

Permian-Triassic Boundary and Fauna at Doi Pha Phlung, Northern Thailand

Ishibashi, Takeshi
Faculty of Science, Kyushu University

Nakornsri, Nikorn
Geological Survey Division, Department of Mineral Resources, Thailand

Nagai, Koichi
Department of Earth Science, Division of General Education, University of the Ryukyus

<https://doi.org/10.5109/1543642>

出版情報 : 九州大学大学院理学研究院紀要 : Series D, Earth and planetary sciences. 28 (2), pp.23-40, 1994-12-26. Faculty of Science, Kyushu University

バージョン :

権利関係 :



Permian-Triassic Boundary and Fauna at Doi Pha Phlung, Northern Thailand

Takeshi ISHIBASHI, Nikorn NAKORNSRI* and Koichi NAGAI**

Abstract

Paratirolites-Tapashanites fauna associated with *Palaeofusulina sinensis* and smaller foraminifers of the Dorashamian (Upper Permian) is collected from the Huai Thak Formation distributing at Doi Pha Phlung, Lampang district of northern Thailand. The minor fault forms the boundary between the Huai Thak and the Lower Triassic Phra That Formations. Some ophiceratid ammonoids and *Claraia* are found in the lowermost horizon of the Phra That Formation.

The Permian Huai Thak Formation is composed of clastic and calcareous sediments with intercalation of chert and tuff, and is estimated to be 1,100m thick. The uppermost shale bed of the formation, about 10m below the P/T boundary, yields *Paratirolites nakornsrii*, *Tapashanites yaowalakae* sp. nov., *Pseudogastriceras* aff. *szechuanense* and *Xenodiscus*? sp. The Lower Triassic ammonite, *Ophiceras sakuntala* Diener is recognized at the lowest bed 1m above the boundary, and several species of *Claraia* are also found about 20m above. Those faunas suggest the *Otoceras woodwardi* Zone of the lower Griesbachian.

Palaeofusulina sinensis, *Reichelina* aff. *changhsingensis*, smaller foraminifers and *Waagenophyllum* aff. *virgalense* are obtained from the Permian limestone at Doi Pha Phlung (Pha Phlung Mt.). The limestone sequence barren of fossils above the *Palaeofusulina* Zone exceeds the thickness of 100m. The contact between this limestone and the ophiceratid shale is not found in the area. The continuous calcareous bed below the *Palaeofusulina* Zone yields *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawai*, *Gallowainella meitienensis*, *Siamnautilus ruchae* gen. et sp. nov., and many brachiopods including *Oldhamina squamosa*. The shale bed of the *Paratirolites-Tapashanites* fauna apparently looks stratigraphically higher than the limestone bed of the *Palaeofusulina* one in the area, but the latter represents a related heteroic facies of the former.

A new genus and species of nautiloid, *Siamnautilus ruchae*, a new species of Dorashamian ammonoid, *Tapashanites yaowalakae* and a Scythian ophiceratid ammonoid, *Ophiceras sakuntala* are described in this paper.

Introduction

The mass extinction of organisms at the end of the Paleozoic Era was an interesting event in the geohistory. Minor events existed at the boundary of many other periods and it is also important to study the cause of extinction for each life. Though the cause of the mass extinction at the end of the Permian Period has been studied from many points of view, only a few localities are known in the world for such purpose. NAKAZAWA (1993) reviewed and discussed the Permian and Triassic boundary in the Tethys realm.

The area surveyed in this study is situated at the northern part of Lampang Prefecture, North Thailand (Fig. 1). It is said that the Permian sequence lasted into the Triassic without any stratigraphic break (BAUM et al., 1970; GOBBETT and HUTCHISON, 1972). The Upper Permian was suggested by the occurrence of plant fossils collected from Phetchabun by KON'NO in 1963. On the other hand, KEMPER (1969, in BAUM et al., 1970) reported *Palaeofusulina*, but considered its fauna as the Middle Permian. TORIYAMA (1973) referred this fauna to the Upper Permian. The Lower Triassic fauna of *Claraia* and ophiceratid ammonoids, was reported from the Phra That Formation by CHONGLAKMANI (1982) for the first time. The existence of Permian-Triassic boundary in Thailand has been presumed by the occurrence of the Upper Permian ammonoids (ISHIBASHI and CHONGLAKMANI, 1990), the Upper Permian foraminifers (SAKAGAMI and HATTA, 1982) and brachiopods (WATERHOUSE, 1983). We worked to collect the information of fossils, preparing the route map and confirming the stratigraphical succession on the east side of the Doi Pha Phlung (Fig. 4). The detailed stratigraphy of the Huai Thak Formation at its type locality is now in preparation. We describe here some Permian and Triassic cephalopods which are useful for the discussion about the P/T boundary and their faunas. Other Permian fauna will be described in a separate paper. Specimens with a prefix TF are deposited at the Geological Survey Division, Department of Mineral Resources, Thailand.

Acknowledgments

We would like to express our cordial appreciation to Mr. Prayong ANGSIWATHANA, Director of the Geological Survey Division, Department of Mineral Resources (DMR), Thailand, for his kind help in giving us every facility for field work. Sincere thanks are extended to Mrs. Rucha Helmcke INGAVAT and Yaowalak CHAIMANEE of the same division for their support in the field work and in the DMR. We greatly appreciate Dr. Chongpan CHONGLAKMANI* of DMR, who kindly offered us the geological information of the study area.

Our sincere thanks are due to Professor Emeritus Tatsuro MATSUMOTO of Kyushu University for valuable suggestions on cephalopod paleontology. This study was financially supported in part by a grant from the Science Research Fund of the Tokyo Geographical Society in 1991

* Present address: Patong Exploration and Mining Co., Ltd. 26th-27th Floor, CTI Tower, 191/18-25 Ratchadaphisek Road, Bangkok 10110, Thailand

Outline of Geology

The Geological map of the Lampang area, northern Thailand, was published by PIYASIN (1972). The study area is situated at the central part of the Lampang Basin (CHONGLAKMANI, 1982). The Middle and Upper Triassic ammonids described by KUMMEL (1960) were collected from the southern part of the basin. The Paleozoic Ngao Group and Mesozoic Lampang Group sediments subordinated with volcanic rocks are widely distributed in this basin. The sedimentary beds and faults mainly run from north to south.

