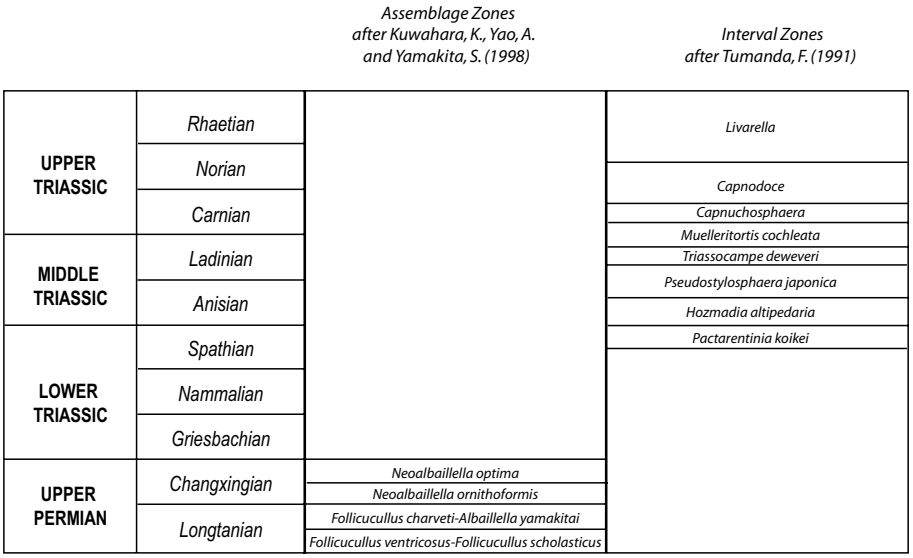


Fig. 2. Permian and Triassic radiolarian zonation schemes used in this study.

The limestone is distributed sporadically. Based on foraminifers, algae, conodonts, Porifera and Cnidaria (Fontaine 1979; Hashimoto et al. 1980; Fontaine et al. 1983, 1986; Wolfart et al. 1986), they range from Middle Permian to Upper Jurassic. The Bureau of Mines and Geosciences (1984) discriminated two limestone units: the Malajon Limestone (Upper Triassic) and the Coron Formation (Upper Triassic to Lower Jurassic). Kiessling & Flügel (2000) described the limestone outcrops on and around Busuanga, assigning them to the Coron Formation. They interpreted the carbonates as reefs (Malajon) and carbonate platforms (Kalampisanan, Busuanga and Coron).

On geologic maps prepared by the Bureau of Mines and Geosciences, clastic rocks are separated into the King Ranch and Liminangcong formations. Several workers used the term Guinlo Formation for the clastic succession (Hashimoto & Sato 1973; Zamoras 2001; Zamoras & Matsuoka 2001). Wolfart et al. (1986) subdivided the clastic rocks into the Coron Formation (Triassic) and the Guinlo Formation (Jurassic). Stratigraphic assignments vary from Middle Jurassic (Tumanda 1991a, 1991b), Middle Jurassic to Upper Jurassic (Tumanda-Mateer et al. 1996) and Middle Jurassic to Lower Cretaceous (Zamoras 2001; Zamoras & Matsuoka 2001). The reported ages of the clastic rocks were established based on radiolarians.

Zamoras (2001) and Zamoras &Matsuoka (2001) introduced the name Bicatan mélange for the minor mélange bodies units they mapped at Buyod Point, Bicatan Peninsula. They recognized two types; limestone-basalt-chert mélange and sandstone-chert-mudstone mélange.

## Radiolarian biostratigraphy

Ninety-four samples yielding identifiable radiolarians comprise part of a suite of 261 samples collected from the Calamian Group of Islands, Palawan. Moderately to well-preserved faunas were recovered from the chert on Busuanga and surrounding islands (Calauit, Dabatonay, Mapadolo, Lusong, Marily, Mayanpayan and Dimanglet). Foraminifers were also noted in samples from Mabudyen and on the islands of Marily, Dimanglet, Mapadolo and Calauit. The conodont *Epigondollela* sp. was found in one sample collected along the Concepcion-Dipuyay road on Busuanga.

In order to establish the age of the radiolarian assemblages, we used the zonation schemes proposed by Kuwahara et al. (1998) for the Upper Permian, and by Tumanda (1991a, 1991b) for the Triassic (Figure 2). The Jurassic biostratigraphic ranges of the radiolarian species discussed in this study have been determined from synthesis of occurrences recorded in the literature.

In the Mabintangin River section (sample location 13), three late Permian zones have been recognized. The presence of *Albaillella cavitata* KUWAHARA was used to delineate the upper Longtanian interval in the Liminangcong Formation. *A. cavitata* KUWAHARA is a common species occurring in the *Follicucullus charveti-Albaillella yamakitai* assemblage zone (Kuwahara et al. 1998). Most of the Mabintangin samples also contain radiolarian assemblages belonging to the succeeding *Neoalbaillella ornithoformis* assemblage zone. *Follicucullus* sp. cf. *F. charveti* CARIDROIT & DE WEVER, *Foremanhelena musashiensis* (SASHIDA & TONISHI), *Albaillella*? *protolevis* KUWAHARA and *Nazarovella gracilis* DE WEVER & CARIDROIT are some of the species found in these samples.

*F. musashiensis* (SASHIDA & TONISHI) and *Albaillella triangularis* ISHIGA, KITO & IMOTO are found in one sample. *F. musashiensis* (SASHIDA & TONISHI) is a common species of the *Neoalbaillella ornithoformis* assemblage zone and the *Neoalbaillella optima* assemblage zone whereas *Albaillella triangularis* ISHIGA, KITO & IMOTO, considering its occurrence, belongs to the *Neoalbaillella optima* zone. Based on this, the sample is assigned to the *Neoalbaillella optima* zone.

Table 1. Radiolarian assemblages from the Liminangcong Formation samples. The samples were collected from the following sections: Dabatonay and Mapadolo, Calauit-Illultuk Bay and Dipuyay-Decalangwang River.

| Sample Location | | Dabatonay (sample location 2) | | | | | | | Mapadolo (sample location 3) | | | Calauit-Illultuk Bay (sample location 1) | | Dipuyay-Decalangwang River (sample location 4) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Sample Number** | **2031109** | **2031110** | **2031111** | **2031112** | **2031114** | **2031116** | **2031117** | **2031101** | **2031102** | **2031103** | **2031904** | **2031905** | **2032008** | **2032009** | **2032010** | **2032011** | **2032013** | **2032040** | **2032057** | **2032049** | **2032050** | **2032014** | **2032016** | **2032018** | **2032019** | **2032020** | **2032021** | **2032022** | **2032023** | **2032024** |
| *Acanthosphaera* (?) *mocki* KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |
| *Archaeocenosphaera* spp. | | x | x | x | x | x | x | x | | x | | x | | x | x | | x | x | x | x | x | x | x | x | x | x | x | | x | x | x |
| *Bulbocyrtium* spp. | | | | | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | |
| *Capnuchosphaera deweveri* KOZUR & MOSTLER, emend. BLOME | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| *Capnuchosphaera missionensis* CORDEY | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| *Celluronta* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Crucella* sp. | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | |
| *Cryptostephanidium cornigerum* DUMITRICA | | x | | | | | | | | | | | | | | | | | | | x | | | | | | | x | | | | |
| *Eptingium manfredi* DUMITRICA | | x | | | x | x | | | | | | | x | | | | | | | x | x | | | | | | x | | x | x | x |
| *Eptingium nakasekoi* KOZUR ET AL. | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | |
| *Eptingium* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Haeckelicyrtium*? sp. | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | |
| *Haliomma* sp. | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | |
| *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | x | | | | | | | x | | | x | |
| *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Hozmadia rotunda* (NAKASEKO & NISHIMURA) | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | |
| *Hozmadia spinifera* SUGIYAMA | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | |
| *Hozmadia* spp. | | x | x | x | | | | | | | | | | | | | | x | | x | x | | x | x | | | x | | | x | |
| *Ladinocampe japonica* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | x | | x | | | | | | | | | | | |
| *Ladinocampe* sp. | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | |
| *Oertlispongus inaequispinosus* DUMITRICA, KOZUR & MOSTLER | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pantanellium* sp. | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | |
| *Pararuesticyrtium* spp. | | x | | | | | | | | | | | | | | | | | x | x | | | | | | | x | x | | x | | |
| *Parasepsagon* spp. | | x | | x | | x | | | | | | | | | | x | | | | | | | x | | | | x | | x | | |
| *Paroertlispongus* spp. | | | | | | | | | | | | | x | | x | x | | x | | | | | | | | | | | | | | |
| *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | x | | | x |
| *Pentactinocarpus fusiformis* DUMITRICA | | x | x | x | x | x | | | | | | | | | | | | | | | x | | | | | | | | | | | |
| *Pentactinocarpus tetracanthus* DUMITRICA | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pentactinorbis kozuri* DUMITRICA | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | |
| *Poulpus* spp. | | | x | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Praeconocaryomma* sp. | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |
| *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA) | | x | | | | | | | | | | | | | | | | | x | x | | | | | | | | x | x | x | x | |
| *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA) | | | | x | x | x | | | | | | | | | | | | | | | x | | | | | | | | x | x | x | |
| *Pseudostylosphaera longispinosa* KOZUR & MOSTLER | | x | x | | | x | x | | | | | | | | | | | | | | x | | | | | | x | | | x | | |
| *Pseudostylosphaera magnispinosa* YEH | | x | | x | | | | | | | | | | | | | | | | x | | | | | | | | | | x | | |
| *Pseudostylosphaera* spp. | | x | | | | x | | x | | | | | | | | | | | | x | x | x | | | | | x | x | | x | x | |
| *Pseudostylosphaera timorensis* SASHIDA & KAMATA | | | | | | | | | | | | | | | | | | | | x | | | | | | | x | x | | | | |
| *Rikivatella* spp. | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | x | | | x | |
| *Sarla* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | |
| *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA) | | | | | | | x | | | | | | | | | | | | | | x | x | | | | | | | | | | |
| *Spinotriassocampe hungarica* KOZUR | | x | | | | x | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| *Spongosilicarmiger* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | x | | | | | | | x | | x | x | | |
| *Spongostephanidium longispinosum* SASHIDA | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauracontium* spp. | | | | | | | | | | | | | | | | | x | | | | | | | x | | | x | | | | x | |
| *Staurolonche fluegeli* KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | x | | |
| *Staurolonche* spp. | | x | x | | | | | x | | | | x | | | | | | | | | x | | | | | | | | | | | x |
| *Staurolonche trispinosa* (KOZUR & MOSTLER) | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | x | | |
| *Tiborella florida* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | x | | x | | | | | | | | x | | x | | |
| *Tiborella magnidentata* DUMITRICA, KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | |
| *Tiborella* sp. | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Triassocampe coronata* BRAGIN | | x | x | x | x | x | | | x | | | | | x | | | | | | x | x | x | | | | | | x | x | x | x | |
| *Triassocampe deweveri* (NAKASEKO & NISHIMURA) | | x | x | x | x | x | x | | | | | | | | x | | | x | x | | x | | | | | | | | x | x | x | |
| *Triassocampe* spp. | | x | x | | | x | | | | | x | | | | | | | x | x | x | x | | | | | | | | x | x | x | |
| *Triassocampe tulbuanensis* TUMANDA | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Trilonche* sp. cf. *T. chiakensis* (SASHIDA & IGO) | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Trilonche* spp. | | | | | | | | | | | | | | | | x | | x | | | | | | | | | | x | | | | x |
| **Range** | | **upmst. Ans-Lad** | **u. Ans.-Lad** | **u. Ans.-Lad** | **u. Ans.-Lad** | **u. Ans.-Lad** | **u. Ans.-Lad** | **u. Ans.-Lad?** | **u. Ans-Lad** | **Crn** | **u. Nor-Rht?** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad?** | **u. Ans-Lad?** | **u. Ans-Lad?** | **u. Ans-Lad** | **u. Ans-l. Lad** | **u. Ans-l. Lad** | **u. Ans-l. Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **Lad** | **u. Ans-Lad** | **u. Ans-Lad** |

