

Carboniferous corals from Northeast Thailand

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Abstract: In the Loei area of Northeast Thailand, a few limestone outcrops contain abundant fasciculate corals (Tetracorallia). These corals belong to *Lublinophyllum*, a genus newly established and still poorly known. They are Upper Bashkirian-Lower Moscovian in age according to a study of the associated microfauna. They are well-preserved and very abundant at Ban Na Charoen, from where a new species is described: *L. thailandicum*. The Ban Na Charoen limestone is Kashirian (Lower Moscovian) in age.

INTRODUCTION

In this paper, general remarks on the geographic distribution of the Carboniferous corals in Southeast Asia are followed by sections dealing with the coral localities of Northeast Thailand and describing the coral samples collected in these localities.

CARBONIFEROUS CORALS IN SOUTHEAST ASIA

The Carboniferous corals from Southeast Asia are known from a few papers (Mansuy 1913; Smith 1948; Hamada 1960; Fontaine 1955, 1961 and 1964; Metcalfe, Idris and Tan 1980). They belong to the Tabulata, Tetracorallia and Heterocorallia.

Tabulata are common in the Upper Tournaisian and in the Viséan; only two genera are well-known: *Syringopora* and *Michelinia*.

Tetracorallia are much more diversified. Many are solitary. The larger ones usually have dissepiments and belong to more than 10 genera: *Pseudouralinia*, *Siphonophyllia?*, *Caninophyllum*, *Caninia*, *Clisiophyllum*, *Arachnolasma*, *Kueichouphyllum*, *Heterocaninia*, *Aulokoninckophyllum*, *Amygdalophyllum*, *Palaeosmia?* The smaller solitary Tetracorallia are generally without dissepiments and they have been assigned to 5 genera: *Cyathaxonia*, *Rotiphyllum*, *Hapsiphyllum*, *Zaphrentites* and *Lophophyllidium*. A few Tetracorallia are compound; they are fasciculate and are divided into 4 genera: *Siphonodendron*, *Solenodendron*, *Diphyphyllum* and *Tschussovskenia*. Massive Tetracorallia have so far not been found. The species described to date are mainly from the Lower Carboniferous, especially from the Upper Viséan—Serpukhovian. However, a few species have been found in the Middle and Upper Carboniferous in Vietnam and Laos.

Heterocorallia are represented by *Hexaphyllia*, a widespread genus, and by *Heterophyllia*, a less common coral. They have been encountered in the Upper Viséan—

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Serpukhovian in Laos, Thailand and Peninsular Malaysia. The presence of *Hexaphyllia* in the Serpukhovian is confirmed in Malaysia by a conodont study (Metcalf, Idris and Tan 1980). Surprisingly, Heterocorallia, which have a simple structure, are abundant in places rich in corals with a high level of organisation; such as solitary Tetracorallia having dissepiments and fasciculate compound Tetracorallia. Apparently, they did not like biotopes with small solitary Tetracorallia without dissepiments (the "Cyathaxonia fauna").

Even though the beds are rich in corals, they rather represent biostromes. The existence of coral reef is not proven yet in the Carboniferous of Southeast Asia. During the Carboniferous, conditions were not optimal for corals in Southeast Asia. They were better in China, where massive Tetracorallia are represented by several genera: *Aulina* (Subgenera *Aulina* and *Pseudoaulina*), *Lithostrotion*, *Ivanovia*, *Arachnastraea*, "*Lithostrotionella*". Moreover, fasciculate Tetracorallia are more varied in China. Lonsdaleiidae are present in China whereas they are absent in Southeast Asia. Therefore, the coral fauna generally appears impoverished in Southeast Asia.

Only during the Upper Viséan—Serpukhovian did corals flourish in several places distributed widely in Southeast Asia: Toc Tat in North Vietnam, Qui Dat in Central Vietnam, Ban Phit in Laos, Ban Sa Ngao in Thailand, Kuantan (Panching limestone) in Malaysia, and Muaro in Central Sumatra. Qui Dat, Ban Phit and Ban Sa Ngao are localities probably belonging to a single Lower Carboniferous shelf which stretched along the northern edge of the Kontum gneissic massif (see fig. 1).

