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Carboniferous and Permian Ammonoids from Northern Thailand

(Paleontological Study of Paleozoic Cephalopods in Southeast Asia-1)

Masayuki FUJIKAWA and Takeshi ISHIBASHI

Abstract

Some Permian and Carboniferous ammonoids have been collected from Lampang, Loei, and Sop Pong areas of northern Thailand. The ammonoids of Lampang area indicate the uppermost Permian (Dorashamian), and those of the latter two areas indicate Lower Pennsylvanian. Nine species of seven genera of the uppermost Permian ammonoids are found in the collected specimens from Lampang area at present as follows; *Prototoceras* sp., *Paratirolites* aff. *spinosus*, *Pseudogastrioceras* aff. *szechuanense*, *Pseudotirolites* sp., *Tapashanites floriformis*, *T. changxingensis*, *Tapashanites* (?) sp., *Huananoceras* (?) sp., and *Xenodiscus* sp.

Lower Pennsylvanian ammonoids consists of *Pseudoparalegoceras* sp., *Gastrioceras* sp. A, *Gastrioceras* sp. B, *Brannerоceras* (?) sp., *Paralegoceras* sp., and *Cravenoceras* (?) sp. occur in the Wang Saphung Formation, distributed around Loei City, Loei area, and two species of Carboniferous ammonoids, *Pronorites arkansasensis* and *Cravenoceras* (?) sp. have been collected in Sop Pong area.

All species of ammonoids except *Pseudogastrioceras* aff. *szechuanse*, *Tapashanites* (?) sp., and *Xenodiscus* sp. are described for the first time in Thailand. The Paleozoic ammonoids have been reported from restricted regions in Thailand until now, and these ammonoids described in this paper are very precious and important for the paleontological and biostratigraphical studies not only in Thailand but in Southeast Asia.

Introduction

The Paleontological and biostratigraphical studies on the Paleozoic taxa have been carried out by many authors on foraminifers, brachiopods, bryozoans, and etc. Meanwhile, Paleozoic ammonoids have been exceedingly rare in Thailand and therefore it have been difficult to discuss biostratigraphy on the basis of ammonoid fossils or to make a comparative study of ammonoids with other regions.

The first record of paleontological study in Thailand is the report of occurrence of Tertiary cyprinid fish near Chiang Mai by ANDERSON (1916). The next, REED (1920) described Carboniferous fauna as ammonoids, gastropods, bivalves, brachiopods, and trilobites, from Phatthalung, Peninsular Thailand. Although a large number of paleontological studies of various taxa have been carried out by many authors since then, the report of Paleozoic ammonoids is still quite restricted (SATO and ISHIBASHI, 1984). This paper presents some of results of the paleontological research in Thailand for a few years. The Paleozoic ammonoids described in this paper were collected from the

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Provinces of Changwat Lampang, Loei, and Mae Hong Son, north Thailand (Fig. 1).

The first locality, Lampang area (Fig. 2), yields many kinds of Permian and Triassic fossils. Many papers on geology and paleontology have recently reported. PIYASIN (1972) divided the Ratburi Group of Permian distributed in this area into the three formations, Kiu Lom, Pha Huat and Huai Thak Formations, in ascending order. SAKAGAMI and HATTA (1982) identified the *Palaeofusulina-Colaniella* Fauna from the eastern foot of Doi Pha Phlung. WATERHOUSE (1983) have reported many upper Dzhulfian brachiopod fossils, as *Oldhamina squamosa*, from three localities. Recently KOGA *et al.* (1998) also described brachiopods such as *Oldhamina* cf. *anshunensis* from the southern part of Doi Pha Phlung. ISHIBASHI and CHONGLAKMANI (1990) reported three genera of Upper Permian ammonoid for the first time in Thailand. These will be referred to the following chapter. Fusulinacean fauna of Doi Pha Phlung also reported by UENO and SAKAGAMI (1991), and various taxa reported until now were compiled and published by ISHIBASHI *et al.* (1998). The detail locality is the same one as locality 7 illustrated in the route map of ISHIBASHI *et al.* (1994).

The second district, Loei area (Fig. 3), has been investigated in several times. The Wang Saphung Formation of Carboniferous and the Saraburi Formation of Permian are widely distributed in this area (CHAROENPRAVAT *et al.*, 1976), and many kinds of fauna occur in the shale beds, limestone beds, and so on. YANAGIDA (1967; 1974) reported some Permian and Carboniferous brachiopods in this area. IGO (1972) described Carboniferous fusulinacean fossils for the first time in Thailand. YANAGIDA (ed.)(1988) reported various taxa as

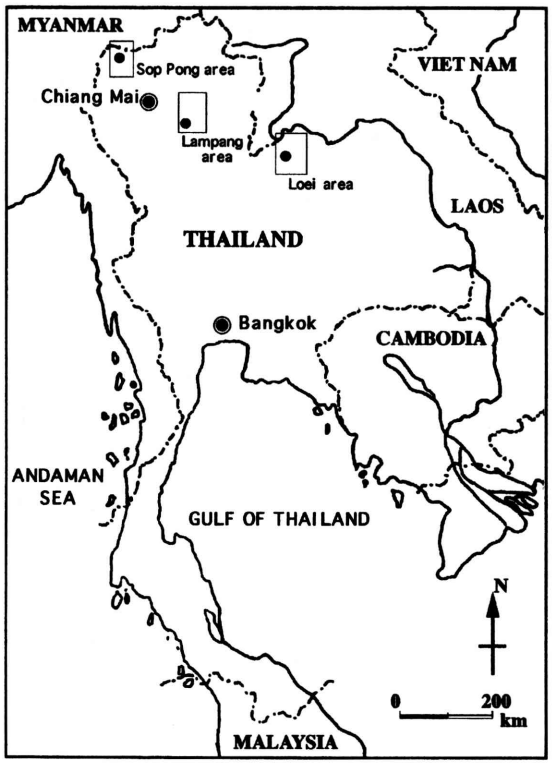

Fig. 1. Index map showing the study areas in Thailand.

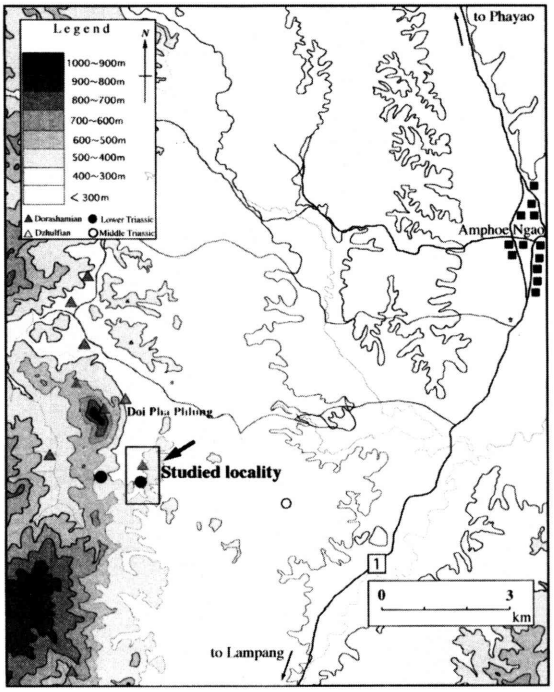

Fig. 2. Map showing the sample locality in Lampang area, northern Thailand.