Table 2. Radiolarians occurring at Dipuyay-Decalangwang River.

| Sample Location | | Dipuyay-Decalangwang River (sample location 4) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Sample Number | 2032025 | 2032026 | 2032027 | 2032028 | 2032029 | 2032030 | 2032031 | 2032032 | 2032033 | 2032034 | 2032035 | 2032036 | 2032037 | 2032038 | 2032039 | 2032041 | 2032042 | 2032043 | 2032044 | 2032045 | 2032046 | 2032047 | 2032048 | 2032051 | 2032052 | 2032054 | 2032055 | 2032059 | 2032058 | 2032060 |
| *Acanthosphaera* (?) *mocki* KOZUR & MOSTLER | | x | | x | | | | | x | | | | | x | | | | | | | | | | | | | | | | | |
| *Archaeocenosphaera* spp. | | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| *Cryptamphorella* sp. | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| *Cryptostephanidium cornigerum* DUMITRICA | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | |
| *Eptingium manfredi* DUMITRICA | | x | x | x | x | x | | x | x | | x | x | x | x | x | x | x | x | x | x | x | | x | | | | x | x | x | x | x | x |
| *Eptingium* ramovsi KOZUR ET AL. | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eptingium* spp. | | x | | x | x | | | x | | | | | | | | | | | | | x | | | | | | | x | | | | |
| *Haliomma* spp. | | | | x | | | | | | | | | x | | | | x | | | | | | | | | | | | | | | |
| *Hexalonche* sp. | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA) | | | | | x | | | x | | | | | | | | | | | | | | | | | | | x | | x | | x | |
| *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER | | | | x | | | | | x | x | x | | | | | | x | | | | | | | x | | | | | | | | |
| *Hozmadia rotunda* (NAKASEKO & NISHIMURA) | | | | | | | | | | | x | | | | | | | | | | | | | | | | x | x | | x | x | |
| *Hozmadia* sp. cf. *H. reticulata* DUMITRICA, KOZUR & MOSTLER | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Hozmadia spinifera* SUGIYAMA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hozmadia* spp. | | | x | x | x | | | x | x | x | x | x | x | | x | | | x | x | x | | | x | | | x | x | | | | | |
| *Katorella bifurcata* KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| *Ladinocampe japonica* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Ladinocampe* sp. | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | |
| *Muelleritortis* sp. | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Napora* spp. | | | | | | | | | | | | | | | | | x | | x | | | | | | | x | | | | | | |
| Nassellaria gen. et. sp. indet. | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Pantanellium* sp. | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pararuesticyrtium* spp. | | x | x | x | x | x | | x | | x | x | | | x | | x | x | x | x | | | x | | | | | x | x | | x | |
| *Parasepsagon* spp. | | | x | | | | | | | | | | | x | x | | | | | | | x | | | | | x | x | x | x | x |
| *Parasepsagon variabilis* (NAKASEKO & NISHIMURA) | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pentactinocapsa awaensis* (NAKASEKO & NISHIMURA) | | x | x | x | x | x | x | x | | x | x | x | x | | x | | x | | | x | | | x | | | | x | x | x | | x |
| *Pentactinocarpus fusiformis* DUMITRICA | | | | | | | | | | | | | x | x | x | x | | | x | x | x | x | x | x | | | | | | | | |
| *Pentactinocarpus tetracanthus* DUMITRICA | | | | | | | | | x | | x | | | | | | | | | | | | | | | | | | | | | |
| *Pentaspongodiscus* spp. | | | | x | x | | | | | | | | x | | | | | | | | x | | | | | | | | | | | |
| *Plafkerium abboti* PESSAGNO | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Poulpus* spp. | | | | | | | | | | | | | x | | | | | | | | | | | | | x | | | | | | |
| *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA) | | x | x | x | x | x | x | x | x | | | x | | x | | x | x | | | x | x | x | x | | x | | x | x | x | x | x |
| *Pseudostylosphaera goricanae* KOZUR ET AL. | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA) | | x | x | x | x | x | x | x | x | | x | x | x | x | x | | x | | x | | | | x | | | | x | x | x | | x |
| *Pseudostylosphaera longispinosa* KOZUR & MOSTLER | | | | x | | | x | x | x | x | x | | | x | x | x | x | | x | x | | x | x | | | | | | | x | |
| *Pseudostylosphaera* spp. | | x | x | | | x | x | x | x | x | x | x | x | x | | | | | x | | | x | x | x | | x | x | | | x | x | |
| *Pseudostylosphaera timorensis* SASHIDA & KAMATA | | | | | | | x | x | x | | | x | | | | | | | x | | | | | | | | | | | | | |
| *Rikivatella* spp. | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | x | | | |
| *Sarla* spp. | | | | | | x | | x | | x | | | x | | | | | | | x | | | | | | | | | | | | x |
| *Sepsagon* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | x | | x | x | x | | | x | | | | | | | | | | | | | |
| *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA) | | | x | x | x | | | x | | x | | | | | | | | | | | | | | | | | x | | x | | x | |
| *Stauracontium* spp. | | | | | | | | | | | | | x | | | | | | | | | | x | | | | | | | | | |
| *Staurolonche* spp. | | x | | x | x | x | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Staurolonche trispinosa* (KOZUR & MOSTLER) | | | | x | x | x | | | | | | | | | | | | | | | | | | | | x | | x | x | | x | |
| *Thaisphaera* spp. | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tiborella florida* (NAKASEKO & NISHIMURA) | | x | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| *Tiborella* sp. cf. *T. anisica* KOZUR & MOSTLER | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tiborella* spp. | | | | x | | x | | | | | x | | | | | | | | | | | | | | | | x | x | | | | x |
| *Triassistephanidium laticorne* DUMITRICA | | | | | | x | | | x | | | | | | | | | | | | | | | | | | | | | | | |
| *Triassocampe campanilis* (KOZUR & MOSTLER) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Triassocampe coronata* BRAGIN | | x | | x | | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | | | x | x | x | x | x | | x | | x | |
| *Triassocampe deweveri* (NAKASEKO & NISHIMURA) | | x | | | x | x | x | x | | | | | x | | x | x | | | | x | x | | | x | x | | | | | | |
| *Triassocampe scalaris* DUMITRICA, KOZUR & MOSTLER | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | |
| *Triassocampe* spp. | | x | x | x | x | x | | | x | x | x | x | x | | x | | x | | x | | | | x | | x | x | x | x | x | | x | |
| *Trilonche* spp. | | | x | | | | x | x | | x | | | | | | | | | x | x | | x | x | | | | | | | | | |
| **Range** | | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-l. Lad | u. Ans-Lad | u. Ans-l. Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-l. Lad | u. Ans-l. Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad | u. Ans-Lad |

Triassic radiolarians were observed from samples collected from several localities. A number of species is common in the *Pseudostylosphaera japonica* interval zone (Tumanda 1991a, 1991b). This zone, considered as late Anisian-early Ladinian in age, is defined by the successive lowest occurrences of *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA) and *Eptingium* group at the base of the zone and *Triassocampe deweveri* (NAKASEKO & NISHIMURA) at the top. Some of the faunas present in our assemblage, which are commonly found in this zone, include *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA), *Eptingium* spp., *Pseudostylosphaera magnispinosa* YEH, *Tiborella florida* (NAKASEKO & NISHIMURA), *Katorella bifurcata* KOZUR & MOSTLER, *Pentactinocarpus tetracanthus* DUMITRICA, *Pentactinorbis kozuri* DUMITRICA, *Staurolonche trispinosa* (KOZUR & Mostler), *Parasepsagon variabilis* (NAKASEKO & NISHIMURA) and *Tiborella magnidentata* DUMITRICA, KOZUR & MOSTLER.

The *Triassocampe deweveri* interval zone (Tumanda 1991a, 1991b) is represented by samples from Dipuyay-Decalangwang River (sample location 4) and Calindo (sample location 10). The following species common to this zone were found in our samples: *Triassocampe deweveri* (NAKASEKO & NISHIMURA), *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA), *Oertlispongus inaequispinosus* DUMITRICA, KOZUR & MOSTLER, *Staurolonche trispinosa* (KOZUR & MOSTLER), *Hozmadia rotunda* (NAKASEKO & NISHIMURA), *Pentactinorbis kozuri* DUMITRICA, *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA), *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA), *Eptingium manfredi* DUMITRICA, *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA), *Cryptostephanidium cornigerum* DUMITRICA and *Parasepsagon variabilis* (NAKASEKO & NISHIMURA).

The Ladinian to probably lower Carnian interval (*Muelleritortis cochleata* interval zone) is represented by sample HKU-PLWN 02031402. This sample is characterized by the presence of the diagnostic species *Muelleritortis cochleata* (NAKASEKO & NISHIMURA). The Carnian and upper Carnian-middle Norian were established based on the presence of *Capnuchosphaera deweveri* KOZUR & MOSTLER, emend. BLOME and *Capnodoce anapetes* DE WEVER, respectively. Based on the presence of *Livarella* spp., the upper Norian-Rhaetian was identified.

Jurassic radiolarians were also observed. Diagnostic species are very rare. However, based on the reported ranges of some species, the samples are assigned Jurassic ages. These include *Katroma westermanni* WHALEN & CARTER (upper Sinemurian), *Plessus* sp. aff. *P. aptus* YEH (lower Sinemurian) and *Transhsuum medium* (Unitary Association Zones 1–7, early-middle Aalenian to late Bathonian-early Callovian).

Following is the description of the localities investigated:

*Calauit-Illultuk Bay (sample location 1)*

Samples HKU-PLWN02031901 to HKU-PLWN02031908 were collected from two coastal sections located at 12°16.078'N/119°52.080'E and 12°17.484'N/119°51.960'E. The lithology present is recrystallized thinly bedded greenish-gray chert. Only two of these samples (HKU-PLWN02031904 and HKU-PLWN02031905) yielded identifiable radiolarians (Table 1). The assemblage present is upper Anisian-Ladinian.

*Dabotonay (sample location 2)*

Samples HKU-PLWN02031109 to HKU-PLWN02031120 were collected from a coastal section (12º6.186'N/119º50.758'E) composed of steeply dipping laminated to thinly bedded red chert. The beds are complexly folded and faulted. Some parts of the section contain manganese nodules. Occurrences of radiolarians in the area are shown on Table 1. Samples HKU-PLWN 02031109 to HKU-PLWN02031112, HKU-PLWN02031114, HKU-PLWN02031116 and HKU-PLWN02031117 contain upper Anisian-Ladinian radiolarians.

*Mapadolo (sample location 3)*

Samples HKU-PLWN02031101 to HKU-PLWN02031108 were collected from a coastal section (12º06.849'N/119º 52.006'E) of complexly folded, steeply dipping laminated to thinly bedded chert. The chert is recrystallized. Three samples yielded rare radiolarians. Samples HKU-PLWN02031101 and HKU-PLWN02031103 contain upper Anisian-Ladinian and upper Norian-Rhaetian assemblages, respectively. Sample HKU-PLWN02031102 yielded Carnian radiolarians (Table 1).

*Dipuyay-Decalangwang River (sample location 4)*

Samples HKU-PLWN02032007 to HKU-PLWN02032060 were collected from a section on the Concepcion-Dipuyay road (12º01.848'N/119º59.792'E). The lithology is predominantly chert with minor siliceous mudstone. Beds strike ~030 and dip steeply to the NW. Three radiolarian assemblages are recognized. The assemblages are diverse and contain well-preserved radiolarians. Samples HKU-PLWN02032008 to HKU-PLWN02032010, HKU-PLWN02032016, HKU-PLWN02032018 to HKU-PLWN 02032021, HKU-PLWN02032023 to HKU-PLWN02032032, HKU-PLWN02032034, HKU-PLWN02032036 to HKU-PLWN 02032039, HKU-PLWN02032041, HKU-PLWN02032042, HKU-PLWN02032045 to HKU-PLWN02032052, HKU-PLWN 02032054, HKU-PLWN02032055 and HKU-PLWN02032058 to HKU-PLWN02032060 contain upper Anisian-Ladinian radiolarians. Samples HKU-PLWN02032033, HKU-PLWN02032035, HKU-PLWN02032040, HKU-PLWN02032043, HKU-PLWN 02032044 and HKU-PLWN02032057 yielded upper Anisian-lower Ladinian radiolarians. Sample HKU-PLWN02032022 contains Ladinian radiolarians. Tables 1 and 2 show radiolarian occurrences in the area.