The geological map of the Doi Pha Phlung area was shown in the previous paper (ISHIBASHI and CHONGLAKMANI, 1990), but we have made a partial revision of it in the present paper. The stratigraphic chart is shown in Fig. 3. The Permian strata consist of the Phra Huat and Huai Thak Formations of the Ngao Group in ascending order. The Ngao Group is now used instead of the Raburi Group for the Upper Paleozoic sediments of the Lampang Basin. The Huai Thak Formation is distributed at the western part of this area. It is composed of shale, limestone, conglomerate and sandstone, and yields most of the Upper Permian invertebrate fossils. The Triassic Lampang Group distributed in the eastern part consists of the Phra That and Hong Hoi Formations, and a few bivalves and ammonoids occur in it. The Permian-Triassic (P/T) boundary passes through from the north to south direction in the central part of the mapping area. The Doi Pha Phlung (mountain) is composed of stratified limestones (Huai Thak Formation). The middle Triassic fossils are reported from the locality nos. 10, 13 and 14, which belong to the Hong Hoi Formation of the Lampang Group (CHONGLAKMANI, 1972)



Fig. 1. Index map showing the study area (in box) in Thailand.

Permian-Triassic Boundary

The Permian-Triassic boundary has been presumed on basis of one occurrence of the paleontological evidence (ISHIBASHI and CHONGLAKMANI, 1990), and the very locality and description of outcrops with the P/T boundary are shown here for the first time.

The locality (Loc. 8) of the P/T boundary is situated about 1.8km, SSE of the Doi Pha Phlung. It is on the bottom of a creek, a branch of the Huai Mae Pa

(Mae Pa river). The creek is empty in the dry season (November to April), but it is often filled up with the water in the rainy season. The route map has been made at loc. no. 7 to 8 along the Huai Mae Pa (Fig. 4). The Triassic Phra That Formation lies in fault contact with the Permian Huai Thak Formation at the outcrop of loc. 8. The P/T boundary is composed of the main fault subordinated with two minor faults in each formation. The fault forming the boundary is about 2m wide and filled with shale fragments and clay. The black shale of the Phra That Formation is harder than that of the Huai Thak Formation. Thus, it is easy to distinguish the one from the other. The Permian fossils have not been found in this outcrop, but the Triassic ophiceratid ammonoids have been collected from the shale bed, about 1m above the boundary. The black shale bed of loc. 9 yielding Triassic bivalve, *claraia*, is stratigraphically about 20m above the boundary.

It is supposed that the P/T boundary runs from NNE to SSW direction on the basis of occurrence and distribution of the Upper Permian and Lower Triassic formations and fossil localities in the study area.

Permian - Triassic Fauna

The Permian-Triassic faunas and floras in North Thailand were summarized by TORIYAMA et al. (1975) and TAMURA et al. (1975). In the Doi Pha Phlung area the Upper Permian was first confirmed by the occurrence of well preserved brachiopods in the Huai Thak Formation (WATERHOUSE, 1983). The three brachiopod localities, T22, 16F and 20F are the same as the localities 11, 12 and 1 in this paper, respectively. The brachiopods described by him are as follows; *Enteletina kwangtungensis* ZHAN, *Acosarina antesulcata* WATERHOUSE, *Meekella kueichowensis* HUANG, *Orthotetina* sp., *Erismatina cooperi* WAT., *?Glyptosteges percostatus* WAT., *Tschernyschewia geniculata* ZHAN, *Lampangella lata* WAT., *Transennatia pitakpaivani* WAT., *Spinomarginifera kueichowensis* HUANG, *S. sp. A*, *S. sp. B*, *Compressoproductus pentagonailis* WAT., *Sarytchevitella tenuissima* WAT., *?Chonoplectoides* sp., *Oldhamina squamosa* HUANG, *?Neowellerella pseudoutah* (HUANG), *Araxathyris* cf. *bisulcata* LIAO, *Septospiriferella felinella* WAT., *Attenuatella piyasini* WAT., *Cruricella subspeciosa* LIAO, *Semibrachythyryna anchunensis* LIAO, *Squamularia postgrandis* WAT., *S. nodosa* CHAO. He said that this brachiopod fauna was found at two horizons to the top of the formation and it was clearly correlative with the 'Lopingian' fauna of southeast China in the restricted sense.

| A g e | | Gp. | Formation | Lithology | Sym |
|-----------------|------------------------|---------------|-----------|--|-----|
| T R I A S S I C | Anisian - Carnian | Lampang Group | Hong Hoi | Sandstone, Shale and Conglomerate | HH |
| | Scythian | | Phra That | Shale, Sandstone and Limestone | PT |
| P E R M I A N | Bolorian - Dorashanian | Ngao Group | Huai Thak | Shale, Limestone, Conglomerate and Sandstone | HT |
| | Sakmarian - Yabashian | | Pha Huat | Limestone | PH |

Fig. 2. Stratigraphic chart of the Permian and Triassic Systems in northern Thailand.