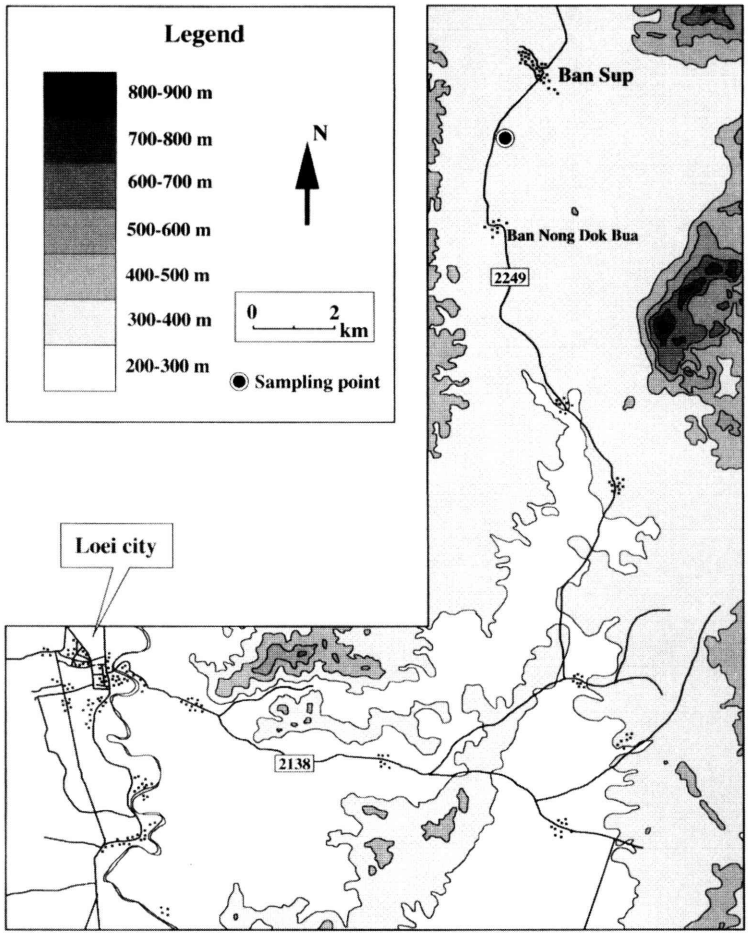

Fig. 3. Map showing the sample locality in Loei area, northern Thailand.

follows; smaller foraminifers, fusulinids, corals, bryozoans, brachiopods, trilobites, ammonoids and so on. KOBAYASHI and SAKAGAMI (1989a; 1989b; 1989c) reported Silurian, Carboniferous and Permian trilobites from each formation in this area. Recently IGO *et al.* (1993) described lower Permian fusulinaceans and ISHIBASHI *et al.* (1996; 1997) reported the occurrences of Permian and Carboniferous ammonoids.

Sop Pong area situates at the northern most part of Thailand (Fig. 4) and the information on paleontology have been quite few until now. CARIDROIT *et al.* (1990) reported a few paleontological results, which is the first paleontological report in this area. Limestone and sandy shale beds distribute in this area and calcareous fossils as fusulinids, foraminifers, algae, corals and bryozoans were reported by FONTAINE *et al.* (1993). The present ammonoids were collected on the information offered by INGAVAT-HELMCKE (1994) from the same locality. INGAVAT-HELMCKE (1994) and ISHIBASHI *et al.* (1997) reported the occurrences of some Carboniferous ammonoids from the same outcrops.

Five genera of Carboniferous ammonoid from Loei area, and two genera from Sop Pong area are presently described (Fig. 5). In addition, nine species of seven genera of Upper Permian ammonoids will be described in this paper join with the Carboniferous ammonoids.

The ammonoid specimens treated in this paper with prefix of TF are kept in the Geological Survey Division, Department of Mineral Resources, Thailand.

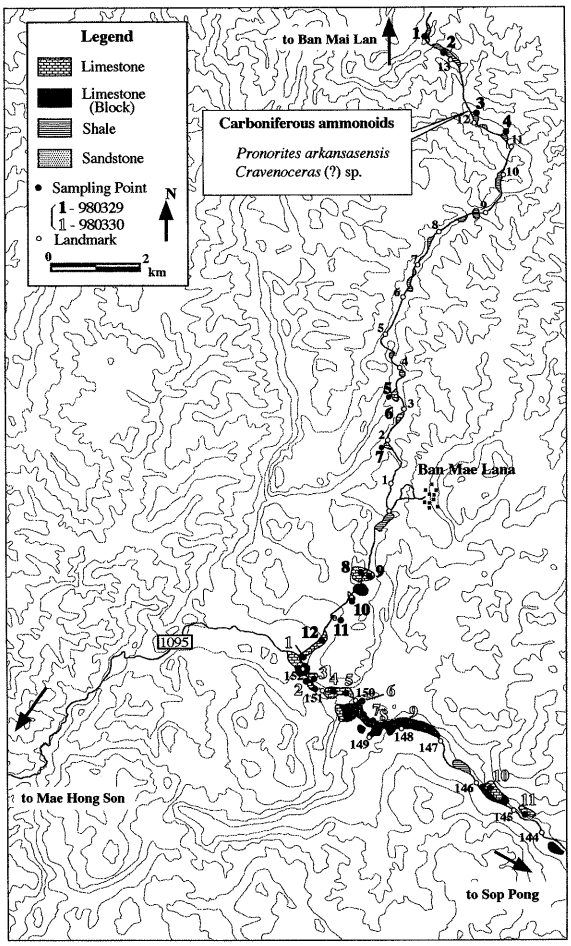

Fig. 4. Map showing the sample locality and profile of the route in Sop Pong area, northwestern Thailand.

Lampang area (Upper Permian)	*Prototoceras* sp. *Paratirolites* aff. *spinosus* (SHEVYREV) *Pseudogastrioceras* aff. *szechuanse* CHAO et LIANG *Pseudotirolites* sp. *Tapashanites floriformis* CHAO et LIANG *T. changxingensis* ZHAO, LIANG et ZHENG *Tapashanites* (?) sp. *Huananoceras* (?) sp. *Xenodiscus* sp.
Sop Pong area (Lower-Middle Pennsylvanian)	*Pronorites arkansasensis* (SMITH) *Cravenoceras* (?) sp.
Loei area (Lower Pennsylvanian)	*Pseudoparalegoceras* sp. *Gastrioceras* sp. A *Gastrioceras* sp. B *Brannerоceras* (?) sp. *Paralegoceras* sp. *Cravenoceras* (?) sp.

Fig. 5. The list of Permian and Carboniferous ammonoids in this study.

Outline of geology

1. *Lampang area*

Permian and Triassic sediments subordinated with volcanic rocks are widely distributed. The geological map of Lampang area was published by PIYASIN (1972) and there have been some more reports of geological studies. The Ngao Group of Permian and Lampang Group of Triassic are widely distributed in this area, and the Ngao Group is divided into the following two formations in ascending order, namely, Pha Huat Formation and Huai Thak Formation. ISHIBASHI and CHONGLAKMANI (1990) subdivided the Huai Thak Formation into two formations in ascending order as the Phra That Formation and the Hong Hoi Formation. The outcrop of this study (Fig. 6), inner side of the branch of the Huai Mae Pha (Mae Pha River), is situated about the 2km SSE of Doi Pha Phlung (Fig. 2). It belongs to the Huai Thak Formation, composed of shale, limestone, conglomerate and sandstone. Most of the Upper Permian invertebrate fossils occur in this formation in Thailand. The Permian-Triassic boundary runs about five hundred meters south from the present outcrop.