*Lusong (sample location 5)*

Samples HKU-PLWN02031802 to HKU-PLWN02031805 were collected from the western coast of Lusong (11°58.899'N/

Table 3. Radiolarian assemblages within the Liminangcong Formation. The samples were collected from Lusong, Marily, Mayanpayan and Dimanglet.

| Sample Location | | Lusong (sample location 5) | | Marily (sample location 6) | | | Mayanpayan (sample location 7) | | | | Dimanglet (sample location 8) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Sample Number** | **2031802** | **2031803** | **2031302** | **2031303** | **2031304** | **2031709** | **2031710** | **2031715** | **2031713** | **2031705** | **2031706** | **2031707** | **2031413** | **2031414** | **2031418** | **2031419** | **2031420** | **2031425** | **2031427** | **2031430** | **2031402** | **2031405** | **2031407** | **2031408** | **2031409** | **2031410** | **2031702** | **2031701** |
| *Acanthosphaera?* sp. | | | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Archaeocenosphaera* spp. | | | | | x | x | | | | | | | | x | | | x | | | | x | x | x | x | | | | x |
| *Archaeodictyomitra* spp. | | | | x | | | | | | x | | | | | | | | | | | x | | | | | | | |
| *Archicapsa* sp. | | | | | x | | | | | | | | | | | | | | | | | | | | | | | |
| *Betraccium deweveri* PESSAGNO & BLOME | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | |
| *Betraccium maclearni* PESSAGNO & BLOME | | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| *Betraccium* sp.cf. *B. inornatum* BLOME | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Busuanga(?)* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Canoptum* spp. | | | | | | | | | | | | | x | | | | x | | | | | | | | | | | |
| *Capnodoce anapetes* DE WEVER | | | | | | | | | | | | | | | | | | | | | | | | | | x | | |
| *Capnodoce extenta* BLOME | | | | | | | | | | | | | | x | | | | | | | | | | | | | | |
| *Capnuchosphaera lea* DE WEVER | | | | | | | | | | | | | | | | | | | | | | | x | x | x | | | |
| *Complexapora* sp. | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |
| *Corum* sp. cf. *C. delgado* SUGIYAMA | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Eptingium* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Gorgansium* sp. | | | | | x | x | | | | | x | | | | | | | | | | | | | | | | | |
| *Haeckelicyrtium*? sp. | | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| *Hagiastrum* sp.? | | | | x | | | | | | | | | | | | | | | | | | | | | | | | |
| *Haliomma* sp. | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| *Japonocampe* sp. | | x | | | | | | | | | | | | | | | | | | | | | | x | | | | x |
| *Katroma coliforme* (HORI) | | | | | | | | | | x | | | | | | | | | | | | | | | | | | |
| *Katroma* sp. | | | | | | | | | | | | | | | | | | | x | | x | | | | | | | |
| *Katroma* sp. cf. *K. irvingi* WHALEN & CARTER | | | | | | | | | | x | | | | | | | | | | | | | | | | | | |
| *Katroma westermanni* WHALEN & CARTER | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |
| *Livarella magna* TEKIN | | | | | | | | | | | | | | | | x | x | x | | | | | | | | | | |
| *Minocapsa* sp. | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| *Muelleritortis cochleata* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | x | | | | | x | |
| *Napora* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pachus multinodosus* TEKIN | | | | | | | | | | | | | | | | | | | | | | | x | | | | | |
| *Pantanellium* sp. | | | | | | | x | | x | | | | x | | | | | | | | | | | | | | | |
| *Pantanellium ultrasincerum* BLOME | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| *Parahsuum simplum* YAO | | | | x | | | | | | x | | | | | | | | | | | | | | | | | | |
| *Parahsuum* spp. | | | | | x | x | | | | | | | x | | | | | | | | x | | | | | | | |
| *Pararuesticyrtium* sp. | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Paroertlispongus* sp. | | | | | | | | | | | x | | | | | | | | | | | | | | | x | | |
| *Paronaella* sp. | | | | | | | | | | | | | | | | | | | | | | | x | | | | | x |
| *Parvicingula* sp. | | | | | | | | | | | | | x | | | | | | | | | | | | | | | |
| *Pentaspongodiscus* sp. | | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pleesus* sp. cf. *P. aptus* YEH | | | | | | | | | | x | | | | | | | | | | | | | | | | | | |
| *Podobursa* sp. | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |
| *Praemesosaturnalis huxleyensis* (CARTER) | | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| *Praemesosaturnalis rugosus* (YEH) | | | | | | | | | | | | | | | | | | | | | | | | | x | | | |
| *Praemesosaturnalis sandspitense* (BLOME) | | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| *Praemesosaturnalis* sp. cf. *P. finchi* (PESSAGNO) | | | | | | | | | | | x | x | | | | | | | | | | | | | | | | |
| *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Pseudostylosphaera spp.* | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Sarla* sp. | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Sethocapsa* spp. | | | | x | | x | | | | | | | | | | x | | | | | x | | | | | | | |
| *Silicarmiger* sp. | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Staurolonche* spp. | | | | | | | | | | | | | | | | | | | | | | | | | | | x | x |
| *Stichocapsa* spp. | | | | | | x | | x | | x | | | | | | | | x | x | x | | | | | | | | |
| *Triassocampe deweveri* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | | | | | | | | x | | | | | | |
| *Trilonche* sp. | | | | | | x | | | | | | x | | | x | | | x | | | | | | | | | | |
| *Tripocyclia* sp. | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| *Vinassaspongus subsphaericus* KOZUR & MOSTLER | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Williriedellum* sp. | | | | | | | | | | | | | x | | | | | | | | | | | | | | | |
| *Xipotheca* sp. cf. *X. rugosa* BRAGIN, emend. TEKIN | | | x | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Range** | | **u. Crn-l. Nor** | **u. Crn-l. Nor** | **Het-Sin?** | **Het-Sin?** | **Het-Sin?** | **Het-Sin?** | **Het-Sin?** | **u. Nor-Rht** | **Sin** | **u. Nor.-Rht** | **u. Nor.-Rht** | **Baj?** | **u. Crn.-Nor** | **u. Nor.-Rht** | **u. Nor.-Rht** | **u. Nor.-Rht** | **u. Nor.-Rht** | **u. Nor.-Rht** | **u. Nor.-Rht** | **Sin** | **Lad-l. Crn** | **u. Crn-l. Nor** | **u. Crn-l. Nor** | **u. Crn-l. Nor** | **u. Nor-Rht** | **u. Crn-Nor** | **Lad-l. Crn** | **u. Crn-Nor** |

Table 4. Radiolarians occurring at Sitio Tingil, Mabudyen, a road cut 35 km east of the township of Coron (11º59.625'N/120º13.637'E) and Calindo.

| Sample Location | | Sitio Tingil (sample location 11) | | | Mabudyen (sample location 12) | | Road cut, township of Coron (sample location 9) | | Calindo (sample location 10) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Sample Number** | **2031210** | **2031217** | **2031220** | **2031201** | **2031202** | **2032118** | **2032119** | **2032102** | **2032103** | **2032106** | **2032109** | **2032110** | **2032112** | **2032117** | **2032101** |
| *Archaeocenosphaera* spp. | | x | x | | | | | | x | x | x | x | | x | x | |
| *Astrocentrus* sp. cf. *A. pulcher* KOZUR & MOSTLER | | x | | | | | | | | | | | | | | |
| *Bulbocyrtium* sp. | | | | | | | | | | | | | x | | | |
| *Canoptum* sp. aff. *C. unicum* PESSAGNO & WHALEN | | | | | | | x | | | | | | | | | |
| *Canoptum* spp. | | | | | | | x | x | | | | | | | | |
| *Capnodoce* sp. cf. *C. anapetes* DE WEVER | | | | x | | | | | | | | | | | | |
| *Celluronta* sp. | | | | | | | | | | | | | x | | | |
| *Deflandrecyrtium carterae* YEH & CHENG | | | | | | | x | | | | | | | | | |
| *Eptingium manfredi* DUMITRICA | | x | | | | | | | x | x | x | x | x | | x | |
| *Eptingium* sp. | | | | | | | | | | x | | | | | | |
| *Hexalonche* sp. | | | | | | | | | | | | x | | | | |
| *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA) | | | | | | | | | x | | | x | | | | |
| *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER | | | | | | | | | x | | | | | | | |
| *Hozmadia rotunda* (NAKASEKO AND NISHIMURA) | | | | | | | | | x | x | | x | x | x | | |
| *Hozmadia* spp. | | | | | | | | | x | | | x | | | x | |
| *Ladinocampe* sp. | | | | | | | | | | | | | | | x | |
| *Linaresia* sp. | | | | | | | | | | | | | | | | x |
| *Livarella magna* TEKIN | | | | | | | x | x | | | | | | | | |
| *Oertlispongus diacanthus* Sugiyama | | x | | | | | | | | | | | | | | |
| *Paleosaturnalis* sp. cf. *P. dotti* (BLOME) | | | | | | x | | | | | | | | | | |
| *Pararuesticyrtium* sp. | | | | | | | | | x | x | | x | | x | | |
| *Parasepsagon* spp. | | | | | | | | | | x | | | | | x | |
| *Parasepsagon variabilis* (NAKASEKO & NISHIMURA) | | | | | | | | | x | | | | | | | |
| *Paronaella* sp. | | | | | | | x | | | | | | | | | |
| *Pentactinocapsa awaensis* NAKASEKO & NISHIMURA | | | | | | | | | | | | | x | | x | |
| *Pentaspongodiscus* spp. | | | | | | | | | | | x | | | x | x | |
| *Praemesosaturnalis gracilis* (KOZUR & MOSTLER) | | | | | | x | | | | | | | | | | |
| *Praemesosaturnalis huxleyensis* (CARTER) | | | | | | x | | | | | | | | | | |
| *Praemesosaturnalis rugosus* YEH | | | | | | x | | | | | | | | | | |
| *Praemesosaturnalis* spp. | | | x | | x | x | | | | | | | | | | |
| *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA) | | | | | | | | | x | | x | x | x | | x | |
| *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA) | | | | | | | | | | x | | | x | x | | |
| *Pseudostylosphaera longispinosa* KOZUR & MOSTLER | | | | | | | | | x | | | | x | | x | |
| *Pseudostylosphaera magnispinosa* YEH | | | | | | | | | | | | | | | x | |
| *Pseudostylosphaera* spp. | | x | | | | | | | | x | x | x | x | x | x | |
| *Pseudostylosphaera timorensis* SASHIDA & KAMATA | | | | | | | | | x | | | | | | x | |
| *Sarla* sp. | | | x | | | | | | | | | | | | | |
| *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | | | x | |
| *Spongosilicarmiger* sp. | | | | | | | | | | | | x | | | | |
| *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA) | | | | | | | | | x | | | x | x | | x | |
| *Spongostylus tricostatus* KOZUR, KRAINER & MOSTLER | | | | | | | | | x | | | | | | | |
| Spumellaria gen. et. sp. indet. | | | | | | | | | x | | | | | | | |
| *Stauracontium* sp. | | | | | | | | | | | x | | | | | |
| *Staurolonche* spp. | | | | | | | | | x | | x | x | | | x | x |
| *Staurolonche trispinosa* (KOZUR & MOSTLER) | | | | | | | | | x | | | | x | | x | |
| *Stichocapsa* sp. | | | | | | | | | | | | | | | | x |
| *Thaisphaera* sp. | | | | | | | | | | | x | | | | | |
| *Tiborella florida* (NAKASEKO & NISHIMURA) | | x | | | | | | | | | | | x | | x | |
| *Tiborella* sp. | | | | | | | | | | | | | x | | | |
| *Transhsuum medium* TAKEMURA | | | | | | | | | | | | | | | | x |
| *Triassocampe coronata* BRAGIN | | | | | | | | | | x | | x | | | x | |
| *Triassocampe deweveri* (NAKASEKO & NISHIMURA) | | | | | | | | | | | | | x | | x | |
| *Triassocampe* spp. | | x | | | | | | | | x | x | x | | x | x | |
| *Trilonche* spp. | | x | | | x | x | | | x | | | | x | | | |
| **Range** | | **u. Ans-l. Lad** | **u. Nor-Rht** | **u. Crn-u. Nor** | **u. Nor-Rht** | **u. Nor-Rht** | **u. Nor-Rht** | **u. Nor-Rht** | **u. Ans-Lad** | **u. Ans.-Lad** | **Lad** | **u. Ans-Lad** | **u. Ans-Lad** | **Lad** | **u. Ans-Lad** | **u. Baj-u. m. Bth?** |

120°00.509'E). The chert present at this locality is dull red and thinly bedded. Bedding is oriented 030/50NW. Two samples, HKU-PLWN02031802 and HKU-PLWN02031803, yielded rare upper Carnian-lower Norian radiolarians (Table 3).