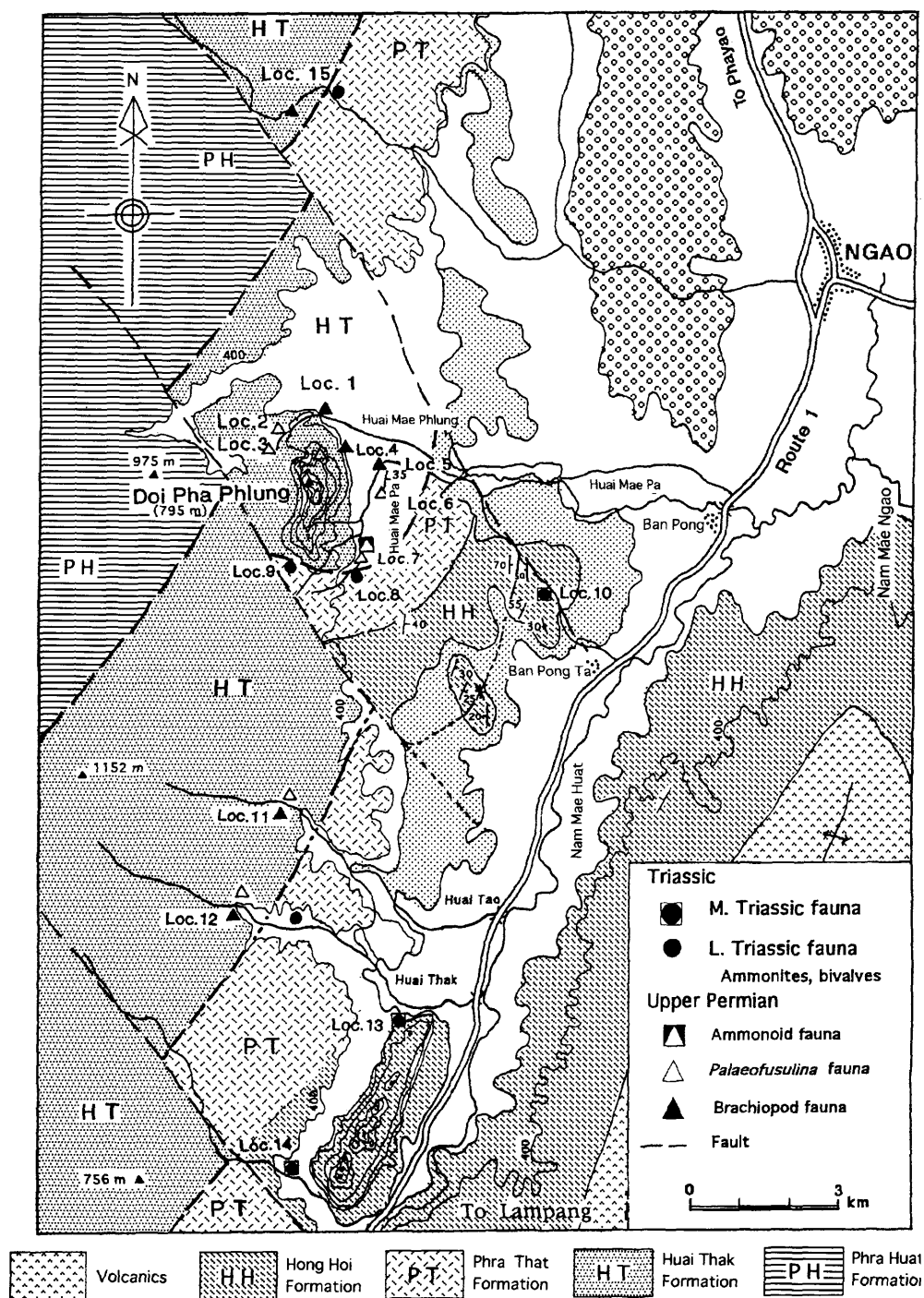


Fig. 3. Geological map of Doi Pha Phlung area, Lampang district, northern Thailand.

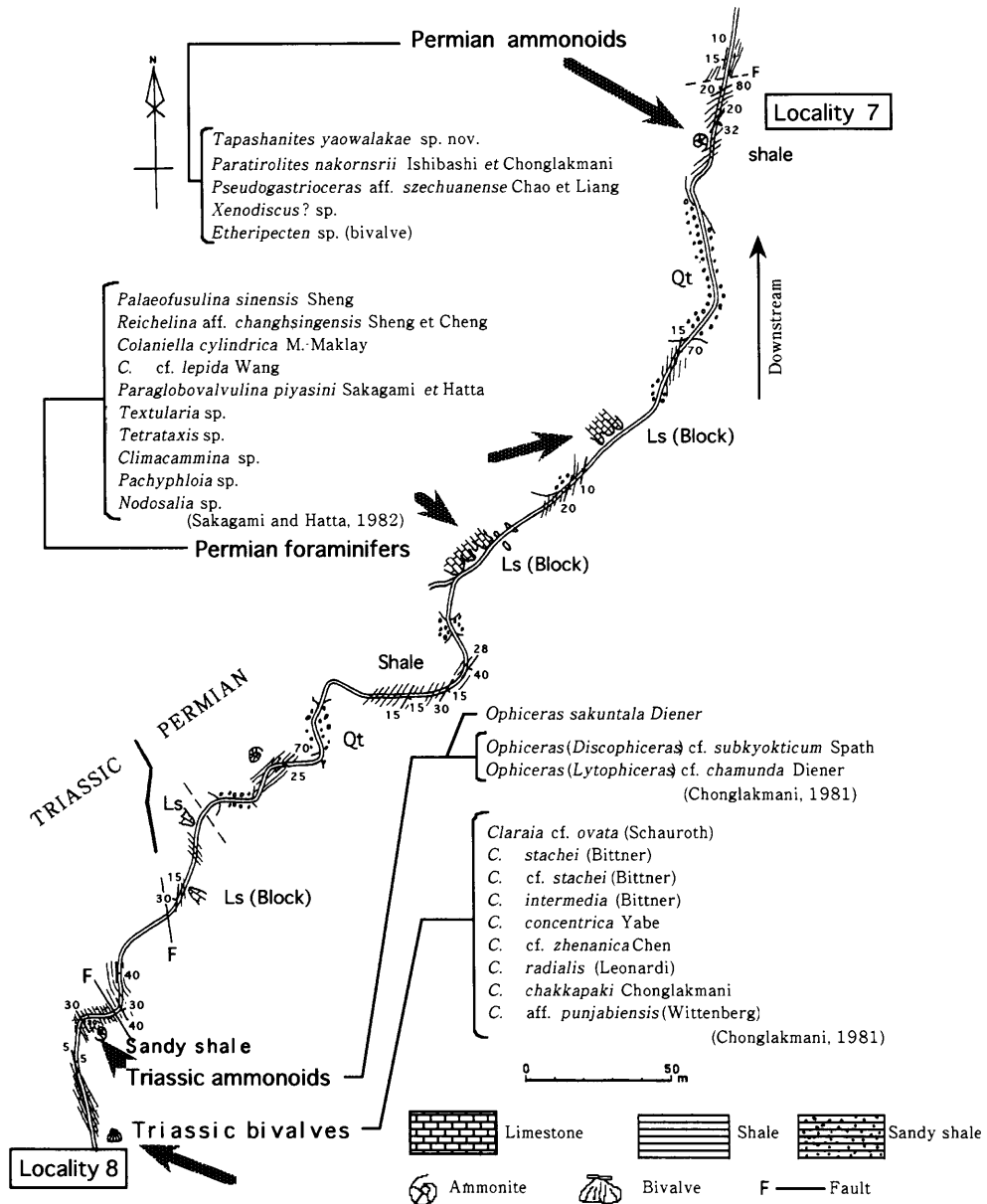


Fig. 4. Route map (between Locality 7 and 8) showing the Permian-Triassic boundary and fossil localities in the southern area of Doi Pha Phlung.