Fig. 6. Photograph of outcrop of bedded shale at Lampang area.

The geology of the Doi Pha Phlung area was described in the two papers, by ISHIBASHI and CHONGLAKMANI (1990) and by ISHIBASHI *et al.* (1994).

2. *Loei area*

There are few reports taken up or discussed about geology in Loei area until now. JACOBSON *et al.* (1969) presented the geological data in northern part of Loei City. The geological map, 1 : 250,000, published by CHAROENPRAVAT *et al.* (1976) was compiled by VIMUKTANANDANA (1988) as the geology and mineral resources map in the same scale. The sampling point on the side of the road (Route 2249) (Fig. 7) is situated at about the 2km SSW of Ban Sup, and the kilometer post signs 19km point along the road from Loei to Ban Sup (Fig. 3). This outcrop belongs to the Wang Saphung Formation of Carboniferous, composed of sandstone, siltstone, shale, tuff, and limestone. It yields many kinds of fossils as ammonoids, bivalves, brachiopods, trilobites,

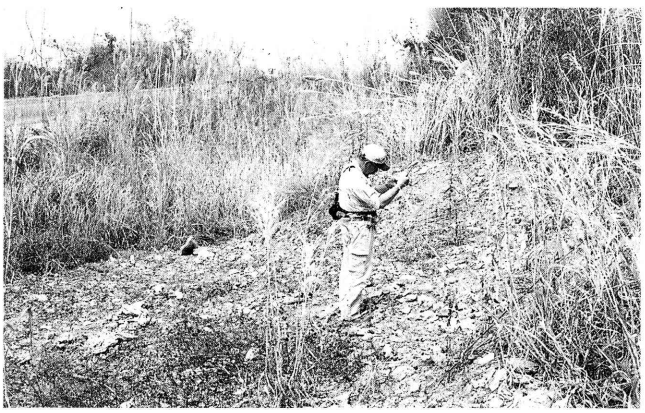

Fig. 7. Photograph of outcrop of brown-pale brown bedded shale at Loei area.

corals, gastropods, and bryozoans. KOBAYASHI and SAKAGAMI (1989b) described Carboniferous trilobite, *Brachymetopus (Brachymetopella) nakornsri* as a new species from the same outcrop. They considered that the age of this outcrop is to be Middle-Upper Carboniferous.

3. *Sop Pong area*

Just a few geological informations have been reported in Sop Pong area. The geological map with explanatory notes was published by HAHN and SIEBENHÜER (1982). This note includes some paleontological informations. FONTAINE *et al.* (1993) mentioned the geology as follows; "the limestones of Sop Pong do not appear as very variable, they commonly consist of grainstones and one may be tempted to consider that they were deposited during a short period". They also reported that the paleontology indicated ages ranging from Early Carboniferous to Late Permian. The outcrop of this study (Fig. 8) is situated at the side of the road from Ban Mae Lana to Ban Mai Lan, and consists of brown shale bed. The kilometer post beside the outcrop indicates 12km from the junction to Ban Mae Lana and Ban Mai Lan (Fig. 4).

Fig. 8. Photograph of outcrop of fine bedded shale at Sop Pong area.

Upper Paleozoic ammonoids in Thailand

1. *Carboniferous*

The Paleontological study about the Paleozoic ammonoids has been quite few in Thailand (Fig. 9), much less Carboniferous ammonoids. The first paleontological report of upper Paleozoic ammonoid in Thailand was from Khuan Din So, Phatthalung, located at Peninsular Thailand. REED (1920) reported three species of Carboniferous ammonoids as *Prolecanites* (?) sp., *Glyphyoceras* (?) sp. and *Pronorites* aff. *cyclolobus* from there.

INGAVAT-HELMCKE (1994) compiled the occurrence of various fossils of Paleozoic strata in Thailand, and reported the occurrence of goniatitid ammonoid closely related to *Pronorites cyclolobus uralensis* from Ban Mae Lana, Sop Pong district, the neighbour to border with Burma (Myanmar), northern Thailand. The latest one was, by ISHIBASHI *et al.* (1997), the occurrence of some more Carboniferous ammonoids as *Branneroceras branneri, Syngastrioceras* sp. *Neogastrioceras* sp., and *Bisatoceras* sp. from Loei area, and *Protocanites* sp. from the same locality of Ban Mae Lana, Sop Pong area.

2. *Permian*

The study of Permian ammonoid in Thailand was somewhat more than that of Carboniferous (Fig. 9). Permian ammonoids, *Agathiceras* aff. *suessi* and *Propinacoceras* sp. were reported by PITAKPAIVAN *et al.* (1969) from two localities, Phukadung of Changwat Loei and Chumphae of Changwat Khon Kaen, both of them situated in northcentral Thailand. This was the first report of Permian ammonoid in Thailand. For the decade of the 1990's, some more reports about Permian

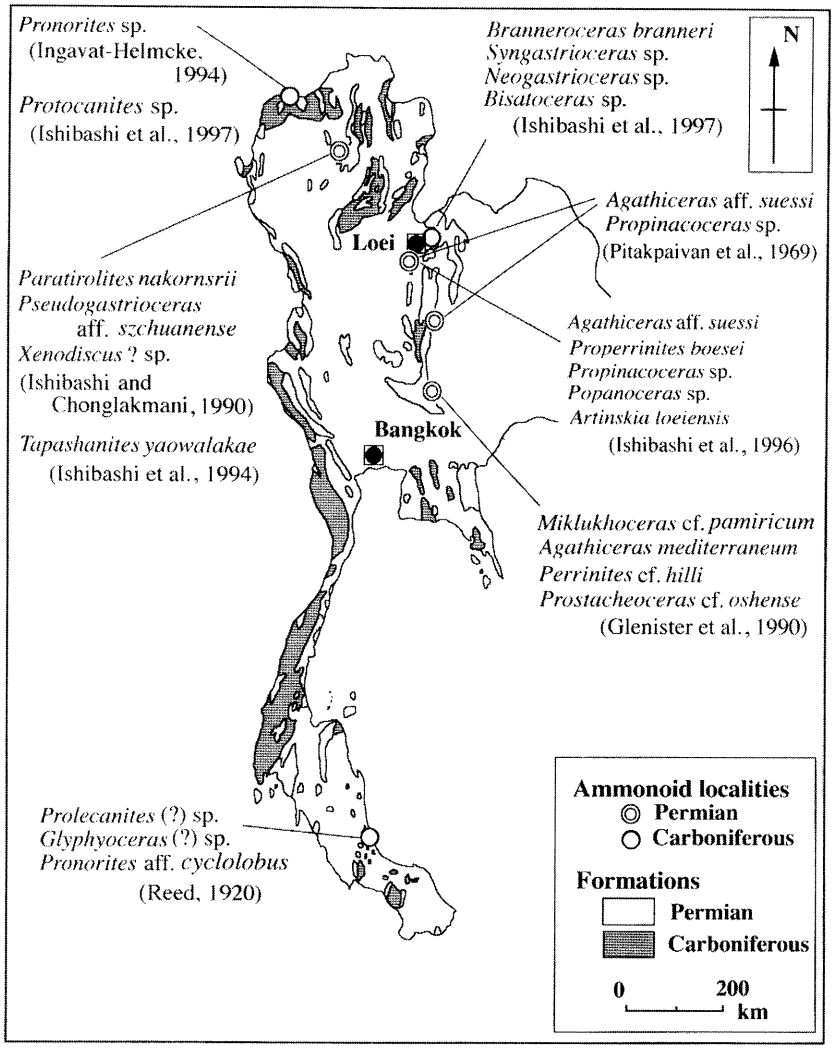

Fig. 9. Map showing the occurrence of Carboniferous and Permian ammonoid in Thailand.