*Marily (sample location 6)*

Samples HKU-PLWN02031302 to HKU-PLWN02031305 were collected from a coastal section consisting of reddish brown chert beds. The section is situated at the SE side of the island, 11°56.848'N/120°00.942'E. Bedding strikes 165 and dips steeply to the east. Three samples (HKU-PLWN02031302 to HKU-PLWN02031304) contain Lower Jurassic? (Hettangian-Sinemurian or younger) radiolarians. The occurrences of radiolarians are shown in Table 3.

*Mayanpayan (sample location 7)*

The coastal outcrop where samples HKU-PLWN02031709 to HKU-PLWN02031715 were collected is located on the SE side of the island, 11°58.816'N/120°07.382'E. It consists of folded thinly to medium bedded reddish brown chert. Samples HKU-PLWN02031709 and HKU-PLWN02031710 contain Lower Jurassic? (Sinemurian or younger) assemblages. Sample HKU-PLWN02031713 contains Sinemurian radiolarians whereas sample HKU-PLWN02031715 yielded upper Norian-Rhaetian radiolarians (Table 3).

*Dimanglet (sample location 8)*

Samples HKU-PLWN02031401 to HKU-PLWN02031435 and HKU-PLWN02031701 to HKU-PLWN02031708 were collected from a continuous chert section exposed along the SE coast of the island (12º01.848'N/119º59.792). The reddish brown chert is thinly to medium bedded. It is highly folded and faulted. Some horizons are massively recrystallized and appear to be thickly bedded. Four radiolarian assemblages are recognized. Samples HKU-PLWN02031410, HKU-PLWN02031413 and HKU-PLWN02031701 yielded upper Carnian-Norian radiolarians. Ladinian – lower Carnian faunas occur in samples HKU-PLWN02031402 and HKU-PLWN02031702 whereas upper Carnian – lower Norian radiolarians are found in samples HKU-PLWN02031405, HKU-PLWN02031407 and HKU-PLWN02031408. Samples HKU-PLWN02031409, HKU-PLWN 02031414, HKU-PLWN20301418 to HKU-PLWN02031420, HKU-PLWN02031425, HKU-PLWN02031427, HKU-PLWN 02031705 and HKU-PLWN02031706 contain upper Norian-Rhaetian faunas. Lower to Middle Jurassic radiolarians occur in samples HKU-PLWN02031430 (Sinemurian or younger) and HKU-PLWN02031707 (Bajocian or younger). Table 3 shows the radiolarians occurring in this area.

*Road cut, 3.5 km east of the township of Coron (sample location 9)*

Two samples, HKU-PLWN02032118 and HKU-PLWN 02032119, were collected from this roadside section (11°59.625'N/120°13.637'E). The chert isweathered and thinly bedded. Bedding strikes 160 and dips gently to the SW. The two samples contain upper Norian-Rhaetian radiolarians (Table 4).

*Calindo (sample location 10)*

Samples HKU-PLWN02032102 to HKU-PLWN02032117 were collected from a roadside section located at 12°00.939'N/ 120°15.681'E. The outcrop is composed of uniformly bedded reddish brown chert. Bedding strikes 030 and dips gently to the NW. Upper Anisian-Ladinian radiolarians occur in samples HKU-PLWN02032102, HKU-PLWN02032103, HKU-PLWN02032109, HKU-PLWN02032110 and HKU-PLWN 02032117 whereas Ladinian radiolarians are present in samples HKU-PLWN02032106 and HKU-PLWN02032112 (Table 4).

A spot sample (HKU-PLWN02032101) was collected from the top of a small hill (100 m high) located at 12°01.477'N/120°16.232'E. The sample, a chert, is upper Bajocian to uppermost middle Bathonian? (Table 4).

*Sitio Tingil, 2.5 km SE of Coconogon Point (sample location 11)*

Samples HKU-PLWN02031209 to HKU-PLWN02031220 and HKU-PLWN02031618 to HKU-PLWN02031621 were collected from a coastal section (12º12.570'N/120º13.282'E) composed of brown, dark gray to black, thinly bedded to laminated chert. The beds are folded and locally highly sheared. Sample HKU-PLWN02031210 yielded upper Anisian-lower Ladinian radiolarians whereas samples HKU-PLWN02031217 and HKU-PLWN02031220 contain upper Norian-Rhaetian and upper Carnian – upper Norian radiolarians, respectively (Table 4).

*Mabudyen, 2 km west of Malawig (sample location 12)*

The coastal section (12º11.941'N/120º13.447) where samples HKU-PLWN02031201 to HKU-PLWN02031207 were collected consists of thinly bedded black-brown chert. The chert is recystallized. Bedding strikes 030 and dips steeply to the NW. Only two samples, HKU-PLWN02031201 and HKU-PLWN02031202, contain identifiable forms (Table 4). The assemblage is upper Norian-Rhaetian.

*Mabintangin River (sample location 13)*

Samples HKU-PLWN02031001 to HKU-PLWN02031017 were collected from a section along the Mabintangin River. The outcrop is composed of folded thinly to medium bedded black chert. Twelve samples yielded identifiable Upper Permian radiolarians. Table 5 shows the radiolarian assemblage in this section.

Table 5. Distribution of Upper Permian radiolarians within the Liminangcong Formation exposed along the Mabintangin River.

| Sample Location | | Mabintangin River | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Sample Number | 2031001 | 2031002 | 2031003 | 2031004 | 2031005 | 2031006 | 2031007 | 2031008 | 2031009 | 2031011 | 2031016 | 2031017 |
| ?*Latentifistula* sp. F sensu KUWAHARA AND YAO | | | | x | | | | | | | | | |
| ?*Stigmosphaerostylus* spp. | | | | | | | x | | | x | | | |
| *Albaillella* ? *protolevis* KUWAHARA | | | | | | | | | | | | x | x |
| *Albaillella cavitata* KUWAHARA | | | | | | | x | x | | | | | |
| *Albaillella* sp. | | | | | | | x | | | | | | |
| *Albaillella triangularis* ISHIGA, KITO & IMOTO | | | | | | | | | x | | | | |
| broken *Follicucullus* spp. | | x | x | | | | x | | | x | | | |
| *Copicyntra* spp. | | | | x | | x | x | | | | | | |
| *Copicyntroides?* sp. A sensu KUWAHARA AND YAO | | x | | | x | | | | | | | | |
| *Copiellintra?* sp. A sensu KUWAHARA AND YAO | | | | | | | x | | | | | | |
| *Deflandrella* sp. | | | | x | | | | | | | | | |
| *Follicucullus porrectus* RUDENKO | | x | x | | | | | | | | | | |
| *Follicucullus* sp. cf. *F. charveti* CARIDROIT & DE WEVER | | | x | | | | | | | | | x | x |
| *Follicucullus* sp. cf. *F. scholasticus* ORMISTON & BOBCOCK | | x | | | | | | | | | | | |
| *Foremanhelena musashiensis* (SASHIDA & TONISHI) | | | | | | | | | x | | | | x |
| *Ishigaum nicolasensis* TUMANDA | | | | | | | | x | | | | | x |
| *Ishigaum* sp. cf. *I. trifustis* DE WEVER & CARIDROIT | | | | x | | | | | | | | | |
| *Ishigaum* spp. | | | x | x | x | | | | | | x | | |
| *Latentibifistula* sp. cf. *L. asperspongiosa* SASHIDA & TONISHI | | x | | | | | | | | | | | |
| *Latentibifistula* spp. | | | | x | | x | | x | | x | | | |
| *Latentifistula* sp. E sensu TUMANDA | | x | | | | | | | | | | | |
| *Latentifistula* spp. | | | | x | x | | x | x | | | x | | x |
| *Nazarovella gracilis* DE WEVER & CARIDROIT | | x | | | | | | | | | | | x |
| *Nazarovella* sp. | | | | x | | | | | | | | | |
| *Polyfistula* sp. | | | | | | | | | | x | | | |
| *Pseudotormentus* sp. | | x | | | | | | | | | | | |
| *Ruzhencevispongus* (?) sp. B sensu TUMANDA | | x | | | | x | | | | | x | | |
| Spumellaria gen. et. sp. indet. | | x | x | x | x | x | x | x | | x | x | | |
| Stauraxon F sensu YAO & KUWAHARA | | x | | | | | | | | | | | |
| *Stigmosphaerostylus* sp. cf. *S. modesta* (SASHIDA & TONISHI) | | | | | x | | | | | | | | x |
| *Trilonche* sp. cf. *T. cimelia* (NAZAROV & ORMISTON) | | | x | | | x | x | x | | | | | |
| *Trilonche* spp. | | | | | | | | x | | x | | | x |
| Range | | Upper Permian | | | | | | | | | | | |

## Summary and Conclusion

This research has expanded the known geographic extent of studied sections and has contributed towards refinement of calibration of the Triassic in Northern Palawan. Samples collected from several sections on Busuanga and surrounding small islands yielded 173 species distributed among 92 genera in 45 families. Most of the samples are Triassic, spanning the time interval, Anisian to Rhaetian. Four of the sections also yield Jurassic faunas; three of which include Lower Jurassic radiolarians whereas two sites contain Bajocian-Bathonian? assemblages. Upper Permian radiolarians were recovered only from sample location 13 at the Mabintangin River in Busuanga. No other Permian outcrops were encountered on the surrounding islands investigated during this study. Lowermost Triassic (Griesbachian and Nammalian) sections are not documented herein and they have not been reported from earlier investigations. It remains unclear whether the absence of the lowermost Triassic outcrops is related to sampling density, poor radiolarian preservation or a possible hiatus coinciding with the worldwide latest Permian catastrophic event.

A previous study of Busuanga (Zamoras 2001; Zamoras & Matsuoka 2001) recognized three structural divisions: Northern Busuanga Belt (NBB), Middle Busuanga Belt (MBB) and Southern Busuanga Belt (SBB). Samples collected during this study were incorporated into the composite stratigraphy of the chert-clastic sequence described by Zamoras (2001). The sections from Calauit-Illultuk Bay, Sitio Tingil and Mabudyen are from the NBB. The Dabatonay, Mapadolo and Calindo sections lie within the MBB. The rest of the sections are from the SBB. Figure 3 shows the data from this study together with the Triassic data of Zamoras (2001) and Zamoras & Matsuoka (2001), and earlier results of Yeh (1992) and Tumanda (1991a, 1991b). In the SBB stratigraphy, Zamoras (2001) noted that the Upper Triassic cherts represent the lower part of the succession. However, the inclusion of data from the present study clearly demonstrates the presence of a Middle Triassic interval in the SBB. Tumanda (1991a, 1991b) also reported an upper Spathian assemblage in Decalangwang.