The Upper Permian foraminifers and fusulinids were described from the limestone blocks collected around locality 1 (SAKAGAMI and HATTA, 1982) as follows : *Reichelina* aff. *changhsingensis* SHENG and CHANG, *R. sp.*, *Palaeofusulina sinensis* SHENG, *Nankinella* sp., *Staffella* sp., *Glomospira* sp., *Agathammina* sp., *Pachyphloia langei* SOSNINA, *Lunucammina* sp., *Colaniella cylindrica* M.-MAKLAY, *C. cf. lepida* WANG, *C. xikouensis* Wang, *C. spp.*, *Climacammina* sp., *Cribrogenerina* sp., *Tetrataxis* sp., *Paraglobivalvulina piyasini* SAKAGAMI and HATTA, and *Nodosalia sagitta* M.-MAKLAY.

UENO and SAKAGAMI (1991) recently reported the Late Permian fusulinacean fauna from two localities HT1 and HT2 which are the same as localities 1 and 2 in this paper, respectively. They described several fusulines from those localities as follows; *Reichelina* cf. *changhsingensis* SHENG et CHANG, *Primoriina* sp., *Gallowayinella guidingensis* LIU, XIAO et DONG, *Palaeofusulina sinensis* SHENG, *P. cf. laxa* SHENG, *Codonofusiella* aff. *kwangsiana fusiformis* SHENG, *Sphaerulina* sp. and *Kahlerina*? sp. KOBAYASHI and SAKAGAMI (1989) described a trilobite, *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawai* KOBAYASHI and HAMADA, collected from the localities 1 and 12 (Pl., 3 Fig. 8). The Upper Permian ammonoids, *Pseudogastrioceras* aff. *szechuanense* CHAO and LIANG, *Paratirolites nakornsrui* ISHIBASHI and CHONGLAKMANI and *Xenodiscus*? sp., were reported from the locality 7 by ISHIBASHI and CHONGLAKMANI (1990).

The Lower Triassic ammonoids and bivalves collected from the localities 8 and 9 were described by CHONGLAKMANI (1981, unpublished Ph.D. thesis) who listed up the following bivalve assemblages; *Claraia* cf. *ovata* (SCHAUROTH), *C. stachei* (BITTNER), *C. cf. stachei* (BITTNER), *C. intermedia* (BITTNER), *C. radialis* (LEONARDI), *C. chakkapaki* CHONGLAKMANI, *C. concentrica* YABE, *C. cf. zhenanica* CHEN and *C. aff. punjabiensis* (WITTENBURG) (CHONGLAKMANI, 1985). Recently the Upper Permian smaller foraminifers, fusulinids, bryozoans, corals, trilobite, brachiopods, bivalves, nautiloid and ammonoids, and Triassic bivalves and ammonoids have been found at the northern and southern area of Doi Pha Phlung. The Middle Triassic ammonoid, *Paraceratites* sp., from loc. 10, bivalves from loc. 14 and conodonts from loc. 13 have been found. These faunas will be described in future.

Biostratigraphic correlation

The biostratigraphic correlation of the Permian fauna in Thailand and adjacent areas has been proposed as regards fusulinacean fauna (*i. e.*, TORIYAMA, PITAKPAIVAN and INGAVAT, 1978; INGAVAT, 1984 etc.). That of the Upper Permian in the Lampang Basin was made concerning the smaller foraminifers and fusulines (SAKAGAMI and HATTA, 1982; UENO and SAKAGAMI, 1991). They concluded that the fusulinacean faunal assemblage could be correlated with the *Palaeofusulina sinensis-Colaniella parva* fauna of South China and other districts.

The brachiopod fauna assemblage described by WATERHOUSE (1983) was correlated with the similar assemblage of the lower Changhsing Formation (Lower Dorashamian) of South China. One of the remarkable species (*Oldhamina formosa*) of brachiopod fauna is found at localities 11, 12 and 15. They are stratigraphically found in the shale bed lower than the *Palaeofusulina* limestone

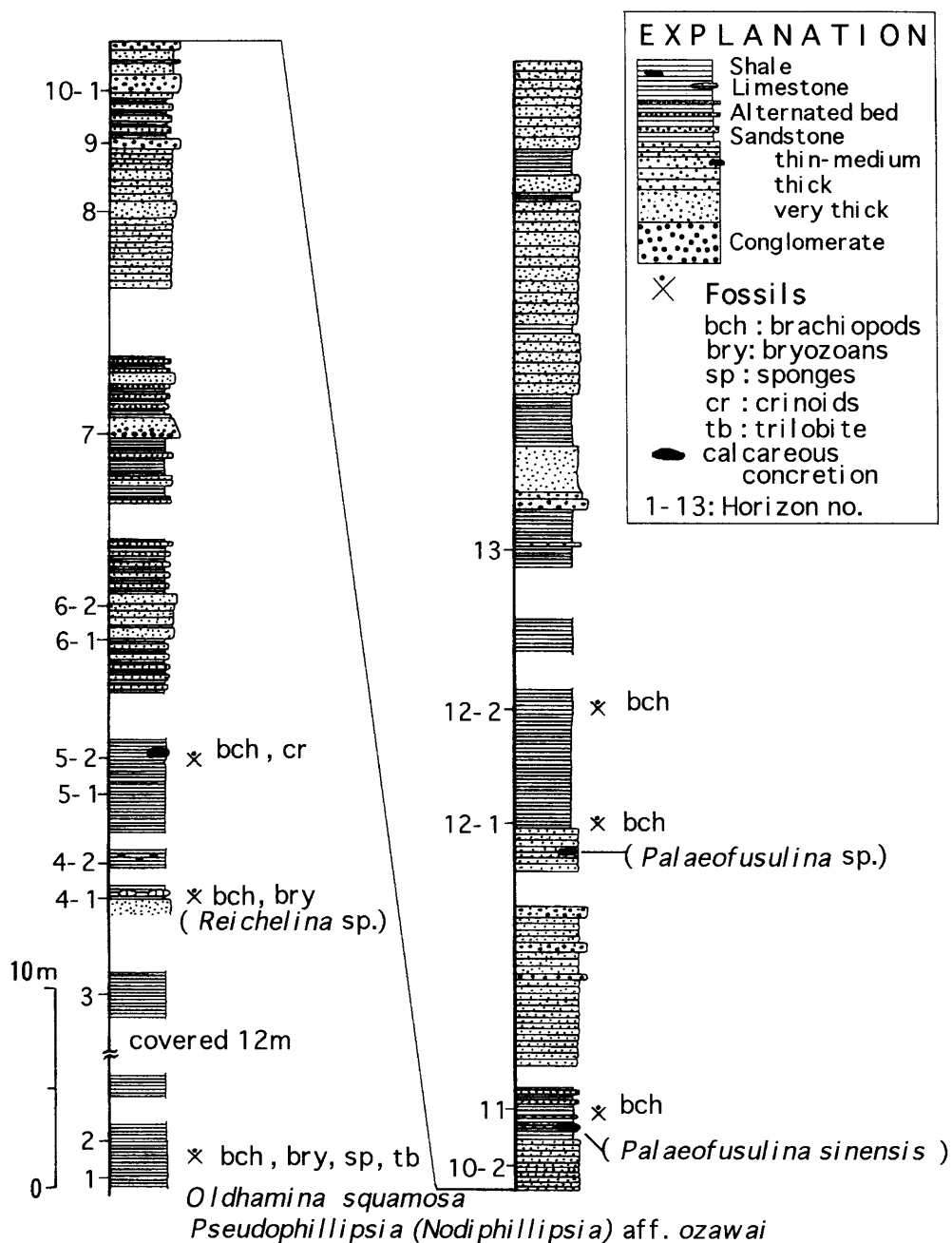


Fig. 5. Columnar section at the type locality (Loc. 12) of the Huai Thak Formation (Fossils in parenthesis occurred in the calcareous concretion).