This account brings new data from Northeast Thailand where the Carboniferous is widely exposed and probably almost complete from the Tournaisian to the Gzhelian. The Viséan, already mentioned by T. Hamada in 1960, is presently better known. At Ban Sa Ngao (75 km northeast of Loei), it is represented by a fossiliferous and widely exposed limestone, whose microfauna is composed of:

Calcspheres: *Diplosphaerina inaequalis*, *Pachysphaerina pachysphaerica*, *Radiosphaera* sp.

Foraminifera: *Earlandia* ex gr. *vulgaris*, *Lugtonia parvula*, *Omphalotis* sp., *Plectogyranopsis* sp., *Endothyranopsis crassa*, *Climacammina* sp., *Endostaffella* sp., *Eostaffella mosquensis*, *Mediocris* sp., *Planospirodiscus* sp., *Asteroarchaediscus* sp.

The microfauna indicates an Upper Viséan age (V3c); it is associated with corals: *Kueichouphyllum sinense*, *Solenodendron furcatum*, *Siphonodendron petalaxoideum*, *Arachnolasma equiseptatum*, *Hexaphyllia mirabilis* and *Heterophyllia* sp.

At Pha Chom Nang, 23 km west of Ban Sa Ngao, limestone lenses occur but are poor in fossils (with scarce solitary Tetracorallia); they contain:

Algae: *Windsoporella* n. sp., *Koninckopora* cf. *tenuiramosa*, *Ortonella* sp.

Foraminifera: *Endothyra* sp., *Plectogyranopsis* sp.

Algosponges: *Moravammia?* n. sp., *Stacheoides* sp.