The chert-clastic succession in North Palawan documents almost 100 My of the history of a subducted oceanic plate.

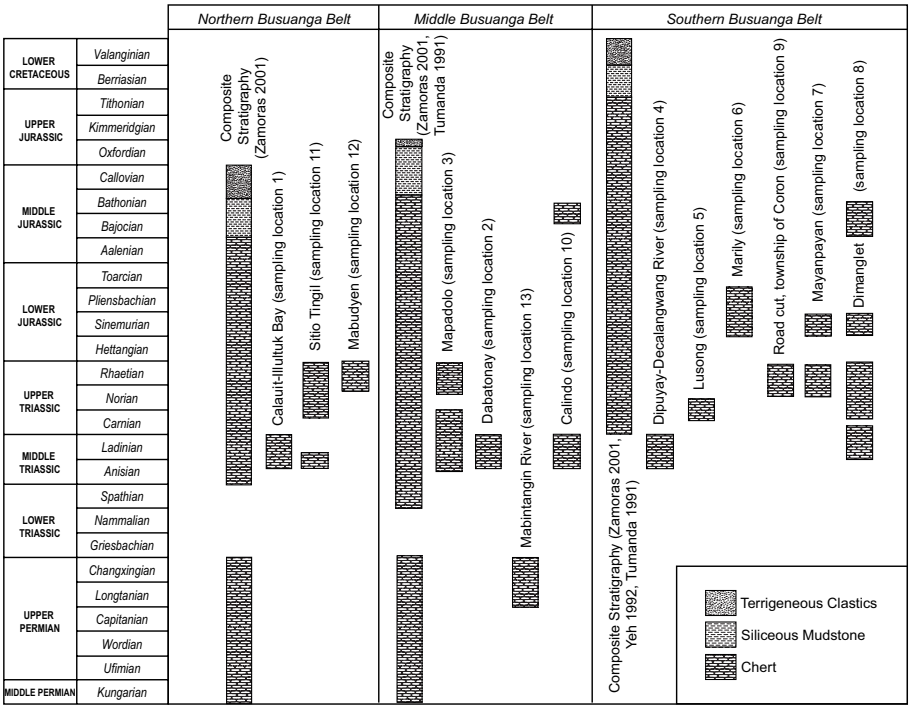


Fig. 3. Stratigraphic ranges of lithologies in the three accretionary belts of Busuanga as constrained by radiolarian faunas.

This plate traveled from a deep sea environment to a convergent margin, which developed along the eastern margin of Asia. However, the paleolatitudes of the block during this journey are still under investigation. Kiessling and Flügel (2000) suggested that the facies and ages of the carbonates from the islands of Malajon, Kalampisanan, Busuanga and Coron do not support a close paleogeographical connection between the NPB and South China Block. They suggested that during the Carboniferous and Permian, the NPB was part of the Indochina Block from which it separated during the Middle Permian. The NPB collided with the South China Block during the Late Cretaceous. Paleomagnetic studies carried out by Almasco et al. (2000) on the NPB show that the paleomagnetic directions fail regional fold tests and have alternating field (AF) demagnetisation features consistent with secondary magnetisation. However, they pointed out that the Cretaceous paleolatitude is still comparable to regions of pervasive Cretaceous remagnetisation in the South China borderland. They suggested that this may reflect similar remagnetisation and is consistent with the NPB's proposed South China origin.

Based on the tectonic model of Maruyama et al. (1997), Zamoras (2001) interpreted the NPB to have been part of the NNW-traveling Izanagi Plate from Late Permian to Late Jurassic-Early Cretaceous. He suggested that the Middle Carboniferous limestone described by Kiessling & Flügel (2000) probably originated from the Farallon Plate. Holloway (1982) noted that during the Middle Jurassic to Late Jurassic an episode of spreading commenced between Australia and a continent/continental fragments to the northwest. He added that this spreading episode produced a NNW-directed plate motion with the oceanic lithosphere being consumed at a NW-dipping subduction zone (East Asian Subduction Zone; Zamoras 2001) on the southeastern margins of the Indochina and South China blocks.

The pelagic sediments in Busuanga and surrounding islands records up to 100 My of deposition. The presence of benthonic and planktonic foraminifers at some localities probably indicates that not all of the chert was deposited below the CCD. Manganese deposits found on Busuanga and Dabatonay indicate an oceanic setting affected by a low average sedimentation rate. The limestone bodies presently found in fault contact with the chert-clastic succession can be interpreted as shallow water facies or carbonate build-ups on seamounts. The facies change from cherts through hemipelagic clastics to terrigenous clastics suggests that the ocean was being influenced by subduction zone related sedimentation by the Middle to Late Jurassic (Aalenian-Bajocian in the NBB, early-late Bathonian in the MBB and early-late Tithonian in the SBB).

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**Plate 1**

Upper Permian radiolarians from the Mabintangin River (sample location 13), Busuanga, Philippines. Scale bars = 100 μm.

Figs. 1–5 from HKU-PLWN02031001, Upper Permian:
1. spherical radiolarian; 2. ?*Copicyntroides* sp. A sensu KUWAHARA & YAO; 3. ?*Nazarovella gracilis* DE WEVER & CARIDROIT; 4, 5. broken *Follicucullus*

Figs. 6–11 from HKU-PLWN02031002, Upper Permian:
6. *Trilonche* sp. cf. *T. cimelia* (NAZAROV & ORMISTON); 7, 8. *Follicucullus porrectus* RUDENKO; 9–11. *Follicucullus charveti* CARIDROIT & DE WEVER

Figs. 12–19 from HKU-PLWN02031003, Upper Permian:
12. spherical radiolarian; 13. ?*Copicyntra* sp.; 14. *Ishigaum* sp. cf. *I. trifustis* DE WEVER & CARIDROIT; 15. *Latentifistula* sp. F sensu KUWAHARA AND YAO?; 16. *Deflandrella* sp.; 17. *Nazarovella* sp.; 18, 19. *Latentibifistula* spp.

Figs. 20, 21 from HKU-PLWN02031004, Upper Permian:
20. *Copicyntroides*? sp. A sensu KUWAHARA AND YAO; 21. *Ishigaum* sp.

Figs. 22–27 from HKU-PLWN02031006, Upper Permian:
22. ?*Stigmosphaerostylus* sp.; 23. *Trilonche* sp. cf. *T. cimelia* (NAZAROV & ORMISTON); 24. *Copicyntra* sp.?; 25. *Copiellintra*? sp. A sensu KUWAHARA AND YAO; 26. *Albaillella* sp.; 27. *Albaillella* sp. cf. *A. cavitata* KUWAHARA

Figs. 28–31 from HKU-PLWN02031007, Upper Permian:
28, 29. *Albaillella cavitata* KUWAHARA; 30. *Ishigaum nicolasensis* TUMANDA; 31. *Latentibifistula* sp.

Figs. 32, 33 from HKU-PLWN02031008, Upper Permian:
32. *Foremanhelena musashiensis* (SASHIDA & TONISHI); 33. *Albaillella triangularis* ISHIGA, KITO & IMOTO

Figs. 34, 35 from HKU-PLWN02031009, Upper Permian:
34. ?*Stigmosphaerostylus* sp.; 35. *Polyfistula* sp.

Fig. 36 from HKU-PLWN02031011, Upper Permian:
36. *Ruzhencevispongus* (?) sp. B sensu TUMANDA

Fig. 37 from HKU-PLWN02031016, Upper Permian:
37. *Albaillella*? *protolevis* KUWAHARA

Figs. 38–41 from HKU-PLWN02031017, Upper Permian:
38. *Ishigaum nicolasensis* TUMANDA; 39. *Trilonche* sp.; 40. *Nazarovella gracilis* DE WEVER & CARIDROIT; 41. *Foremanhelena musashiensis* (SASHIDA & TONISHI)

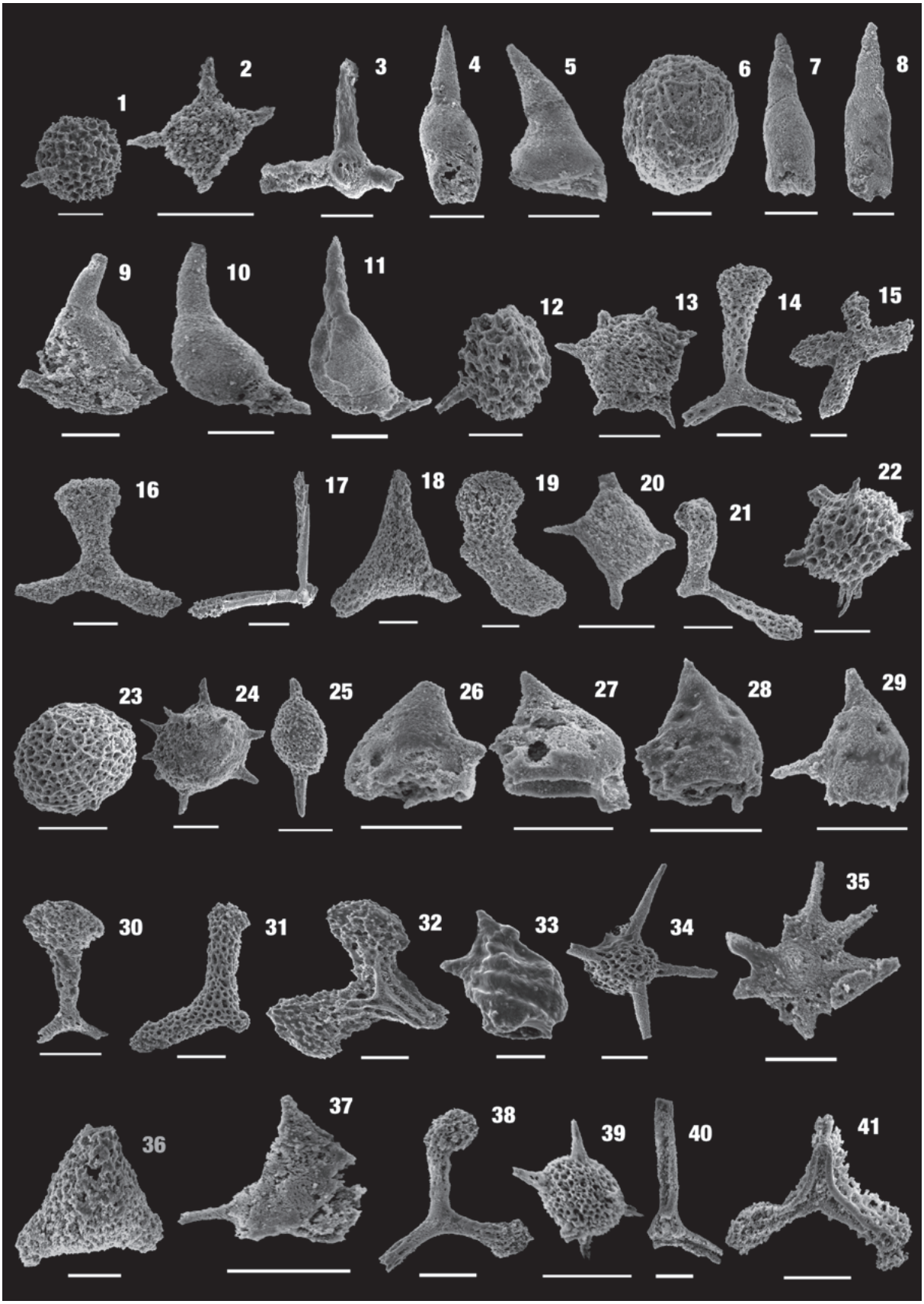
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**Plate 2**

Middle to Upper Triassic radiolarians from Mapadolo (sample location 3) (figs. 1–4), Dabatonay (sample location 2) (figs. 5–35) and Mabudyen (sample location 12) (figs. 36–40), Philippines. Scale bars = 100 μm.