ammonoid were published. There are two papers reported in 1990. The one is by ISHIBASHI and CHONGLAKMANI (1990), and the other is by GLENISTER *et al.* (1990). The former is from Doi Pha Phlung, Lampang district, northwest Thailand. These ammonoid species are as follows; *Paratirolites nakornsrii, Pseudogastrioceras* aff. *szchuanense*, and *Xenodiscus* ? sp. The latter reported some ammonoids without photographs as *Miklukhoceras* cf. *pamiricum, Agathiceras mediterraneum, Perrinites* cf. *hilli*, and *Prostacheoceras* cf. *oshense*, from Changwat Nakhorn Ratchasima, central Thailand. ISHIBASHI *et al.* (1994) reported the occurrence of Permian ammonoid *Tapashanites yaowalakae* from Doi Pha Phlung, Lampang district, northwest Thailand. Five species such as *Agathiceras* aff. *suessi, Properrinites boesei, Propinacoceras* sp., *Popanoceras* sp., and *Artinskia loeiensis*. have also been reported from Loei area (ISHIBASHI *et al.*, 1996).

Concluding remarks

Nine species of seven genera of Upper Permian and six genera of Carboniferous ammonoids are described. The Permian ammonoids from Lampang area, as *Prototoceras* sp., *Paratirolites* aff. *spinosus, Pseudogastrioceras* aff. *szechuanense, Pseudotirolites* sp., *Tapashanites floriformis, T. changxingensis, Tapashanites* (?) sp., *Huananoceras* (?) sp., and *Xenodiscus* sp., indicate uppermost Permian (Dorashamian). The ammonoids from Loei area consist of *Pseudoparalegoceras* sp., *Gastrioceras* sp. A, *Gastrioceras* sp. B, *Brannerоceras* (?) sp., *Paralegoceras* sp., and *Cravenoceras* (?) sp., indicate Lower Pennsylvanian. The Carboniferous ammonoids also collected from Sop Pong area, as *Pronorites arkansasensis* and *Cravenoceras* (?) sp., indicate Lower to Middle Pennsylvanian though the stage is indistinct. All genera of ammonoids except *Pseudogastrioceras* aff. *szechuanse, Tapashanites* (?) sp., and *Xenodiscus* sp. are described for the first time in Thailand. The Paleozoic ammonoids have been reported from restricted regions in Thailand until now, and these ammonoids described in this paper are very precious and important for the paleontological and biostratigraphical studies not only in Thailand but in Southeast Asia.

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Systematic Paleontology

Class CEPHALOPODA CUVIER, 1797
Subclass AMMONOIDEA ZITTEL, 1884
Order PROLECANITIDA MILLER and FURNISH, 1954
Superfamily MEDLICOTTIACEAE KARPINSKY, 1889
Family PRONORITIDAE FRECH, 1901
Genus *Pronorites* MOJSISOVICS, 1882

Type species.- Goniatites cyclolobus PHILLIPS, 1836
Pronotites arkansasensis (SMITH)
[Pl. 2; Figs. 14-17, 31-35 : Text-fig.10]

Synonymy.-

1896. *Pronorites cyclolobus* var. *arkansasensis,* SMITH, *Proc. Am. Phil. Soc.*, **35**, p. 267, pl.24, figs. 1-4.
1903. *Pronorites cyclolobus* var. *arkansasensis*, SMITH, *U. S. Geol. Surv. Mon.* **42**, p. 43, pl. 12, figs. 12-15.
1913. *Pronorites arkansasensis,* SMITH, *Zittel-Eastman Textbook of Paleontology*, **1**, ed. 2, p. 633, text-fig. 1183.
1930. *Pronorites arkansasensis,* MILLER, *J. Paleont.*, **4**, p. 394.

1937. *Pronorites arkansasensis*, PLUMMER and SCOTT, *Univ. Texas Bull.*, **3071**, p.57-59, pl. 2, figs. 1-4.
1938. *Pronorites arkansasensis*, MILLER and MOORE, *J. Paleont.*, **12**, (4), p. 345, pl.43, figs. 8, 9, text-fig. 1.
1944. *Pronorites arkansasensis*, MILLER and OWEN, *J. Paleont.*, **18**, (5), p. 420, pl. 63, figs. 3, 4, text-fig. 1.
1944. *Pronorites arkansasensis*, SHIMER and SHROCK, *Index fossils of North America*, p. 567, pl. 232, figs. 1, 2.
1957. *Pronorites arkansasensis*, MILLER and FURNISH in MILLER, FURNISH and SCHINDEWOLF, *Treatise on Invertebrate Paleontology*, Part L, Mollusca 4, p. L71, figs. 10A, 117.
1962. *Pronorites arkansasensis*, UNKLESBAY, *Oklahoma Geol. Surv. Bull.*, **96**, p. 119-121, pl. 19, figs. 1-4, text-fig. 16.
1971. *Pronorites arkansasensis*, NISHIDA, *Bull. Akiyoshi-dai Sci. Mus.*, (7), p. 19-21, pl. 7, text- fig. 1.

Material.- Nine specimens were examined (TF2377-2385), some of them are laterally compressed, and others are single specimens. Five specimens have suture-lines.

Description.- Conch discoidal to subdiscoidal, subrectangular in cross-section. Shell moderate in size, moderately evolute, with flattened lateral side, venter gently rounded. Ventral part and surface ornament are not preserved. The external suture have trifid pointed ventral lobe, and a pair of first lateral lobes divided by a wide, somewhat constricted, spaturate secondary saddle. Four or five additional pairs of lateral lobes are also constricted and pointed. The suture-lines of some specimens (Pl. 2; Figs. 31-35) are visible. These suture-lines are illustrated in Fig. 10.