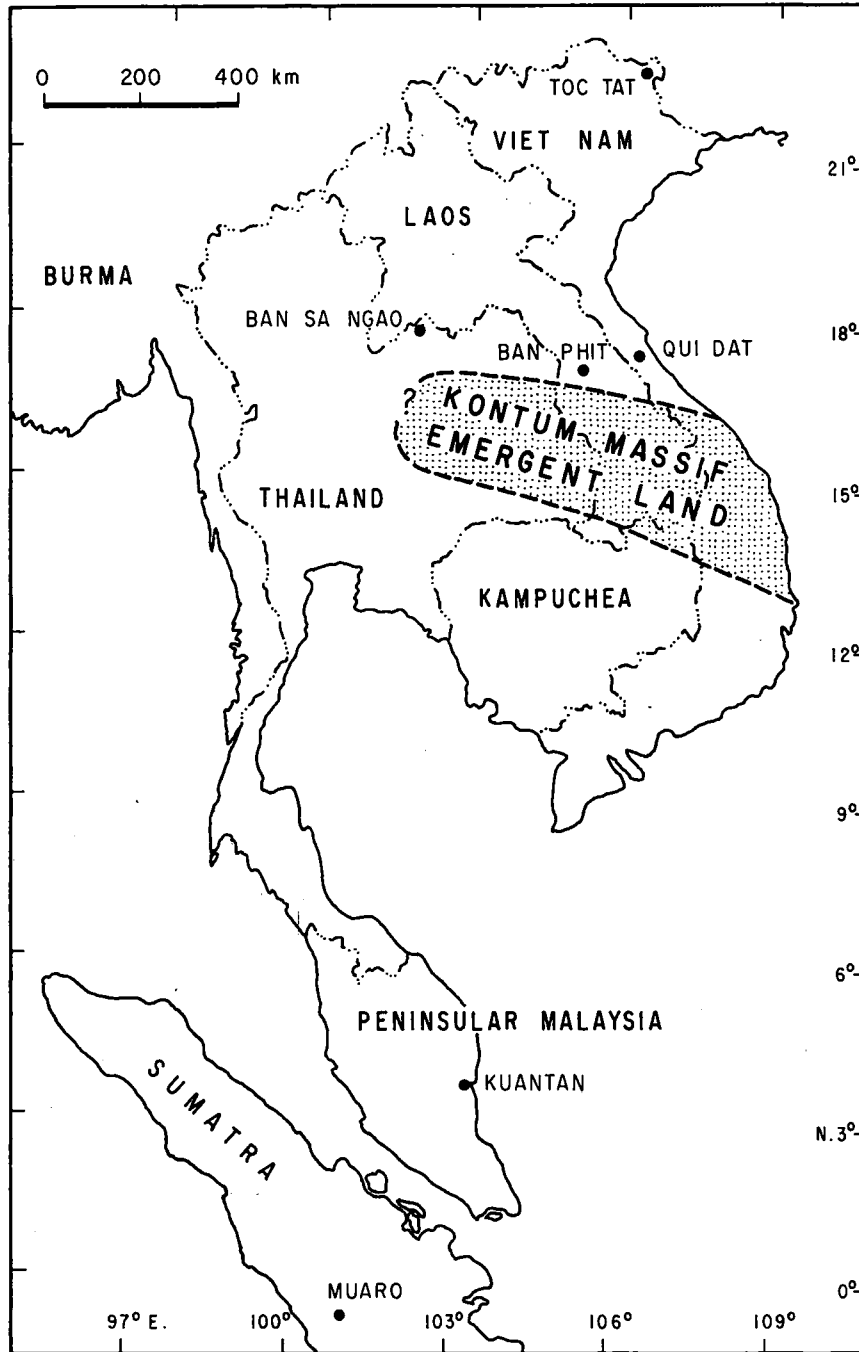


Fig. 1. Index map showing location of limestone outcrops of Upper Viséan—Serpukhovian age which are rich in corals.

These fossils are Viséan in age (Middle Viséan or Upper Viséan?).

The Upper Bashkirian and the Moscovian (Kashirian) provided corals which are described below.

LOCALITIES

Three localities will be mentioned in this note: two hills (Ban Na Charoen and Phu Tum) about 50 km southeast of Loei and a small valley (Ban Tha Sot) 38 km north-northeast of Loei. A limestone, generally micritic, outcrops largely at Ban Na Charoen and Phu Tum; it is restricted to lenses intercalated in a shale in the Ban Tha Sot area. Judging from the character of the sediments, the environment was not very good for corals. However, it was not severe; fasciculate corals could thrive and at Ban Na Charoen reach a large size.

Ban Na Charoen is the richer locality. One kilometer from Ban Na Charoen village to the south ($102^{\circ} 01' 30''$; $17^{\circ} 11' 30''$), a roadcut has unearthed a biostrome at the foot of a limestone hill. Large fasciculate colonies up to one meter high are scattered along the road. They are not in living position; they were shifted after their death and their corallites are presently parallel to the stratification. Moreover, many colonies were broken and corallite fragments are common. All the collected samples belong to only one species: *Lublinophyllum thailandicum*, and they have provided the holotype of this new species. They are accompanied by big crinoid stems. Both corals and crinoids are relatively large in size. The enclosing rock is a bedded micrite, gently dipping, poor in microfauna. Thin sections show some bryozoa fragments, a few tests of *Tuberitina* and of *Syzrania*. This rock seems to be Lower Moscovian in age. This age is better indicated by a sample (T250) collected around 20 m above the coral bed and rich in foraminifera: *Bradyina* cf. *lepida*, *Globivalvulina* sp., *Eostaffella acuta*, *Ozawainella* sp., *Profusulinella* sp., *Schubertella obscura*, *Schubertella gracilis*, *Hemigordius* sp., *Syzrania bella*. This microfauna indicates a Lower Moscovian age (probably Kashirian). Another sample (T309), taken in the courtyard of a pagoda more than 100 m from the bed rich in corals, is already Kassimovian in age and contains *Bradyina pauciseptata*, *Bradyina* sp., *Endothyranella* sp., *Ozawainella mosquensis*, *Protriticites* sp., *Calcitornella* sp., *Hemigordius* sp., and *Syzrania* sp. Hence the coral bed, Lower Moscovian in age, is overlain by a limestone ranging from the end of the Lower Moscovian to at least the Kassimovian.

At the southern tip of Phu Tum hill (102° ; $17^{\circ} 05' 30''$), 11 km from Ban Na Charoen to the south-southwest, a fasciculate coral was found a few years ago and preserved at the Museum of the Department of Mineral Resources (Bangkok, no. 17-118). No information is available on this locality; the rock is a micrite without microfauna. The coral has narrow corallites (about 1 cm in diameter); septa are straight. This coral displays some affinities with *Lublinophyllum thailandicum*.