Fig. 1 from HKU-PLWN02031101, upper Anisian-Ladinian
*Crucella* sp.

Figs. 2, 3 from HKU-PLWN02031102, Carnian:
2. *Capnuchosphaera deweveri* KOZUR & MOSTLER, emend. BLOME; 3. *Capnuchosphaera missionensis* CORDEY

Fig. 4 from HKU-PLWN02031103, upper Norian-Rhaetian?
*Haeckelicyrtium*? sp.

Figs. 5–15 from HKU-PLWN02031109, uppermost Anisian-Ladinian:
5. *Pentactinocarpus fusiformis* DUMITRICA; 6. *Archaeocenosphaera* (?) sp.; 7. *Triassocampe* sp.; 8. *Spinotriassocampe hungarica* KOZUR; 9. *Eptingium manfredi* DUMITRICA; 10. *Spongostephanidium longispinosum* SASHID; 11. *Tiborella* sp.; 12. *Parasepsagon* sp.; 13. *Pseudostylosphaera longispinosa* KOZUR & MOSTLER; 14. *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA); 15. *Pseudostylosphaera magnispinosa* YEH

Figs. 16–22 from HKU-PLWN02031110, upper Anisian-Ladinian:
16. *Archaeocenosphaera* (?) sp.; 17, 18. *Poulpus* spp.; 19. *Pentactinocarpus fusiformis* DUMITRICA; 20. *Oertlispongus inaequispinosus* DUMITRICA, KOZUR & MOSTLER; 21. *Triassocampe deweveri* (NAKASEKO & NISHIMURA); 22. *Triassocampe coronata* BRAGIN

Figs. 23–26 from HKU-PLWN02031111, upper Anisian-Ladinian:
23. ?*Archaeocenosphaera* sp.; 24. *Pentactinocarpus fusiformis* DUMITRICA; 25. *Hozmadia* sp.; 26. *Pseudostylosphaera magnispinosa* YEH

Figs. 27–34 from HKU-PLWN02031114, upper Anisian-Ladinian:
27. *Triassocampe coronata* BRAGIN; 28. *Spinotriassocampe hungarica* KOZUR; 29. *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA); 30. *Pentactinocarpus tetracanthus* DUMITRICA; 31. *Pentactinocarpus fusiformis* DUMITRICA; 32. *Eptingium manfredi* DUMITRICA; 33. *Parasepsagon* sp.; 34. *Poulpus* sp.

Fig. 35 from HKU-PLWN 02031116, upper Anisian-Ladinian:
35. *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA)

Figs. 36–40 from HKU-PLWN02031202, upper Norian-Rhaetian:
36. *Praemesosaturnalis huxleyensis* (CARTER); 37. *Praemesosaturnalis gracilis* (KOZUR & MOSTLER); 38–40. *Praemesosaturnalis* spp.

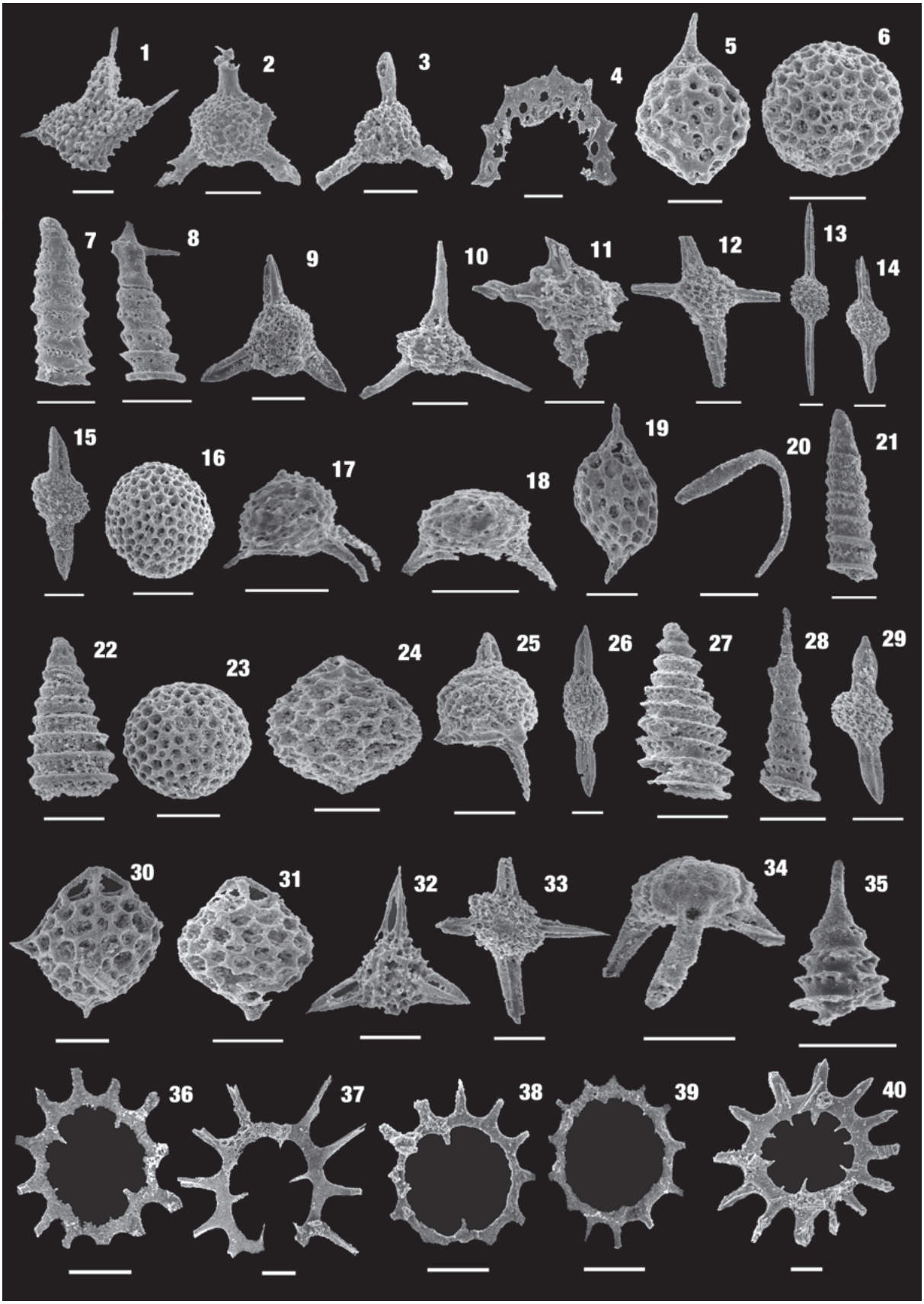
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**Plate 3**

Middle Triassic to Lower Jurassic radiolarians from Mabudyen (sample location 12) (figs. 1, 2), Sitio Tingil (sample location 11) (figs. 3–6), Marily (Figs. 7–15) and Dimanglet (sample location 8) (figs. 16–37), Philippines. Scale bars = 100 μm.

Figs. 1, 2 from HKU-PLWN02031202, upper Norian-Rhaetian:
1. *Praemesosaturnalis rugosus* (YEH); 2. *Paleosaturnalis* sp. cf. *P. dotti* (BLOME)
Figs. 3–5 from HKU-PLWN02031210, upper Anisian-lower Ladinian:
3, 4. *Oertlispongus diacanthus* SUGIYAMA; 5. *Astrocentrus* sp. cf. *A. pulcher* KOZUR & MOSTLER
Fig. 6 from HKU-PLWN02031220, upper Carnian-upper Norian:
6. *Capnodoce* sp. cf. *C. anapetes* DE WEVER
Figs. 7–9, from HKU-PLWN02031302, Hettangian-Sinemurian?:
7, 8. *Parahsuum simplum* YAO; 9. *Sethocapsa* sp.;
Figs. 10, 11 from HKU-PLWN02031303, Hettangian-Sinemurian?:
10, 11. *Archicapsa* sp.
Figs. 12–15 from HKU-PLWN02031304, Hettangian-Sinemurian?:
12. *Pantanellium ultrasincerum* BLOME; 13. *Haliomma* sp.; 14. *Trilonche* sp.; 15. *Sethocapsa* sp.
Figs. 16–19 from HKU-PLWN02031402, Ladinian-lower Carnian:
16. *Napora* sp.; 17. *Silicarmiger* sp.; 18. *Muelleritortis* sp.; 19. *Pararuesticyrtium* sp.
Figs. 20–23 from HKU-PLWN02031405, upper Carnian-lower Norian:
20. *Haeckelicyrtium*? sp.; 21. *Latium* sp.; 22. *Capnuchosphaera lea* DE WEVER; 23. *Pachus multinodosus* TEKIN
Fig. 24 from HKU-PLWN02031407, upper Carnian-lower Norian
24. *Capnuchosphaera lea* DE WEVER
Fig. 25 from HKU-PLWN02031413, upper Carnian-Norian
25. *Capnodoce extenta* BLOME
Figs. 26–28 from HKU-PLWN02031414, upper Norian-Rhaetian:
26. *Betraccium maclearni* PESSAGNO & BLOME; 27. *Betraccium deweveri* PESSAGNO & BLOME; 28. *Praemesosaturnalis sandspitense* (BLOME)
Fig. 29 from HKU-PLWN02031418, upper Norian-Rhaetian:
29. *Betraccium deweveri* PESSAGNO & BLOME
Fig. 30 from HKU-PLWN02031419, upper Norian-Rhaetian:
30. *Canoptum* sp.
Figs. 31, 32 from HKU-PLWN02031420, upper Norian-Rhaetian:
31. *Acanthosphaera* sp.; 32. *Livarella magna* TEKIN
Figs. 34–37 from HKU-PLWN02031430, Sinemurian
33. *Archaeodictyomitra* sp.; 34. *Parahsuum* sp.*; 35*. *Katroma westermanni* WHALEN & CARTER; 36. *Podobursa* sp.; 37. *Sethocapsa* sp.

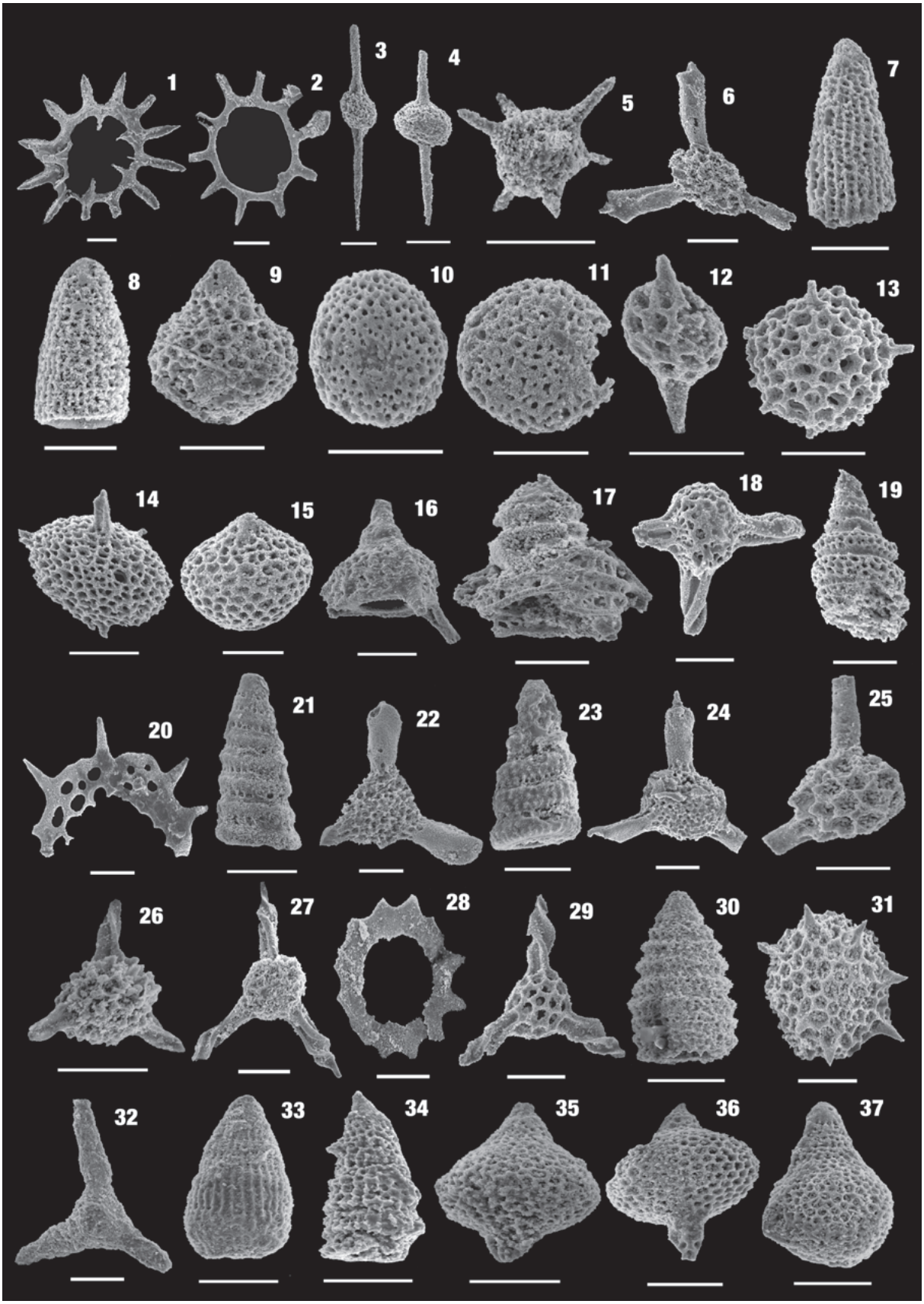
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**Plate 4**