Remarks.- The ammonoid fossils, collected from the same horizon of the present specimens, have been reported by INGAVAT-HELMCKE (1994) and ISHIBASHI *et al.* (1997). as the genera *Pronorites* and *Protocanites* without description or plate. The authors regard them as the genus *Pronorites*. The genus *Pronorites*, which is widespread all over the world, has described by MOJSISOVICS (1882) for the first time, and described by many authors since then. *Pronorites arkansasensis* described by PLUMMER and SCOTT (1937) extremely resemble the present specimen. The external suture of *Stenopronorites arkansiensis* (SMITH) described by GORDON JR. (1964) might also resemble that of present specimens, but *Stenopronorites* has high-whorled conch, and the tripartite ventral lobe is not pointed. *Pronorites arkansasensis* described by NISHIDA (1971) is similar to the present specimen but the former has lower prong on the center of trifid ventral lobe. *Pseudopronorites arkansiensis* might be close to the present specimens. *P. arkansiensis* was described by NASSICHUK (1975), NISHIDA and KYUMA (1982), NISHIDA *et al.* (1998) and others. However, the shape of the pair of saddles which subdivide first lateral lobes is quite different. *P. arkansiensis* has higher and narrower saddles. Moreover a number of lobes of *P. arkansiensis* are more than those of *Pronorites arkansasensis*. INGAVAT-HELMCKE (1994) proposed these goniatitid ammonoids closely related to *Pronorites cyclolobus uralensis* from the Urals and southern China, however the present specimens have wider umbilicus and the pair of first lateral lobes of *P. cyclolobus uralensis* divided narrower secondary saddle. The characteristics of the present specimen also resemble the fossils described in synonymy papers the above-mentioned, thus those are identified as *P. arkansasensis*.

Occurrence.- Fine shale bed near the Burmese border. 5 km north of Ban Mae Lana, Sop Pong district, northwestern Thailand. Lower to Middle Pennsylvanian.

Order GONIATITIDA HYATT, 1884
Superfamily GASTRIOCERATACEAE HYATT, 1884
Family GASTRIOCERATIDAE HYATT, 1884
Genus *Gastrioceras* HYATT, 1884
Type species.- Ammonites listeri SOWERBY, 1812
Gastrioceras sp. A
[Pl. 2; Figs. 2, 8, 9]

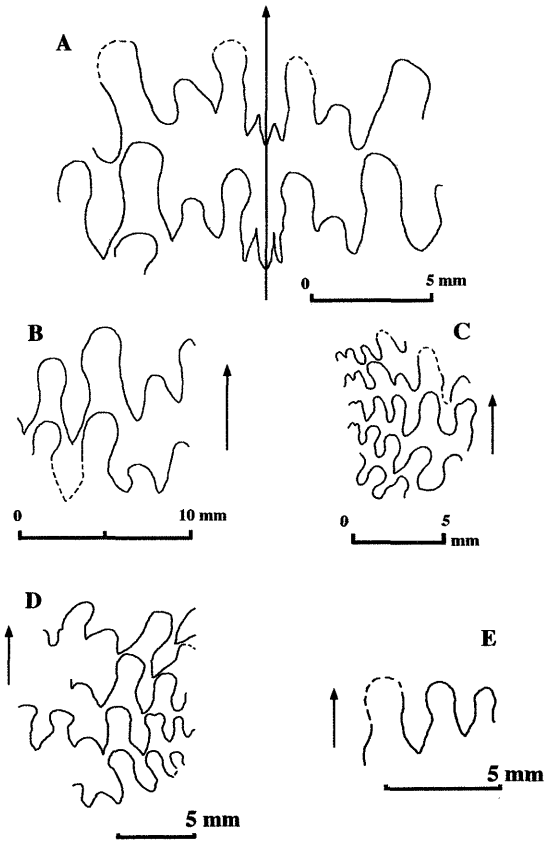

Fig. 10. Suture-lines of *Pronorites arkansasensis* from Sop Pong area.
A : Pl. 2, Fig. 34, B : Pl. 2, Fig. 33, C : Pl. 2, Fig. 31, D : Pl. 2, Fig. 32, E : Pl. 2, Fig.35.

Material.- Three specimens (TF2386-2388), parts of outer whorl cast, were incompletely preserved.

Descriptive remarks.- Shell moderate in size, evolute, ornamented by transverse rib-like nodes, which extended from the umbilical shoulder onto the flanks, die out on ventrolateral shoulder. The umbilical part, venter, and the external suture are not preserved.

The present specimens might resemble to *G. listeri* described by PLUMMER and SCOTT (1937), however the umbilical part and venter are indistinct and the ribs are tighter than the present specimen.

Occurrence.- Shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

Gastrioceras sp. B
[Pl. 2; Figs. 3, 6, 7, 10]

Material.- Four specimens were examined (TF2389-2392). One specimen is outer mould, and other three are incomplete specimens, parts of the outer whorl.

Descriptive remarks.- Shell moderate in size, evolute, ornamented by transverse ribs, which elongated from the umbilical shoulder onto the ventrolateral shoulder. The ribs are highest on the

midpoint of lateral side. The umbilical part, venter, and the external suture are not preserved.
The conch shape and ribs of the present specimens show a few characteristics, which might be useful to determine the genus name. The characteristics is extremely similar to those of *Gastrioceras liratum* described by NASSICHUK (1975).

Occurrence.- Shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

Family PARAGASTRIOCERATIDAE RUZHENCEV, 1951
Genus *Pseudogastrioceras* SPATH, 1930
Type species.- Goniatites abichianus MÖLER, 1879
Pseudogastrioceras aff. *szechuanense* CHAO et LIANG
[Pl.3; Figs. 3, 12]

Compare.-
1965. *Pseudogastrioceras szechuanense*, CHAO, *Cephalopod Fossils of China*, pp. 18-21, pl. 2, figs. 18-20, text-fig. 4a.
1966. *Pseudogastrioceras szechuanense*, CHAO, *Acta. Stratig. Sin.* pp. 170-187, pl. 2, figs. 18-20.
1974. *Pseudogastrioceras szechuanense*, CHAO, *A Handbook of the Stratigraphy and Palaeontology in Southwest China*. p. 304, pl. 160, figs. 1-2.
1978. *Pseudogastrioceras szechuanense*, ZHAO *et al., Paleont. Sin.*, **154**, (N. S.) B, (12), pp. 73- 74, pl. 9, figs. 1-2; pl. 10, figs. 1-4, 16b.
1990. *Pseudogastrioceras* aff. *P. szechuanense*, ISHIBASHI et CHONGLAKMANI, *Jour. Southeast Asian Ear. Sci.*, **3**, (3), pp. 164-165, fig. 5, a-c.

Material.- Two specimens were examined (TF2393, 2394). One is the outer mould, and the other is outer cast.

Description.- Conch subdiscoidal to elliptical, Shell moderate in size, involute, laterally compressed. Umbilical part is poorly preserved, only a part of closed umbilicus is visible. Shell is smooth and flattened in lateral part. Ventral shoulder is gently rounded, and one specimen has longitudinal striae on ventrolateral shoulder. The external suture is absent.

Remarks.- Genus *Pseudogastrioceras* was reported by ISHIBASHI and CHONGLAKMANI (1990) in northern Thailand for the first time, and this was the only report about *Pseudogastrioceras* in Thailand. The authors have investigated the same horizon and locality for this study, and have obtained two more specimens with some other kinds of ammonoid fossils. The present specimens resemble *Pseudogastrioceras* aff. *P. szechuanense* described by ISHIBASHI and CHONGLAKMANI. These specimens also similar to *P. szechuanense* described by ZHAO *et al.* (1978) in some characteristics, but those might be not enough for determination of species.
One specimen (Pl. 3, Fig. 12), without any ornamentation, has examined for its closed umbilicus, flattened lateral side, and rounded ventral shoulder to venter.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Superfamily SCHISTOCERATACEAE SCHMIDT, 1939
Family BRANNEROCERATIDAE PLUMMER and SCOTT, 1937
Genus *Branneroceras* PLUMMER and SCOTT, 1937
Type species.- Gastrioceras branneri SMITH, 1896
Branneroceras (?) sp.
[Pl. 2; Fig. 4]

Material.- Only one specimen (TF2395), a part of whorl, was examined.