Three kilometers east of Ban Tha Sot, a small valley (Huai Nam) is dug into a shale containing limestone lenses. The soft shale is generally eroded and concealed by a few meters of soil; the limestone lenses crop out and are easily seen from far where vegetation is not thick. Bedding strikes N12°W; the dip is vertical. At the top of the

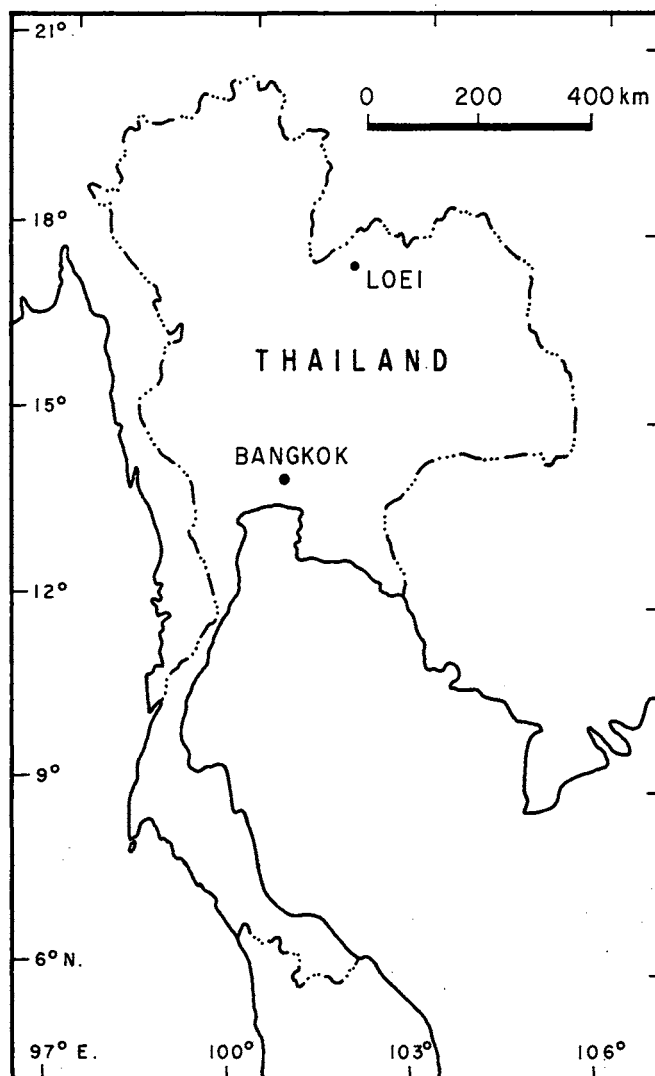


Fig.2. Map showing location of Loei, Northeast Thailand. Coral localities are in the area of Ban Na Charoen and Phu Tum, 50 km southeast of Loei, and Ban Tha Sot, 38 km north-northeast of Loei.

western slope of the valley, a limestone has provided thin sections barren of microfauna. At the bottom of the valley, a few small limestone lenses, one meter thick or less, contain abundant fasciculate corals, akin to *Lublinophyllum thailandicum*; one very rich limestone lens is 3 m long and 0.4 m thick. Often poorly preserved and crushed, the corals have a smaller size than specimens from Ban Na Charoen. The limestone is micrite containing bryozoa fragments and the following microfossils:

Algae: *Atractyliopsis* sp., *Velebitella* n. sp. aff. *simplex*, *Dasycladaceae* indet.

Calcspheres: *Diplosphaerina inaequalis*, *Pachysphaerina pachysphaerica*

Foraminifera: *Earlandia elegans*, *Endothyra* sp., *Bradyina nautiliformis*, "*Palaeospiroplectammina*" ex gr. *conspicua*, *Climacammina* sp., *Globivalvulina* sp., *Eostaffella* cf. *mixta*, *Millerella?* sp., *Semistaffella?* sp., *Ozawainella* cf. *donbassensis*, *Staffella* sp. (= *Pseudoendothyra* auct.), *Profusulinella rhombiformis*, *Schubertella obscura*, *Archaeodiscus* sp., *Asteroarchaeodiscus* sp., *Glomospira* sp., *Cornuspira* sp., *Ammovertella* sp., *Palaeonubecularia* sp.