beds at the northern foothill of the Doi Pha Phlung. *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawa* occurs at the localities 1* and 12, and *Gallowayinella guidingensis* yields only at localities 1 and 2. The stratigraphic horizon of *Gallowayinella guidingensis* suggests the Lower Dorashamian in South China (SHENG and RUI, 1980; LIN, 1980).

The *Oldhamina formosa*-*Palaeofusulina sinensis* fauna occurred in localities 12 and 11 is at the higher horizon than at locality 1 because of lacking in *Gallowayinella guidingensis*. The calcareous shale bed at locality 2 yields *Gallowayinella guidingensis* with some brachiopods, and gradually changes to bedded limestone which includes some smaller foraminifers and fusulines described by SAKAGAMI and HATTA (1982). As mentioned above, the Upper Permian faunas have been found around the Doi Pha Phlung and the generalized stratigraphy in this area was shown by ISHIBASHI and CHONGLAKMANI (1990). The serial sequence measured at locality 12 (Huai Thak) indicated in Fig. 5 shows that sediments about 120m thick lie on the *Oldhamina* and *Palaeofusulina*-bearing bed. Some brachiopods and fusulines-bearing limestone blocks are contained at several horizons in this columnar section, and more detailed information is now assessed.

PALEONTOLOGY

Class Cephalopoda CUVIER, 1797
 Subclass Nautiloidea AGASSIZ, 1847
 Order Nautilida AGASSIZ, 1847
 Suborder Tainoceratina HYATT, 1883
 Superfamily Tainocerataceae HYATT, 1883
 Family Tainoceratidae HYATT, 1883
 Genus *Siamnautilus* gen. nov.

Type species.—*Siamnautilus ruchae* ISHIBASHI, NAKORNSRI et NAGAI, gen. et sp. nov.

Etymology.—The generic name is referred to the old name of Thailand.

Diagnosis.—Shell moderate in size, evolute, having round venter, strong clavi on lateral surface without radial ribs. Clavi making 4 rows from umbilical to ventrolateral shoulders, of which umbilical clavi smaller than others. Siphuncle unknown.

Description.—Shell moderate in size, evolute, gradually increases its height. Surface ornamented by clavi, without ribs. Clavi disposed in four spirral rows, becoming gradually stronger from umbilicus to venter, smallest on umbilical shoulder, moderate in two lateral rows and strongest on ventrolateral shoulder. Ventrolateral clavi cross the line of ventral shoulder and its angle rapidly increases toward the living chamber. Suture simple, with shallow lateral lobe.

* KOBAYASHI and SAKAGAMI (1989) described *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawai* KOBAYASHI and HAMADA from the present locality (This is the same locality as their loc. no. 88080703)

| Region Age | | West Tethys | | Central Tethys | | East Tethys | | |
|---------------|-------------|----------------|-----------------------|-------------------|-------------|--|--------------------------|-----------------|
| | | Russian Tethys | Abadeh | Salt Range | Kashmir | North Thailand | South China | |
| UPPER PERMIAN | L. TRIASSIC | Griesbachian | L. Triassic | Unit A | Kathwai Fm. | Khunamuh Formation | Phra That Fm. | Feixianguan Fm. |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| UPPER PERMIAN | | Dorashamian | Dorashamian Fm. | Hambast Formation | | | | Changxing Fm. |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| UPPER PERMIAN | | Dzhulfian | Julfa Fm. | | Chhidru Fm. | Zewan Formation | Huai Thak Formation | Wujiaping Fm. |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| UPPER PERMIAN | Midian | Khachik Fm. | Lepidolina Yabeina | Abadeh Fm. | Wargal Fm. | Colaniella Reichelina Nanlingella simplex | Colaniella Abadenella | Yenqiao Fm. |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Fig. 6. Correlation Chart of the Upper Permian and Lower Triassic in the Tethys region.

Remarks.—The present specimen has remarkable characteristics on whorl with many strong clavi. This genus is placed in the family Tainoceratidae, Superfamily Tainocerataceae, because the tainoceratid nautiloids have generally such clavi, nodes and tubercles as decoration on lateral surface. The new genus *Siamnautilus* is very similar to the genus *Tylonautilus* PRINGLE and JACKSON (1928) established on the type species, *Nautilus (Discites) nodiferus* ARMSTRONG, 1886, from the Lower Carboniferous of Scotland. The latter genus has on its venter a median sulcus bordered by 2 thin lirae followed by 3 rows of nodes and on its flank of whorl 3 rows of spiral nodes which are radially arranged. *Siamnautilus* has smooth venter without ventral sulcus and 2 thin lirae on ventral shoulder. This genus resembles *Hefengnautilus* XU, 1977, which was established on *Hefengnautilus pernodosus*, the type species, from the Lower Permian of central South China, but the latter is different from the former in having only one row of nodes on the whorl flank. Some genera such as Middel Triassic *Pleuronautilus* and Permian *Tylonautilus* in the family Tainoceratidae have several rows of nodes or tubercles on lateral whorl but their nodes or tubercles are aligned on radial ribs. On the ground of above comparison, *Siamnautilus* gen. nov. is established as a member of the family of Tainoceratidae.

Geological age: Lower Dorashamian, Upper Permian.

Siamnautilus ruchae ISHIBASHI, NAKORNSRI

et NAGAI, gen. et sp. nov.

Pl., 3 Fig. 1a-b and 2; Text-fig. 7.

Holotype.—*Siamnautilus ruchae* ISHIBASHI, NAKORNSRI et NAGAI gen. et sp. nov.