Descriptive remarks.- Shell moderate in size, evolute with wide umbilicus. Laterally rounded, having the distinct transverse ribs and partly longitudinal ridges on lateral to ventrolateral side. This present specimen is fragmental and poorly preserved. The external suture is not also preserved. The characteristics of this specimen similar to those *Paragastrioceras* of Permian, though the latter has larger outer whorl. The genus *Branneroceras*, belonging to Family Brannerocerati dae, might be proposed if the present specimen is not outer whorl but inner. The present specimen might extremely resemble *Gastrioceras branneri branneri* described by MILLER and DOWNS (1948). *G. branneri* redefined as *Branneroceras branneri* by PLUMMER and SCOTT (1937). Therefore the authors described this specimen as the genus *Branneroceras*.

Occurrence.- Shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

Family SCHISTOCERATIDAE SCHMIDT, 1929
Genus *Paralegoceras* HYATT, 1884
Type species.- *Goniatites iowensis* MEEK and WORTHEN, 1860
Paralegoceras sp.
[Pl. 2; Fig. 5]

Material.- Single specimen (TF2398).

Description.- Conch discoidal, evolute. The whorls are coiling triangularly. The pronounced transeverse ribs ornament umbilical shoulder. Those extend to the lateral side, and decreasing to ventrolateral shoulder. Venter smooth, arched. Umbilical part has not been preserved. The external suture is not preserved.

Remarks.- Some kinds of Carboniferous ammonoid have triangular whorl. *Diaboloceras*, *Paralegoceras*, and *Pintoceras* (= *Eoshistoceras*), of the family Schistoceratidae, and *Winslowoceras*, *Eowellerites*, and *Wellerites*, of the family Welleritidae, are those. It is frequently difficult to distinguish for lack of the characteristics of the specimen. The present specimen resemble several *Diaboloceras* specimens, but the former has smooth venter and the ribs are faint compare from the latter's one. *Paralegoceras texatum* described by UNKLESBAY (1962) and *P. texatum* described by MILLER and FURNISH (1940) might be the closest to the present specimen. Those specimen have gently coiled triangular whorl, and the ribs also resemble. However, the suture-lines of the present specimens are absent. Welleritid ammonoids from the Akiyoshi Limestone Group, Japan (KYUMA and NISHIDA, 1992), have triangular whorl, but their transverse lirae is shallower and finer than the ribs of *Paralegoceras*.

Occurrence.- Shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

Superfamily SOMOHOLITACEAE RUZHENCEV, 1938
Family PSEUDOPARALEGOCERATIDAE LIBROVITCH, 1957
Genus *Pseudoparalegoceras* MILLER, 1934
Type species.- *Gastrioceras russiense* TZWETAEV, 1888
Pseudoparalegoceras sp.
[Pl. 2; Figs. 1, 11]

Material.- Two specimens were examined (TF2396, 2397). One is outer mould, the other is incomplete, only part of outer cast.

Description.- Shell large in size, moderately evolute, laterally compressed. The umbilicus is

about one-third of the diameter. Umbilical shoulders are rounded, Shell is smooth and the ornament is absent. Umbilical shoulder is not angular but steeply rounded. The external suture is invisible.

Remarks.- The genus *Pseudoparalegoceras* was proposed by MILLER (1934) on the basis of the number of external sutures lobe.

A number of species of *Pseudoparalegoceras* have been proposed since then, and discussed by many authors. These specimens might extremely resemble *P. compressum* described by NISHDA (1971) and by NISHIDA and KYUMA (1982) the most but the present ones are poorly preserved that some characteristics are absent, only the lateral side of outer whorl are observed.

Occurrence.- Shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

Superfamily NEOGLYPHIOCERATACEAE PLUMMER and SCOTT, 1937
Family CRAVENOCERATIDAE RUZHENCEV, 1957
Genus *Cravenoceras* BISAT, 1928
Type species.- Homoceras malhamense BISAT, 1924
Cravenoceras (?) sp.
[Pl. 2; Figs. 12, 13, 18-30]

Material.- Fifteen compressed specimens were examined (TF2399-2413). Two specimens were from Loei area, and others were from Sop Pong area.

Descriptive remarks.- Shell moderate to small in size, evolute, laterally compressed. Lateral side is ornamented by fine growth lines. The external suture is not preserved.

The genus *Cravenoceras* was proposed by BISAT (1928), on the basis of *Homoceras malhamense* BISAT, from England. This genus is particularly widespread geographically and confined to Namurian. A number of species of this genus have various conch shapes and ornaments, and present specimens resemble some of them. Unfortunately all present specimens are not well preserved, therefore it is difficult to determine the species name.

Cravenoceras friscoense described by SAUNDERS (1973) resembles the persent specimens collected from Sop Pong area but the characteristics are not enough to identify them.

Occurrence.- Two specimens were from shale bed of the Wang Saphung Formation, 2 km SW of Ban Sup (Route 2249), Loei district, northern Thailand. Lower Pennsylvanian.

The other thirteen specimens were from fine shale bed near the Burmese border. 5 km north of Ban Mae Lana, Sop Pong district, northwestern Thailand. Lower to Middle Pennsylvanian.

Order CERATITIDA HYATT, 1884
Superfamily XENODISCACEAE FRECH, 1902
Family XENODISCIDAE FRECH, 1902
Genus *Xenodiscus* WAAGEN, 1879
Type species.- Xenodiscus plicatus WAAGEN, 1879
Xenodiscus sp.
[Pl. 3; Figs. 14, 15]

Material.- Two incomplete specimens (TF2414, 2415), parts of outer whorl, were examined.

Descriptive remarks.- Fragmental shell moderate in size, evolute. Surface is ornamented with fine radial ribs, which wind on the ventrolateral shoulder. Umbilical shoulder is slightly rounded. The external suture is invisible. Umbilicus and ventral part are not preserved. The characteristics of the present specimens similar to *Xenodiscus* sp. indet. described by ISHIBASHI and CHONGLAKMANI

(1990) from the same horizon. They also resemble *Xenodiscus muratai* described by BANDO (1979), but the present specimens might have stronger ribs than that specimen.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Family TAPASHANITIDAE ZHAO, LIANG et ZHENG, 1978

Genus *Tapashanites* CHAO et LIANG, 1965

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

Tapashanites floriformis CHAO et LIANG

[Pl. 3; Fig. 6]

Synonymy.-

1965. *Tapashanites floriformis* CHAO, *Scientia Sinica*, **14**, (12), pl.2, figs. 21, 22, text-fig. 4c.

1966. *Tapashanites floriformis* ZHAO, *Acta. Stratig. Sin.* **1**, pl. 2, figs. 21, 22.

1974. *Tapashanites floriformis* CHAO, *A Handbook of the Stratigraphy and Palaeontology in Southwest China.*, p. 305, pl. 159, figs. 1-3.

1978. *Tapashanites floriformis* ZHAO *et al., Paleont. Sin.*, **154**, (N. S.) B, (12) pp. 112-113, pl.12, figs. 7-9; pl. 13, figs. 3-5, text-fig. 61

Material.- One incomplete specimen (TF2416), a part of the outer whorl.