Algosponges: *Beresella erecta*, *Dvinella* sp., *Praedonezella* sp., *Donezella lutugini*, *Conilalia* sp., *Cuneiphycus (Foliophycus)* sp., *Ungdarella uralica*.

These microfossils indicate an Upper Bashkirian age because Archaeodiscidae are still present and associated with a newcomer: *Profusulinella*.

Genus *Lublinophyllum* Khoa 1977

Type species: *Lublinophyllum fedorowskii* Khoa 1977, p. 373–375, fig. 37 and 38 in text; pl. 18, fig. 2a–b; pl. 19, fig. 2; pl. 20, fig. 1a–c, 2–4. Upper Viséan, Lublin area in Poland.

Original diagnosis: "Colony fasciculate; lateral increase; minor septa short; cardinal septum shortened in the ephebic stage; counter septum equal to or longer than the other major septa; peripheral dissepiments often lonsdaleoid; tabulae trapezoid; microstructure trabecular".

Geographic and stratigraphic distribution: In addition to the sample collected in the Upper Viséan of Poland, N. D. Khoa 1977 quoted "*Campophyllum caninoides* Sibly" described by Vassiljuk (1960, p. 62–63, pl. 14, fig. 1–1d) as belonging to *Lublinophyllum*. However, the specimens studied by Vassiljuk, collected in the Donetz Basin, are different by their well-developed lonsdaleoid dissepiments, which have a regular shape and are situated at the dissepimentarium periphery. The same author mentioned also a few other samples from USSR and Great Britain as possibly belonging to *Lublinophyllum*. Even though these comparisons are doubtful, the discovery of *Lublinophyllum* in Thailand shows that this genus is likely to be widespread in the Carboniferous of Eurasia. Presently, its known stratigraphic range is from the Upper Viséan to the Lower Moscovian.

Lublinophyllum thailandicum nov. sp.

Pl. 1, fig. 1–4; pl. 2, fig. 1, 5–6.

Material studied; Specimens from Ban Na Charoen preserved at the Department of Mineral Resources in Bangkok: no. 1080A to G, and in Fontaine collection in Paris: no. T249.

Description: Fasciculate corallum, reaching a large size; one specimen is almost one meter high, whereas common coralla are half that size. Cylindrical corallites, from 15 to 30 mm in diameter, are contiguous or less than 2 cm apart; they are straight and parallel. The corallite wall is very thin (0.2 to 0.25 mm thick), and often absent; it has