Middle Triassic to Lower Jurassic radiolarians from Dimanglet (sample location 8) (figs. 1–15), Mayanpayan (sample location 7) (figs. 16, 17), Lusong (sample location 5) (figs. 18, 19), Calauit-Illultuk Bay (sample location 1) (figs. 20–21) and Dipuyay-Decalangwang River, Busuanga (sample location 4) (figs. 22–44), Philippines. Scale bars = 100 μm.

Figs. 1–3 from HKU-PLWN02031701, upper Carnian-Norian:
1. *Eptingium* sp.; 2. *Japonocampe* sp.; 3. *Corum* sp. cf. *C. delgado* SUGIYAMA

Figs. 4–7 from HKU-PLWN02031702, Ladinian-lower Carnian:
4. *Busuanga* (?) sp.; 5. *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA); 6. *Vinassaspongus subsphaericus* KOZUR & MOSTLER; 7. *Muelleritortis cochleata* (NAKASEKO & NISHIMURA)

Fig. 8 from HKU-PLWN02031705, upper Norian-Rhaetian:
8. *Paroertlispongus* sp

Figs. 9, 10 from HKU-PLWN02031706, upper Norian-Rhaetian:
9, 10. *Praemesosaturnalis* sp. cf. *P. finchi* (Pessagno)

Figs. 11–15 from HKU-PLWN02031707, Bajocian?, could be younger:
11, 12. *Williriedellum* sp.; 13–15. *Parahsuum* sp.

Figs. 16, 17 from HKU-PLWN02031713, Sinemurian:
16. *Pleesus* sp. cf. *P. aptus* YEH; 17. *Katroma coliforme* (HORI)

Fig. 18 from HKU-PLWN02031802, upper Carnian-lower Norian:
18. *Canoptum farawayense* BLOME

Fig. 19 from HKU-PLWN02031803, upper Carnian-lower Norian:
19. *Xipotheca* sp. cf. *X. rugosa* BRAGIN, emend. TEKIN

Fig. 20 from HKU-PLWN02031904, upper Anisian-Ladinian:
20. *Rikivatella* sp.

Fig. 21 from HKU-PLWN02031905, upper Anisian- lower Ladinian:
21. *Triassocampe tulbuanensis* TUMANDA

Figs. 22–24 from HKU-PLWN02032013, upper Anisian-Ladinian:
22. *Paroertlispongus* sp.; 23. *Triassocampe* sp.; 24. *Triassocampe deweveri* (NAKASEKO & NISHIMURA)

Fig. 25 from HKU-PLWN02032018, upper Anisian-Ladinian:
25. *Praeconocaryomma* sp.

Figs. 26–28 from HKU-PLWN02032020, upper Anisian-Ladinian:
26. *Pseudostylosphaera timorensis* SASHIDA & KAMATA; 27. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA); 28. *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA)

Figs. 29–32 from HKU-PLWN02032021, upper Anisian-Ladinian:
29. *Pararuesticyrtium* sp.; 30. *Tiborella florida* (NAKASEKO & NISHIMURA); 31. *Eptingium nakasekoi* KOZUR & MOSTLER; 32. *Cryptostephanidium cornigerum* DUMITRICA

Figs. 33–39 from HKU-PLWN02032022, LADINIAN:
33. *Pentactinocapsa awaensis* NAKASEKO & NISHIMURA; 34. *Hozmadia rotunda* NAKASEKO & NISHIMURA; 35. *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA); 36. *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA); 37. *Parasepsagon* sp.; 38. *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA); *Triassocampe coronata* BRAGIN

Figs. 40–44 from HKU-PLWN02032023, upper Anisian-Ladinian:
40. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA); 41. *Pseudostylosphaera magnispinosa* YEH; 42. *Tiborella magnidentata* Dumitrica, KOZUR & MOSTLER; 43. *Staurolonche trispinosa* (KOZUR & MOSTLER); 44. *Tiborella florida* (NAKASEKO & NISHIMURA)

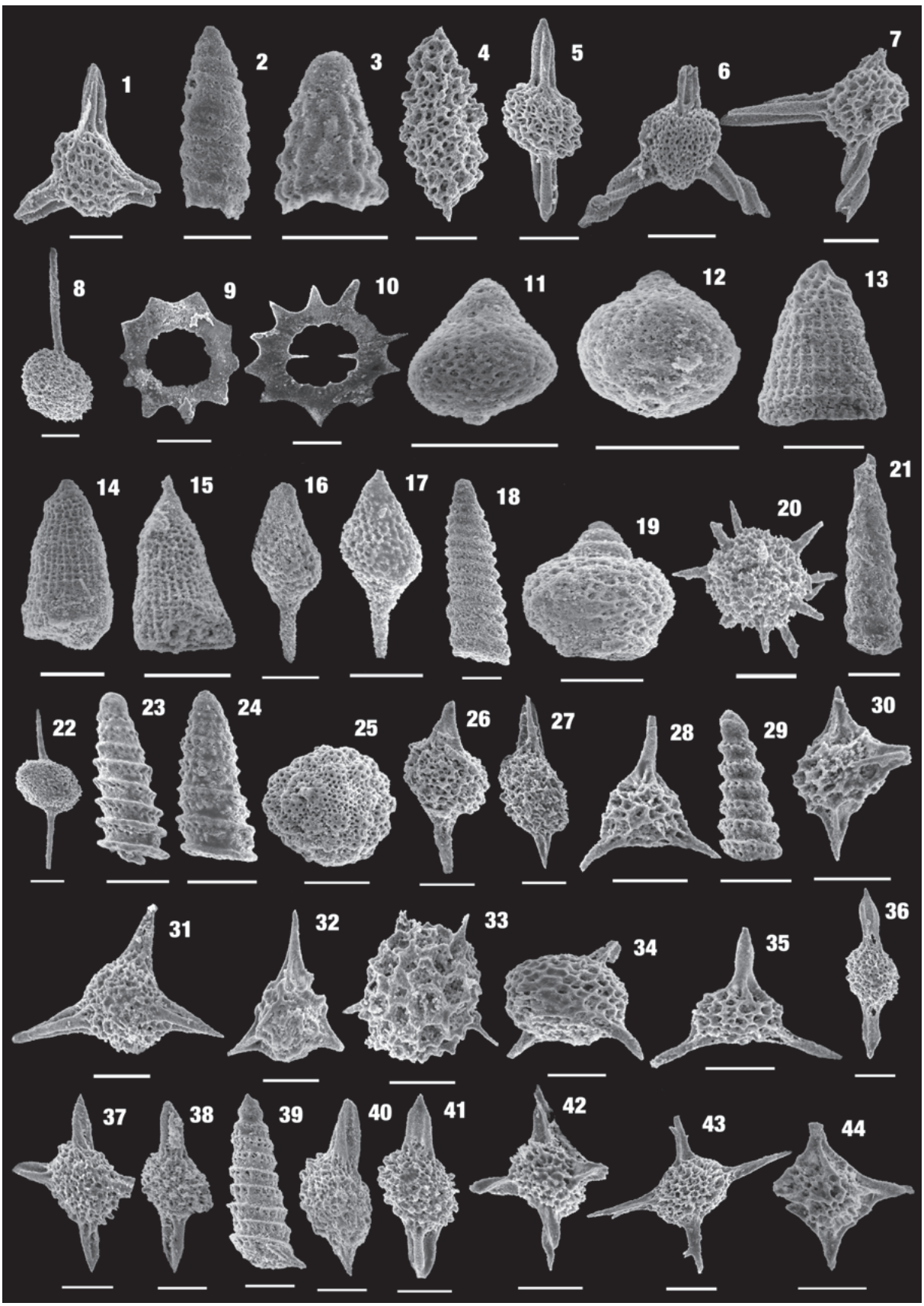
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**Plate 5**

Middle to Upper Triassic radiolarians from Dipuyay-Decalangwang River (sample location 4), Busuanga, Philippines. Scale bars = 100 μm.

Figs. 1–4 from HKU-PLWN02032025, upper Anisian-Ladinian:
1. *Acanthosphaera* (?) *mocki* KOZUR & MOSTLER; 2. *Thaisphaera* sp.; 3. *Pararuesticyrtium* sp.; 4. *Eptingium ramovsi* KOZUR et al.

Figs. 5–9 from HKU-PLWN02032029, upper Anisian-Ladinian:
5. *Triassocampe coronata* BRAGIN; 6. *Staurolonche* sp.; 7. *Staurolonche trispinosa* (KOZUR & MOSTLER); 8. *Sarla* sp.; 9. *Triassistephanidium laticorne* DUMITRICA

Figs. 10–18 from HKU-PLWN02032027, upper Anisian-Ladinian:
10. *Pentactinocapsa awaensis* NAKASEKO & NISHIMURA; 11, 12. *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER; 13. *Hexalonche* sp.; 14. *Pseudostylosphaera goricanae* KOZUR ET AL.; 15. *Epigondollela* sp.; 16. *Tiborella* sp.; 17. *Plafkerium abboti* PESSAGNO; 18. *Parasepsagon variabilis* NAKASEKO & NISHIMURA

Figs. 19–26 from HKU-PLWN02032031, upper Anisian-Ladinian:
19. *Pentactinocapsa awaensis* NAKASEKO & NISHIMURA; 20. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA); 21. *Pseudostylosphaera timorensis* SASHIDA & KAMATA; 22, 23. *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA); 24. *Pseudostylosphaera japonica* (NAKASEKO & NISHIMURA); 25. *Triassocampe deweveri* (NAKASEKO & NISHIMURA); 26. *Triassocampe coronata* BRAGIN

Figs. 27, 28 from HKU-PLWN02032037, upper Anisian-Ladinian:
27. *Triassocampe scalaris* DUMITRICA, KOZUR & MOSTLER; 28. *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA)

Figs. 29–31 from HKU-PLWN02032041, upper Anisian-Ladinian:
29, 30. *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER; 31. *Napora* sp.

Figs. 32, 33 from HKU-PLWN02032049, upper Anisian-Ladinian:
32. *Cryptostephanidium cornigerum* DUMITRICA; 33. *Ladinocampe japonica* (NAKASEKO & NISHIMURA)

Fig. 34 from HKU-PLWN02032050, upper Anisian-Ladinian:
34. *Bulbocyrtium* sp.