Material.—One outer mould (FT2330a), one inner cast (TF2330b) and an outer rubber cast (TF2330c) from FT2330a are examined here.

Derivation.—The specific name is dedicated to Mrs. Rucha Helmcke INGAVAT who has contributed greatly to the study of the fusulinacean paleontology in Thailand.

Diagnosis.—Shell moderate in size, evolute, with elliptical clavi. Surface having four rows of clavi. Clavi of ventrolateral shoulder larger than those of umbilical shoulder, but only the ventrolateral ones remain on the body-chamber where those on other three rows disappear.

Description.—Shell moderate in size, about 9 cm in diameter, discoidal and laterally compressed; venter arched and smooth; umbilicus narrow, about one-fourth of the shell-diameter. Whorl ornamented on its side

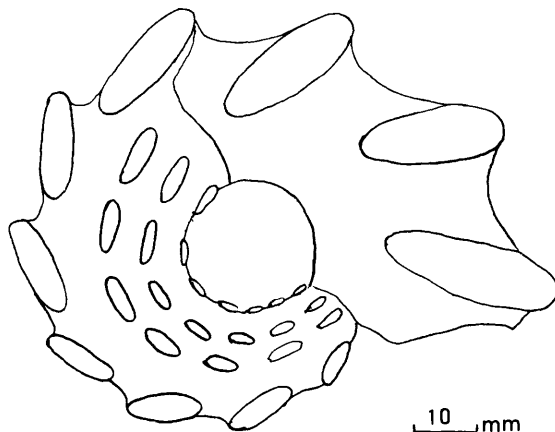


Fig. 7. Drawing of *Siamnautilus ruchae* ISHIBASHI, NAKORNSRI et NAGAI gen. et sp. nov.

by four rows of clavi which are elliptical clavi, making four rows on lateral side, increasing their size toward body chamber, strongest on ventrolateral shoulder, those of three rows disappearing on body chamber, Suture simple, showing a shallow and broad lateral lobe.

Remarks.—The present specimen is similar to *Hefengnautilus pernodosus* XU in having row of nodes on flank, but the latter has nodes instead of clavi. *Tylonautilus permicus* described by HAYASAKA (1957) from the middle Permian Takakurayama Formation in Fukushima Prefecture, Japan resembles the present species in having four or five rows of nodes on flank which strengthen in outer whorl, but the former has clearly strong radial ribs on which nodes are aligned. The same species was also described by YANAGISAWA (1967) on several specimens from the same area. They are well-preserved and show the characteristics of the genus and the species. The other specimens under the same specific name illustrated by KOIZUMI (1975) from the Kanokura Formation in Iwate Prefecture, Japan, also have the same characteristics as the Takakurayama specimens.

Occurrence.—Calcareous shale bed of the Huai Thak Formation exposed at the foothill of Doi Pha Phlung (Loc. 1), Amphoe Ngao, northern Thailand.

Subclass Ammonoidea AGASSIZ, 1847

Order Ceratitida HYATT, 1884

Superfamily Xenodiscaceae FRECH, 1902

Family Xenodiscidae FRECH, 1902

Genus *Tapashanites* CHAO et LIANG, 1965

Type species.—*Tapashanites floriformis* CHAO et LIANG, 1965

Tapashanites yaowalakae ISHIBASHI, NAKORNSRI et NAGAI, sp. nov.

Pl. 3, Fig. 3-6.

Holotype.—TF2331 (Pl., 3 Fig. 3) from locality 7, the Huai Thak Formation in the Doi Pha Phlung area, northern Thailand.

Derivation of name.—Dedicated to Mrs. Yaowalak CHAIMANEE of Geological Survey Division, Thailand, who found the above specimen.

Material.—Four specimens (TF2331-TF2335) are examined, one (TF 2332) of which is a rubber cast made from an outer mould.

Diagnosis.—Shell moderate in size, evolute with wide umbilicus, and ornamented by radial ribs, where are gently sinuous on ventrolateral shoulder, coarse and strong on inner whorl, denser on outer whorl.

Description.—Shell moderate in size, evolute. Radial ribs strong on the main part, curved sinuously at ventrolateral shoulder weakening outerward; intercostal spaces wide in outer whorl and radial slender ribs with wide intercostal spaces at earlier growth-stage; umbilicus widely opened, occupying about a half of the shell diameter.

Remarks.—A number of species belonging to the genus *Tapashanites* are reported from South China. *Tapashanites mingyuexiaensis* described by CHAO et al. (1978) from Meishan, South China, has similar characteristics to the present specimens, but differs in having nodes on the inner whorl instead of radial ribs. Almost all the species described under the same genus have similar nodes in inner

whorl. The characteristics of inner whorl of the present specimen are apparently like those of *Iranites ishii* described by BANDO, 1979, from Abaden, central Iran. One of the present specimens (Pl., Fig. 6) may be placed in the genus *Iranities* according to the characteristics of inner ribs. The present specimens occur in association with *Paratirolites nakornsrii*, *Pseudogastrioceras* aff. *szechuanense*, and *Xenodiscus*? sp. of Dorashamian, Upper Permian (ISHIBASHI and CHONGLAKMANI, 1990).

Occurrence.—Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung (Loc. 7)*

Superfamily Noritaceae KARPINSKY, 1889

Family Ophiceratidae ARTHABER, 1911

Genus *Ophiceras* GRIESBACH, 1880

(=*Acanthophticeras* DIENER, 1916 ; *Ophiceras* (*Lytophticeras*) SPATH, 1935)

Type species.—*Ophiceras tibeticum* GRIESBACH, 1880

Ophiceras sakuntala DIENER

Pl., 3 Fig. 7

Synonymy.—

- 1897. *Ophiceras sakuntala* DIENER ; *Pal. Ind.* [15], **2**, (1), p. 114, pl. 10, figs. 1-8 ; pl. 11, figs. 1, 2, 4.
- 1909. *Ophiceras sakuntala* DIENER ; KRAFFT et DIENER, *Ibid.*, [15], **6**, (1), p. 81.
- 1913. *Ophiceras sakuntala* DIENER ; DIENER, *Ibid.*, [N.S.], **5**, (1), p. 15, pl. 1, figs. 1, 2.
- 1925. *Ophiceras* (*Lytophticeras*) *sakuntala* DIENER ; DIENER, *Leitfossilien der Trias*, p. 82, pl. 22, fig. 2.
- 1930. *Ophiceras* (*Lytophticeras*) *sakuntala* DIENER ; SPATH, *Meddl. om. Grønland*, p. 19, pl. 2, fig. 8 ; pl. 4, fig. 7a-b.
- 1934. *Ophiceras* (*Lytophticeras*) *sakuntala* DIENER ; SPATH, *Cat. fossil ceph. Bri. Mus.*, pt. 4, p. 76, pl. 1, fig. 2 ; text-fig. 13a-b.
- 1954. *Ophiceras* (*Lytophticeras*) *sakuntala* DIENER ; KIPARISOVA, *Comp. Rend.*, **49**, pt. 6, pl. 16, pl. 6, fig. 2.
- 1961. *Lytophticeras sakuntala* (DIENER) ; KIPARISOVA, *Trudy. Bses. Nauts. Isred.*, **48**, p. 37, pl. 7, fig. 2 and 6.
- 1981. *Ophiceras* (*Lytophticeras*) *sakuntala* DIENER ; BANDO, *Palaeont. Indica*, [N.S.], **46**, p. 146, pl. 16, fig. 5 ; pl. 17, fig. 1 ; pl. 18, fig. 2.