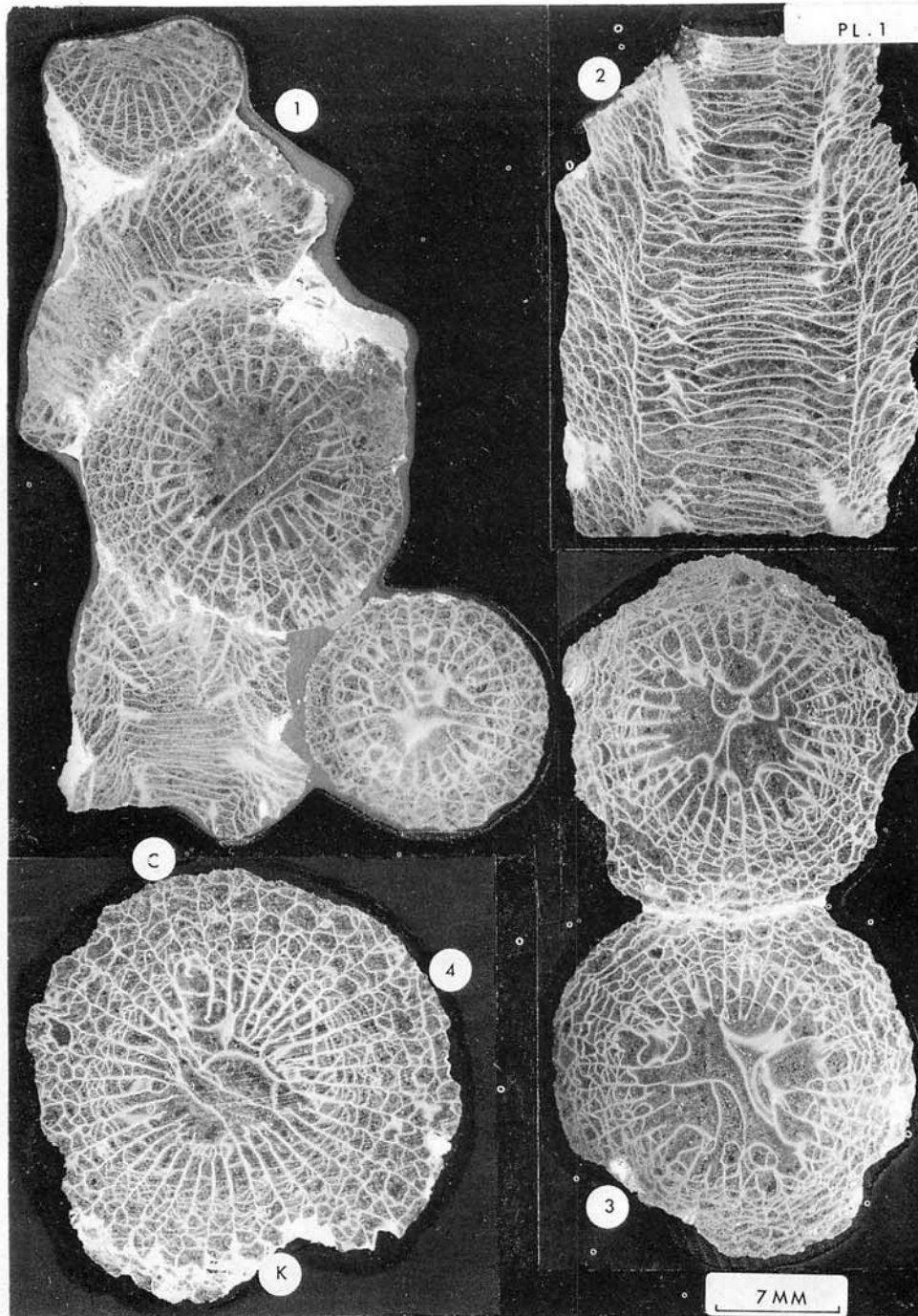


PLATE 1

Thin sections from samples no. 1080, collected at Ban Na Charon and preserved at the Department of Mineral Resources (Bangkok)

Fig.1. *Lublinophyllum thailandicum* nov. sp. Corallites in transverse and longitudinal sections. Stylooliths are visible. Cardinal septum is easy to be recognized on transverse sections; it is shorter than the other major septa.

Fig.2. *Lublinophyllum thailandicum* nov. sp. Longitudinal section. Tabulae are almost flat, often incomplete. Dissepiments are well-developed.

Fig.3. *Lublinophyllum thailandicum* nov. sp. Transverse sections. Landsdaleoid dissepiments appear in the middle of the dissepimentarium.

Fig.4. *Lublinophyllum thailandicum* nov. sp. Transverse section. The cardinal septum (C) and the counter septum (K) are indicated.