Description.- Shell moderate in size, evolute, with wide umbilicus. The transversely elongated ribs are highest on umbilical shoulder and become gently faint to ventrolateral shoulder. The external suture is invisible.

Remarks.- There have been many occurrences and reports of the genus *Tapashanites* from South China. Many species belong to this genus and each have various characteristics. The present specimen has transverse ribs but not so strong compare with other species in this genus. *T. floriformis* described by ZHAO *et al.* (1978) might be resemble the present specimen the most. ISHIBASHI *et al.* (1994) described *Tapashanites yaowalakae* from the same horizon, but the present specimen has straight and shallower ribs. *T. yaowalakae* has nodes on the inner whorl but this characteristics are not good for distinguish in present study.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Tapashanites changxingensis ZHAO, LIANG et ZHENG

[Pl. 3; Fig. 18]

Synonymy.-

1978. *Tapashanites changxingensis* ZHAO, LIANG et ZHENG, *Paleont. Sin.*, **154**, N. S. **B**, (12), p.117, pl.12, figs. 10-12; pl. 13, figs. 1, 2, text-figs. 65A, 66.

Material.- One incomplete specimen (TF2417), a part of the outer whorl.

Description.- Shell moderate in size, evolute, with wide umbilicus. Fine radial ribs are gently sinuous on lateral side. The external suture is invisible.

Remarks.- The present this specimen is fragmental so only the lateral characteristics is observed. Comparing from some other species belonging to genus *Tapashanites* (*T. floriformis, T. chaotianensis, T. tenuicostatrus*, and etc.), the present specimen has finer radial ribs and the dosal shoulder rounds more gently. ISHIBASHI *et al.* (1994) described *Tapashanites yaowalakae* from the same horizon but some characteristics are obviously different from those of the present specimen.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Tapashanites (?) sp.
[Pl. 3; Fig. 4 : Text-fig.11]

Material.- One fragmental, laterally compressed specimen was examined (TF2418). The external suture was preserved.

Descriptive remarks.- Shell moderate in size, evolute, with wide umbilicus. The external suture is incompletely preserved (Fig. 11). Ventral lobe and umbilical part are missing, thus the number of lateral lobe are indistinct. Those lobes are somewhat constricted, each prongs serrated. There are two or three lateral lobes on each lateral side at least. Comparing from some other species belonging to genus *Tapashanites* (*T. floriformis, T. chaotianensis, T. tenuicostatrus*, and etc.) described by ZHAO *et al.* (1978), the hight of the second or third lateral saddle is higher than that of other species. The present specimen might belong to other genus of family Tapashanitidae. ISHIBASHI *et al.* (1994) described *Tapashanites yaowalakae* from the same horizon but the suture-line is not preserved, so it might be conceivable that the present specimen is *T. yaowalakae*.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

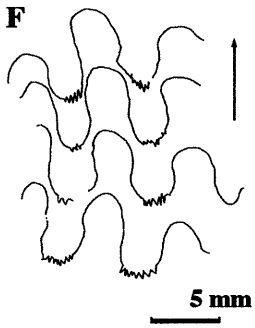

Fig. 11. Suture-line of *Tapashanites* (?) sp. from Huai Mae Pa, southern area of Doi Pha Phlung, Lampang area. F : Pl. 3, Fig. 4.

Family DZHULFITIDAE SHEVYREV, 1965
Genus *Paratirolites* STOYANOW, 1910
Type species.- Paratirolites kittli STOYANOW, 1910
Paratirolites aff. *spinosus* (SHEVYREV)
[Pl. 3; Fig. 2]

Compare.-

1965. *Dzhulfites spinosus* SHEVYREV, in RUZHENCEV and SARYCHEVA, *Trudy. Paleont. Inst., Acad. Nauk SSSR*, **108**, p. 173, pl. 21, fig. 9.

1968. *Dzhulfites spinosus*, SHEVYREV, *Ibid*, **119**, p. 88, pl. 2, figs. 3, 4.

1973. *Paratirolites spinosus* (SHEVYREV), TEICHERT, KUMMEL and SWEET, *Bull. Mus. Comp. Zool.*, **145**, (8), p. 413, pl. 6, figs. 2, 6; pl.7, figs. 4, 5 (non figs. 10, 11).

1979. *Paratirolites spinosus* (SHEVYREV), BANDO, *Mem. Fac. Educ., Kagawa Univ.*, 2, **29**, p. 136, pl. 5, fig. 11; pl. 6, fig.4, 5.

Material.- One compressed specimen (TF2419).

Description.- Shell moderate in size, evolute with wide umbilicus. Laterally compressed, nodes on the inner whorl and other surface ornamentation is absent. The external suture is invisible.

Remarks.- There has been only one report about the occurrence of genus *Paratirolites* from Thailand. *P. nakornsrii* described by ISHIBASHI and CHONGLAKMANI (1990), that has large nodes, which increases gradually towards the outer, on the ventrolateral side. The present specimen occurred from same horizon, but the latter has quite different characteristics. *Paratirolites compressus* described by EHIRO (1996) has large nodes on inner whorl, but those nodes are radial and elongated from umbilical shoulder to ventral shoulder. Comparing with the specimens described by BANDO (1979), the present specimen so resembles but has relatively indistinct, faint nodes on umbilical shoulder.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Family HUANANOCERATIDAE ZHAO, LIANG et ZHENG, 1978

Genus *Huananoceras* CHAO et LIANG, 1974

Type species.- *Huananoceras involutum* CHAO et LIANG, 1974

Huananoceras (?) sp.

[Pl. 3; Figs. 8-11]

Material.- Four incomplete specimens (TF2420-2423), parts of the whorl, were examined.

Descriptive remarks.- The present specimens have fine transverse striae, which curved gently on lateral side. The genus *Huananoceras* was established by CHAO et LIANG (1974), and some species belonging to this genus has been described from south China. The present specimens might similar to *H. involutum* described by ZHAO *et al.* (1978) but this characteristics is not enough to distinguish the genus or species name.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Family PSEUDOTIROLITIDAE CHAO *et al.*, 1965

Genus *Pseudotirolites* Sun, 1939

Type species.- *Tirolites asiaticus* JAEKEL, 1929

Pseudotirolites sp.

[Pl. 3; Figs. 5, 17]

Material.- Two specimens (TF2424, 2425). One specimen is the outer cast, and the other is outer mould of the part of whorl.

Description.- Shell moderate in size, evolute, wide and high ribs elongated, curved sinuously. Venter and inner whorl are not clear. The external suture is not preserved.

Remarks.- The genus *Pseudotirolites* was established by SUN (1939) on the basis of *Tirolites asiaticus* JAEKEL (1929). This genus has been described from south China, and *P. guixianensis* might be resemble the present specimens. However the lack of several characters, the species name of these specimens will not be distinguished.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

Superfamily OTOCERATACEAE HYATT, 1900

Family OTOCERATIDAE HYATT, 1900

Genus *Prototoceras* SPATH, 1930
Type species.- Ceratites tropitus ABICH, 1878
(=*Otoceras trochoides* ARTHABER, 1900;
non *Ceratites trochoides* ABICH, 1878)
Prototoceras sp.
[Pl. 3; Figs. 1, 7, 13, 16]

Material.- Four specimens were examined (TF2426-2429).