Figs. 35–41 from HKU-PLWN02032052, upper Anisian-Ladinian:
35. *Sepsagon* sp.; 36, 38. *Hozmadia* sp.; 37. *Archaeocenosphaera* sp.; 39. *Hozmadia rotunda* (NAKASEKO & NISHIMURA); 40. *Tiborella* sp.; *Katorella bifurcata* KOZUR & MOSTLER

Figs. 42, 43 from HKU-PLWN02032057, upper Anisian-lower Ladinian:
42. *Archaeocenosphaera* sp.; 43. *Pentactinocorbis kozuri* DUMITRICA

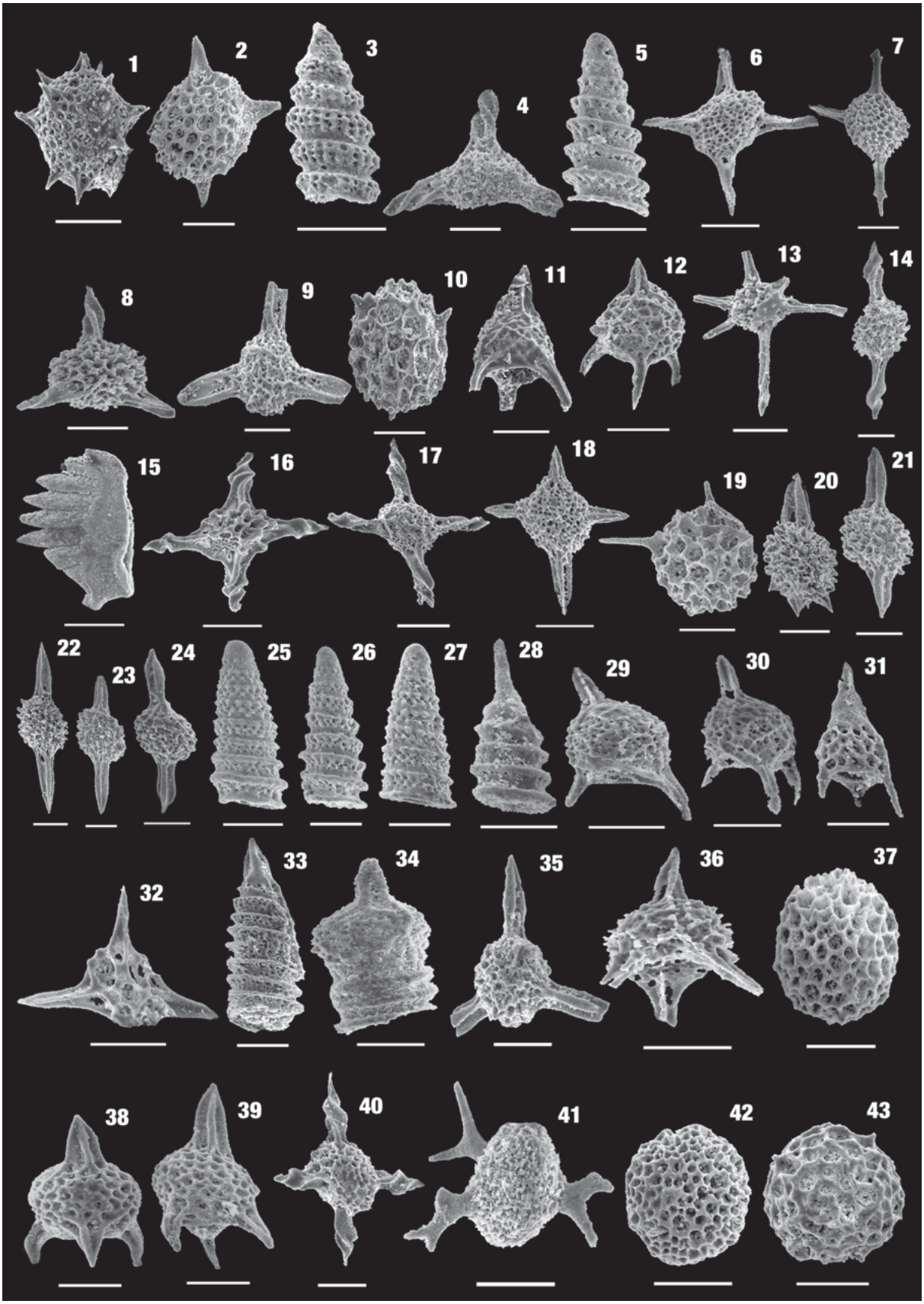
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**Plate 6**

Middle Triassic to Middle Jurassic radiolarians from Dipuyay-Decalangwang River (sample location 4) (figs. 1–9), Calindo (sample location 10) (figs. 10–41) and a road cut, 3.5 kms east of the township of Coron (sample location 9) (figs. 42–45). Scale bars = 100 μm.

Figs. 1–6 from HKU-PLWN02032057, upper Anisian-lower Ladinian:
1a. *Hozmadia spinifera* SUGIYAMA; 1b. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA); 2, 3. *Paratriassocampe* sp.; 4. *Triassocampe coronata* BRAGIN; 5, 6. *Tiborella florida* (NAKASEKO & NISHIMURA)

Figs. 7–9 from HKU-PLWN02032060, upper Anisian-Ladinian:
7. *Staurolonche trispinosa* (KOZUR & MOSTLER); 8. *Hozmadia rotunda* (NAKASEKO & NISHIMURA); 9. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA)

Figs. 10–13 from HKU-PLWN02032101, upper Bajocian-uppermost middle Bathonian:
10. *Stichocapsa* sp.; 11. *Linaresia* sp.; 12. *Staurolonche* sp.; 13. *Transhsuum medium* TAKEMURA

Figs. 14–22 from HKU-PLWN02032102, upper Anisian-Ladinian:
14. *Paratriassocampe* sp.; 15. *Pseudostylosphaera longispinosa* KOZUR & MOSTLER; 16. *Pseudostylosphaera compacta* (NAKASEKO & NISHIMURA); 17. *Spongostylus tricostatus* KOZUR, KRAINER & MOSTLER; 18. *Eptingium manfredi* DUMITRICA; 19. *Hozmadia reticulata* DUMITRICA, KOZUR & MOSTLER; 20. *Hozmadia rotunda* (NAKASEKO & NISHIMURA; 21. ?*Hexalonche* sp.; 22. *Staurolonche* sp.

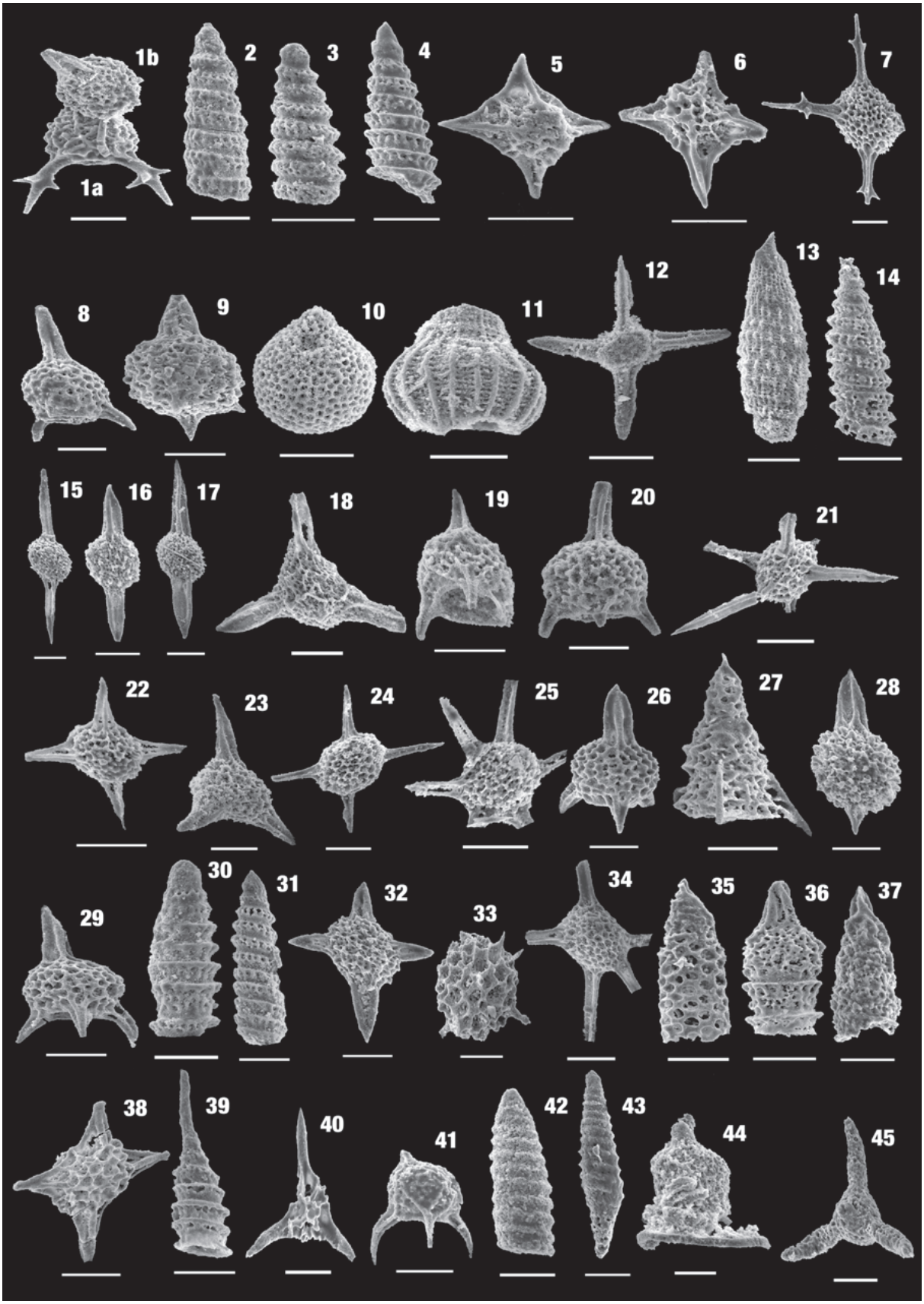
Figs. 23–25 from HKU-PLWN02032106, Ladinian:
23. *Eptingium manfredi* DUMITRICA; 24. *Stauracontium* sp.; 25. *Pentaspongodiscus* sp.

Figs. 26–32 from HKU-PLWN02032109, upper Anisian-Ladinian:
26. *Hozmadia rotunda* (NAKASEKO & NISHIMURA); 27. *Spongosilicarmiger* sp.; 28. *Hindeosphaera spinulosa* (NAKASEKO & NISHIMURA); 29. *Hozmadia rotunda* (NAKASEKO & NISHIMURA); 30. *Triassocampe coronata* BRAGIN; 31. *Paratriassocampe* sp.; 32. *Parasepsagon variabilis* (NAKASEKO & NISHIMURA)

Figs. 33–36, 38 from HKU-PLWN02032110, upper Anisian-Ladinian:
33. *Pentactinocapsa awaensis* NAKASEKO & NISHIMURA; 34. ?*Trilonche* sp.; 35. *Celluronta* sp.; 36. *Bulbocyrtium* sp.; 38. *Tiborella florida* (NAKASEKO & NISHIMURA)

Figs. 37, 39–41 from HKU-PLWN02032117, upper Anisian-Ladinian:
37. ?*Ladinocampe* sp.; 39. *Spinotriassocampe annulata* (NAKASEKO & NISHIMURA); 40. *Spongostephanidium japonicum* (NAKASEKO & NISHIMURA); 41. *Hozmadia* sp.

Figs. 42–45 from HKU-PLWN02032118, upper Norian-Rhaetian:
42. *Canoptum* sp.; 43. *Canoptum* sp. aff. *C. unicum* PESSAGNO & WHALEN; 44. *Deflandrecyrtium carterae* YEH & CHENG; 45. *Livarella magna* TEKIN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