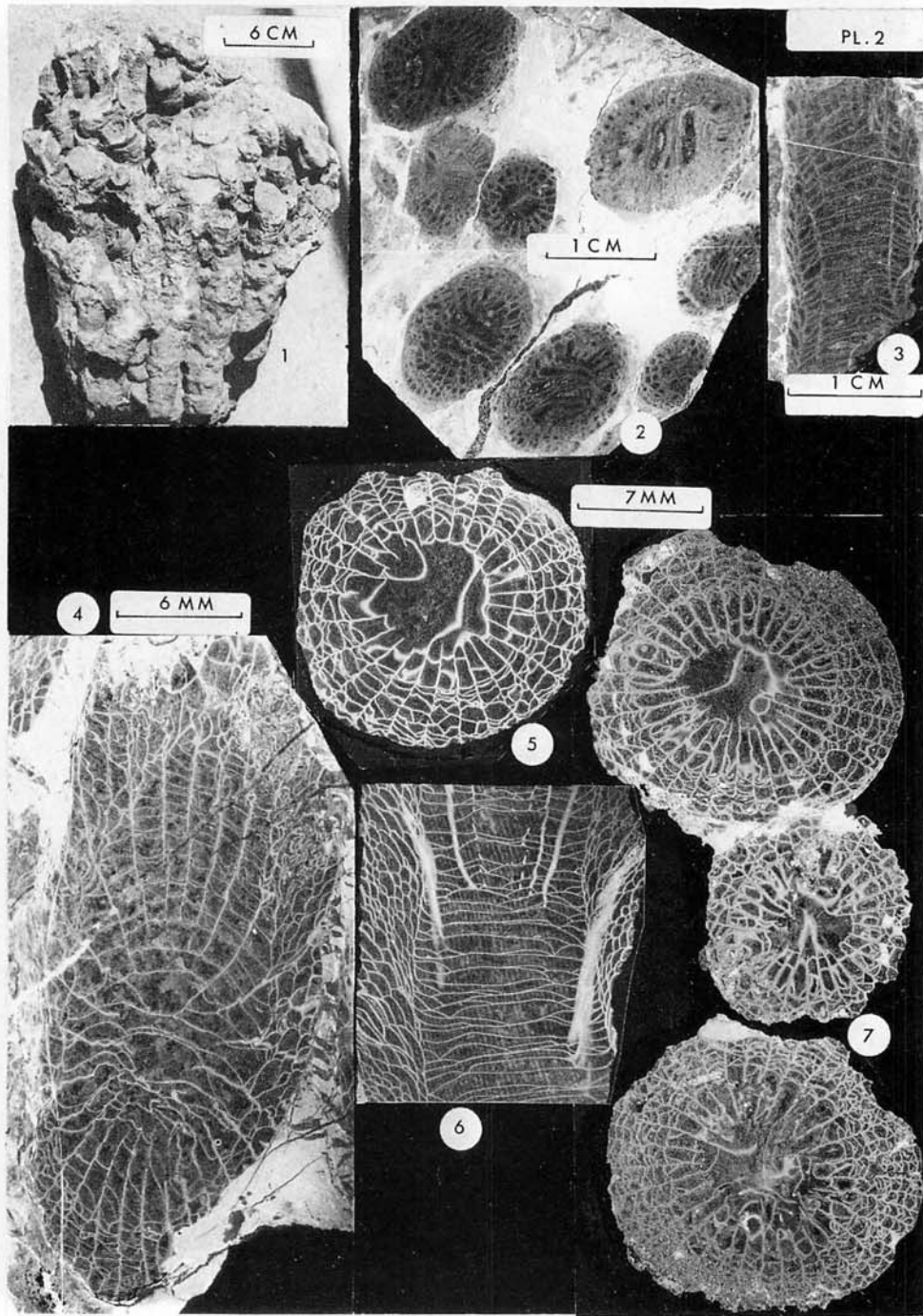


PLATE 2

- Fig.1. *Lublinophyllum thailandicum* nov. sp. Fasciculate colony collected at Ban Na Charoen and preserved at the Department of Mineral Resources (Bangkok). Corallites are tightly spaced.
- Fig.2. *Lublinophyllum thailandicum*? Transverse section. Sample from Phu Tum.
- Fig.3. *Lublinophyllum thailandicum*? Longitudinal section of a corallite. Sample from Phu Tum.
- Fig.4. *Lublinophyllum thailandicum* nov. sp. Oblique section. Sample from Ban Tha Sot, destroyed only in a small part.
- Fig.5 and 7. *Lublinophyllum thailandicum* nov. sp. Transverse sections. Samples from Ban Na Charoen.
- Fig.6. *Lublinophyllum thailandicum* nov. sp. Longitudinal section of a corallite. Sample from Ban Na Charoen.