Description.- Shell large in size, evolute with wide umbilicus, laterally compressed. Ventral and umbilical shoulders are not angular, umbilicus is not deep. Surface ornament is absent and smooth. The external suture is not visible.

Remarks.- The present specimens are too poorly preserved to examine minutely. *P. compressum* described by BANDO (1979) resembles these specimens, at the points of the shell form or proportion of conch diameter and umbilicus. *P. fregchengense* described by ZHAO *et al.* (1978) also resembles the present specimen but the former has deeper umbilicus. EHIRO and BANDO (1985) described *Prototoceras japonicum* and some more species of *Prototoceras*. Those specimens have involute conch compare with the present specimens. Therefore the present specimens are not so closely related to *P. japonicum*.

Occurrence.- Shale bed of the Huai Thak Formation, southern part of Doi Pha Phlung, Lampang district, northwest Thailand. Upper Permian.

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Plate 2

Explanation of Plate 2

Figs. 1, 11 *Pseudoparalegoceras* sp. (Fig. 1 × 1.0 ; Fig. 11 × 1.5) (TF2396, TF2397)
Figs. 2, 8, 9 *Gastrioceras* sp. A(Fig.2 × 1.0 ; Figs. 8, 9 × 1.5) (TF2386-TF2387)
Figs. 3, 6, 7, 10 *Gastrioceras* sp. B (Fig. 3 × 1.0 ; Figs. 7, 10 × 1.5 ; Fig. 6 × 2.0) (TF2389-TF2392)
Fig. 4 *Brannerоceras* (?) sp. (× 1.5) (TF2395)
Fig. 5 *Paralegoceras* sp. (× 1.0) (TF2398)
Figs. 14-17, 31-35 *Pronorites arkansasensis* (SMITH)
(Figs. 14, 15, 17 × 1.0 ; Figs. 16, 18, 31 × 1.5 ; Figs. 32 ～ 35 × 2.0) (TF2377-TF2380, TF2381-TF2385)
Figs. 12, 13, 18-30 *Cravenoceras* (?) sp. (Fig. 18 × 1.5 ; Figs. 12, 13, 19 ～ 22, 28 × 2.0 ; Figs. 23 ～ 27, 29, 30 × 3.0) (TF2399-TF2413)

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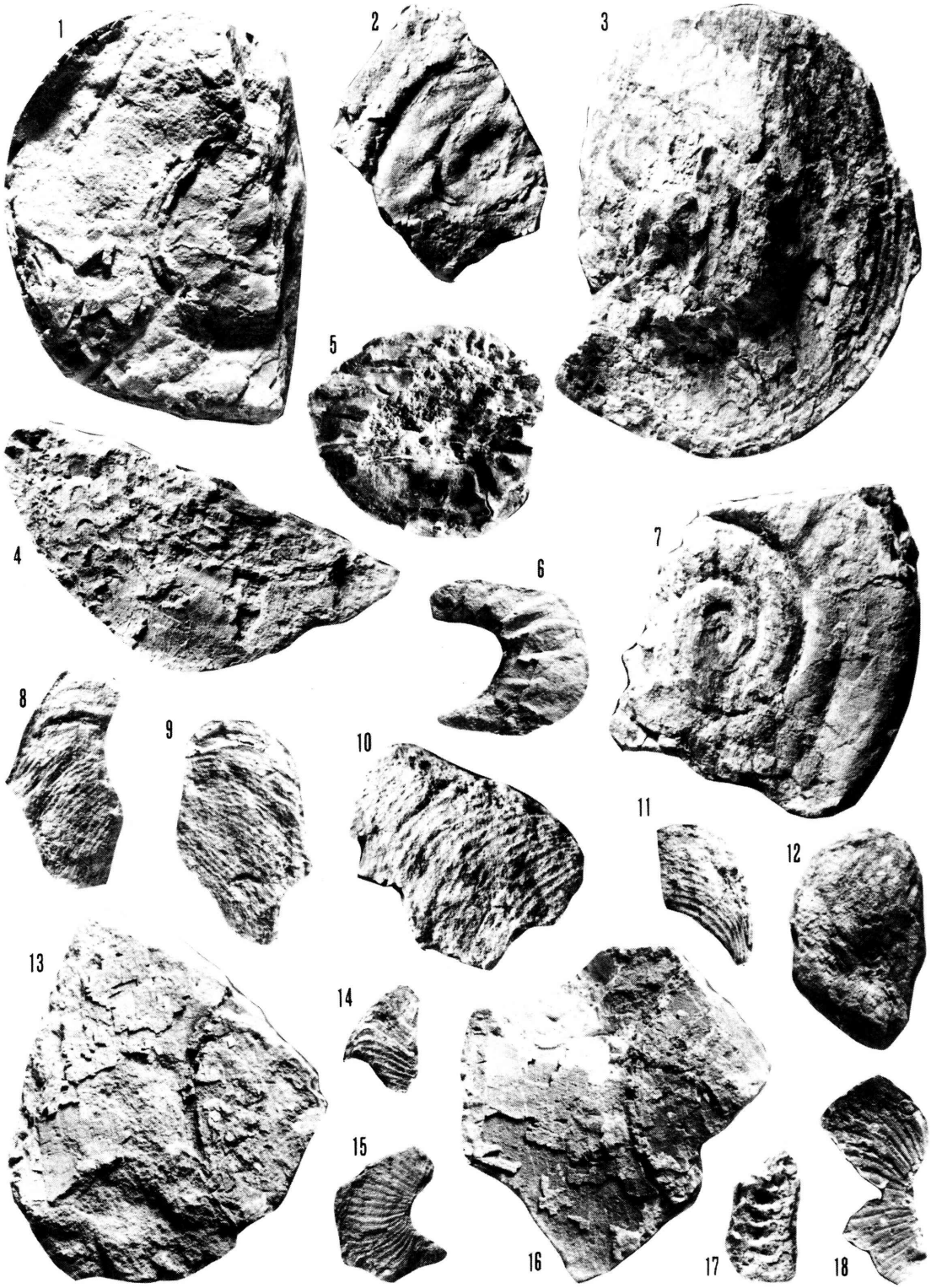
Plate 3

Explanation of Plate 3

Figs. 1, 7, 13, 16 *Prototoceras* sp. (× 1.0) (TF2426-TF2429)
Fig. 2 *Paratirolites* aff. *spinosus* (SHEVYREV) (× 1.0) (TF2419)
Fig. 3, 12 *Pseudogastrioceras* aff. *szechuanense* CHAO et LIANG (Fig. 3 × 1.0 ; Fig. 12 × 1.5) (TF2393, TF2394)
Fig. 4 *Tapashanites* (?) sp. (× 1.0) (TF2418)
Figs. 5, 17 *Pseudotirolites* sp. (Fig. 5 × 1.0 ; Fig. 17 × 1.5) (TF2424, TF2425)
Fig. 6 *Tapashanites floriformis* CHAO et LIANG (× 1.0) (TF2416)
Fig. 18 *Tapashanites changxingensis* ZHAO, LIANG et ZHENG (× 1.5) (TF2417)
Figs.8-11 *Huananoceras* (?) sp. (× 1.0) (TF2420-TF2423)
Figs. 14, 15 *Xenodiscus* sp. (× 1.0) (TF2414-TF2415)



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