Material.—The specimen at hand is an incomplete one (TF2336). The whorl diameter is about 53mm and width is about 20mm.

Description.—Shell moderate in size, evolute, laterally compressed, with rounded venter, rounded convex sides and umbilical shoulder. Diameter of the umbilicus about one third of shell. Outer whorl trapezoidal in cross-section. Surface ornament

* This is the same locality as Loc. 1 in ISHIBASHI and CHONGLAKMANI (1990).



uncertain. Suture exposed on the inner cast is ceratitic, consisting of three arched lateral saddles and denticulated lateral lobes.

Remarks.—SPATH (1930) proposed the subgenus *Lytophiceras* under the genus *Ophiceras*, with the type-species *Ophiceras chamunda* DIENER, which is more or less involute, discoidal development of *Ophiceras*, without its high umbilical rim. TOZER (1981) discussed the phylogeny of the Triassic ammonoids and he considered that this subgenus was synonymous with the genus *Ophiceras*. We here accept the TOZER's opinion. The present specimen is rather involute than the holotype from the Niti pass and the paratype from Shalshal Cliff of the Himalaya described by DIENER (1897). BANDO (1979) reported the same species from the Khunamuh Formation, Guryul Ravine, north of Barus, central Iran. One of the Iranian specimen (BANDO, 1981, pl. 16, fig. 5a-b) is very similar to the Thailand one in respect of whorl evolution and suture.

Occurrence.—Sandy shale bed of the Phra That Formation, southern part of Doi Pha Phlung (Loc. 8)

References

- ARMSTRONG, J. (1886): Description of two new species of shells from the Carboniferous limestone of Clydesdale. *Trans. Geol. Soc. Glasgow*, **2**, pt. 1, 74-75, pl. 1.
- BANDO, Y. (1979): Upper Permian and Lower Triassic ammonoids from Abadeh, central Iran. *Mem. Fac. Educ., Kagawa Univ.*, II, **29**, (2), 103-138, pls. 1-11.
- (1981): Lower Triassic ammonoids from Guryul Ravine and the Spur three Kilometers north of Barus. In NAKNZAWA, K. and KAPOOR, H. M. (eds.). *Palaeont. Indica*, [46], p. 137-177 incl. pls. 14-20.
- BAUM, F., BRAUN, E.v., HAHN, L., HESS, A., KOCH, K.E., KRAUSE, G., QUARCH, H. and SIEBENHUNER, M. (1970): On the geology of northern Thailand. *Beih. Geol. Jb.*, **102**, 1-23.

Explanation of Plate 3

- Figs. 1a-b and 2. *Siamnautilus ruchae* ISHIBASHI, NAKORNSRI et NAGAI gen. et sp. nov.
 1a. An outer mould (TF2330a) $\times 1$.
 1b. An inner cast (TF2330c) $\times 1$.
 2. An outer rubber cast (TF2330b) from TF2330a $\times 1$.
 Loc. 1.
- Figs. 3-6. *Tapashanites yaowalakae* ISHIBASHI, NAKORNSRI et NAGAI sp. nov.
 Fig. 3-5. (TF2331-TF2333) $\times 1$; Fig. 6. (TF2334) $\times 1.5$.
 Fig. 3. *Holotype* (TF2331)
 Loc. 7.
- Fig. 7. *Ophiceras sakuntala* DIENER
 TF2335 $\times 2$.
 Loc. 8.
- Fig. 8. *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawai* KOBAYASHI et HAMADA
 An internal mould of pygidium (TF2336) $\times 5$.
 Loc. 12.

- CHAO, K. K. and LIANG, L. (1965): *The cephalopods of China*, Acad. Sci. China, 387 p.
- , LIANG, X. and ZHENG, Z. (1978): Late Permian cephalopods of South China. *Palaeont. Sinica*, [N.S.], B154, (12), 1-194, pls. 1-34.
- CHONGLAKMANI, C. (1972): Stratigraphy of the Triassic Lampang Group in northern Thailand. *Geol. Soc. Thailand, newsletter*, 5, (5-6), 33-36.
- (1981): The systematics and biostratigraphy of Triassic bivalves and ammonoids of Thailand. *Unpublished Ph. D. Thesis, Univ. Auckland*.
- (1982): The Mesozoic marine faunas of Thailand and their paleogeographic implications. *Bull. Soc. Paleont. Ital.*, 21, 255-266.
- (1985): On *Claraia* from northern Thailand (abstract). In *Annual Technical Meeting*, Chiang Mai Univ., p. 3.
- DIENER, C. (1897): Himalayan Fossils, The Cephalopoda of the Lower Triassic. *Palaeont. Indica*, [15], 2, pt. 1, 1-118.
- (1913): Triassic Fauna of Kashmir. *Ibid.*, 5, pt. 1, 1-13.
- (1916): Einige Bemerkungen zur Nomenklatur der Trias-cephalopoden. *Zentralbl. Min. Geol. Palaeont.*, 97-105.
- (1925): Leitfossilien der Trias, Wirbellose Tiere und Kalkalgen. In GURICH G. (ed.). *Leitfossilien*, Berlin, 4, 118p.
- GOBBETT, D. J. and HUTCHISON, C. S. (1972): *Geology of the Malay Peninsula*. Wiley Interscience, New York, 438p.
- GRIESBACH, C. L. (1880): Palaeontological notes on the Lower Trias of the Himalayas. *Rec. geol. Surv. India*, 13, pt. 2, 94-113.
- HAYASAKA, I. (1957): Two Permian nautiloids from Takakurayama near Yotsukuramachi, Fukushima Prefecture. *Rept. Yokohama Nat. Univ.*, [2], (6), 21-30, pls. 8-9.
- INGAVAT, R. (1984): On the correlation of the Permian foraminiferal faunas of the western, central and eastern provinces of Thailand. *Mem. Soc. geol. France*, [N.S.], (147), 93-100.
- ISHIBASHI, T. and CHONGLAKMANI, C. (1990): Uppermost Permian ammonoids from northern Thailand. *Jour. Southeast Asian Ear. Sci.*, 3, (3), 163-170.
- KEMPER, E., in BAUM, F. et al. (1970): On the geology of northern Thailand. *Beih. Geol. Jb.*, 102, 1-23.
- KIPARISOVA, L. D. (1954): A contribution to the stratigraphy of the Lower Triassic of the South-Ussuri coastal region (Primorie). *Comp. Rend (Doklady) Acad. Sci. USSR.*, 49, pt. 6, 438-441.
- (1961): Palaeontological basis of the stratigraphy of the Triassic Formation in Ussuriland. pt. 1, Cephalopoda. *Trudi. Bses. Nauk. Issed., Geol. Inst. (VSEGEI)*, 48, 1-278.
- KOBAYASHI, T. and SAKAGAMI, S. (1989): A Permian trilobite from North Thailand. *Proc. Jap. Acad.*, 65, [B], (4), 67-69.
- KOIZUMI, H. (1975): *Paleozoic cephalopods of Japan*. Agataishi-bunko, 149 p. (in Japanese)
- KONNO, E. (1963): Some Permian plants from Thailand. *Jap. Jour. Geol. Geogr.*, 34, (2-4), 139-159, pl. 8.
- KRAFFT, A. and DIENER, C. (1909): Himalayan Fossil, Lower Triassic Cephalopoda from Spiti, Malla Johar and Byans. *Palaeont. Indica*, [15], 6, 1-189.