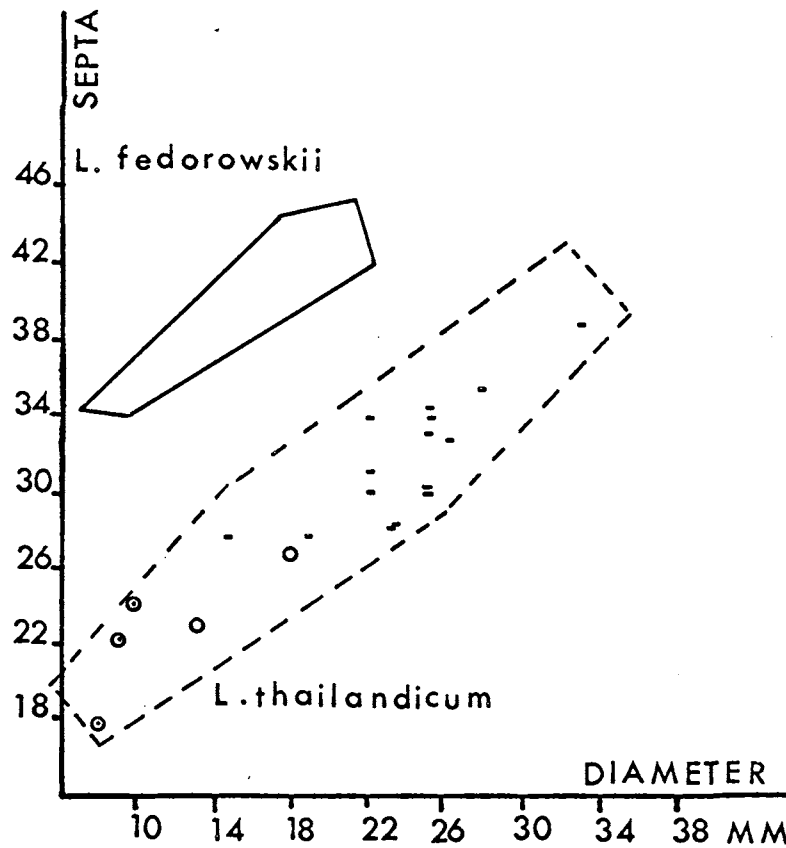


Fig. 3. Variation of number of major septa with corallite diameter for two species of Lublinophyllum.

- Samples from Ban Na Charoen
- Samples from Ban Tha Sot
- ⊙ Samples from Phu Tum

been destroyed by erosion or by diagenesis (stylolites are common). Septa are radially arranged, 28×2 to 34×2 in number, thin and tortuous in the dissepimentarium, almost straight and lightly thickened in the tabularium. Major septa are well developed, often continuous; however, they are locally discontinuous in a few corallites. Their length is equal to three quarters of the corallite radius. Cardinal septum is generally easy to be recognized; it is shorter than the other major septa. Counter septum is impossible to be recognized except in a few corallites where it is a little longer than the other major septa. Minor septa are poorly developed, discontinuous or even absent; they are confined to a narrow zone in the dissepimentarium periphery. Dissepiments, frequently anastomised in transverse sections, are numerous and distributed in 5 to 9 rows; inclined towards the tabularium, they are rather irregular in size, a few are large. Lonsdaleoid dissepiments appear in the middle of the dissepimentarium of the ephelic stage; some are long and disrupt up to 6 septa of both orders. The dissepimentarium width is equal to $1/4$ to $2/5$ of the corallite

radius. Tabulae occupy a large zone, corresponding to 3/5 to 3/4 of the corallite diameter. They are slightly upwards arched or almost flat in a relatively wide part (around 1 cm across) of the corallite axial zone; they are anastomised and downwards warped in a narrow periaxial zone (2 to 3 mm wide); they are abundant, 9 to 15 giving a height of 1 cm. Microstructure is often well-preserved. The corallite wall is composed of fibers perpendicular to the corallite surface. Septa end in the wall as wedges. They are built up by a thin mesozone, black and lightly indented, wrapped up in a fibrous stereozone.

Discussion: The few well-preserved corals from Ban Tha Sot (Collection Fontaine T285) appear to be akin to the specimens found at Ban Na Charoen. However, their tabulae (pl. 2, fig. 4) are more distant from one another and a little more strongly arched; their dissepiments are relatively large.

The sample from Phu Tum, known only by two thin sections (pl. 2, fig. 2–3), has smaller corallites than those of *Lublinophyllum thailandicum*; lonsdaleoid dissepiments seem to be absent.

Lublinophyllum fedorowskii Khoa 1977 is different from *L. thailandicum* by its more numerous septa (Pl. 1, fig. 2), by its tabulae clearly divided in two areas: axial and periaxial, and by the trapezoid aspect of the axial part of the tabulae.

Stratigraphic range: The type of *Lublinophyllum thailandicum*, which were collected at Ban Na Charoen, are Lower Moscovian (Kashirian) in age. The corals from Ban Tha Sot are only akin to the corals from Ban Na Charoen; they are Upper Bashkirian in age. The age of the coral from Phu Tum is unknown.

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