- KUMMEL, B. (1960): Triassic ammonoids from Thailand. *J. Paleont.*, **34**, 682-694, pls. 83-84.
- LIN, J. X. (1980): On the age and stratigraphical significance of the genus *Gallowayinella*. *Bull. Yichang Inst., Geol. Min. Res., Chinese Akad. Geol. Sci.*, **1**, (2), 37-45, pl. 1. (in Chinese with English abstract)
- NAKAZAWA, K. (1993): Stratigraphy of the Permian-Triassic transition and the Paleozoic/Mesozoic boundary. *Bull. Geol. Surv. Japan*, **44**, (7), 425-445. (in Japanese with English abstract)
- PIYASIN, S. (1972): *Geology of Lampang Sheet NE 47-7, scale 1:250,000*. Geol. Surv. Div., Dept. Min. Resour., Thailand.
- PRINGLE, T. and JACKSON, J. W. (1928): *Tylonautilus nodiferus* gen. nov.=*Nautilus (Discites) nodiferus* ARMSTRONG, a Carboniferous guide fossil. *Naturalist*, (863), 373-378, pl. 11.
- SAKAGAMI, S. and HATTA, A. (1982): On the Upper Permian *Palaeofusulina-Colaniella* fauna from Khao Doi Pha Phlung, North Thailand. *Geol. Palaeont. SE. Asia*, **24**, 1-14, Univ. Tokyo Press.
- SHENG, J. Z. and RUI, L. (1980): On the age of the genus *Gallowayinella*, with reference to the boundary between the Changhsingian stage and Wuchiaping stage. *Jour. Strat.*, **4**, (3), 233-235. (in Chinese)
- SPATH, L. F. (1930): The Eo-Triassic invertebrate fauna of east Greenland, *Medd. om Grønland*, **83**, 1-90, pls. 1-11.
- (1934): *Catalogue of fossil Cephalopoda in British Museum (Natur. Hist.)*, pt. 4. The Ammonoidea of the Triassic. 521 p.
- (1935): Additions to the Eo-Triassic invertebrate fauna of East Greenland. *Medd. om Grønland*, **98**, pt 2, 1-115, pl. 23.
- TAMURA, M., HASHIMOTO, W., IGO, H., ISHIBASHI, T., IWAI, J., KOBAYASHI, T., KOIKE, T., PITAKPAIVAN, K., SATO, T. and YIN, E. H. (1975): The Triassic Systems of Malaysia, Thailand and some adjacent areas. *Geol. Palaeont. SE Asia*, **15**, 103-149.
- TORIYAMA, R. (1973): Upper Permian fusulinan zones. The Permian and Triassic Systems and their mutual boundary. *Canadian Soc. Petrol. Geol. Mem.*, **2**, 498-512.
- , HAMADA, T., IGO, H., INGAVAT, R., KANMERA, K., KOBAYASHI, T., OZAWA, T., PITAKPAIVAN, K., PIYASHIN, S., SAKAGAMI, S., YANAGIDA, J. and YIN, E. H. (1975): The Carboniferous and Permian Systems in Thailand and Malaysia. *Geol. Palaeont. SE Asia*, **15**, 39-76.
- , PITAKPAIVAN, K. and INGAVAT, R. (1978): The paleogeographic characteristics of fusuline faunas of the Rat Buri Group in Thailand and its equivalent in Malaysia: In NUTALAYA, P. (ed.). *Proceedings of the third GEOSEA*, 107-111; Bangkok.
- TOZER, E. T. (1981): Triassic ammonoidea: Classification, evolution and relationship with Permian and Jurassic forms. In HOUSE, M. R. and SENIOR, J. R. (eds.): *The Ammonoidea-The evolution, classification, mode of life and geological usefulness of a major fossil group*. *Syst. Assoc. Spec.*, **18**, 593 p., Academic Press, London.
- UENO, K. and SAKAGAMI, S. (1991): Late Permian fusulinacean fauna of Doi Pha Phlung, North Thailand. *Trans. Proc. Palaeont. Soc. Japan*, [N.S.], (164), 928-943.

- WATERHOUSE, J. B. (1983): A Late Permian littoniid fauna from northwest Thailand. *Paper No. 10*, 11-153, Dept. Geol., Univ. Queensland.
- XU, G. (1977): Cephalopoda. In XU. G. and WIE R. (eds.): *Palaeontological atlas of central-South China*, pt. 2, Late Paleozoic, 855 p., pls. 1-253. Geol. Pub. House (in Chinese)
- YANAGISAWA, I. (1967): Geology and paleontology of the Takakurayama-Yaguki area, Yotsukura-cho, Fukushima Prefecture. *Sci. Rept. Tohoku Univ.*, [2nd], **39**, (1), 63-112, pls. 1-6.