



Middle Carboniferous cephalopods from Loei area, northern Thailand

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Abstract: The Carboniferous cephalopods are abundantly recognized at “Barite Mine”, northern part of Loei-city, northern Thailand. The fauna of “Barite Mine” consists of various taxa such as cephalopods, brachiopods, corals, bivalves and gastropods etc. More than three hundreds specimens of cephalopods consisting of ammonoids, nautiloids and orthoceratids are collected and are replaced by barite minerals. Five genera of ammonoids and five genera of nautiloids are identified at present. In addition to these, one new genus and two new species of ammonoid are included. The identified cephalopod species are as follows; *Branneroceras branneri*, *Diaboloceras involutum*, *Syngastrioceras* sp., *Neogastrioceras* sp., *Bisatoceras* sp., *Catastroboceras subsulcatifomae*, *Epidomatoceras doohylense*, *Gzheoloceras* sp., *Temnocheilus* sp., and *Epistroboceras* sp. These cephalopod fauna indicates the age from Namurian to Moscovian of the Middle Carboniferous. This fauna is very important to construct the biostratigraphy based upon the Paleozoic ammonoid zones in Southeast Asia.

INTRODUCTION

The present paper deals with the Carboniferous cephalopods collected from north of Loei-city, Changwat Loei, north Thailand (Fig. 1).

The standard biostratigraphy of Carboniferous and Permian have been constructed on the basis of fusulinaceans in Thailand (Pitakpaivan, 1965; Baum *et al.*, 1970; Igo, 1972; Toriyama *et al.*, 1975; Ingavat *et al.*, 1980; Ingavat, 1984; Toriyama, 1984). Meanwhile, the Carboniferous and Permian ammonoids have been rarely reported from Southeast Asia as well as Thailand and the biostratigraphy depends on Paleozoic ammonoid has never been proposed until now. They have been sporadically reported from the restricted regions of Southeast Asia (*e.g.*, Timor and Thailand). In Thailand, Reed (1920), Ingavat-Helmcke, (1994) and Ishibashi *et al.* (1997) have only reported the occurrence of Carboniferous ammonoids including questionable species, but none of them have been described. The Indonesian Timor is the only known occurrence of Carboniferous ammonoids in Southeast Asia (Haniel, 1915). On the other hand, the Permian ammonoids have been reported from

several districts of Thailand (Pitakpaivan *et al.*, 1969; Glenister *et al.*, 1990; Ishibashi and Chonglakmani, 1990; Ishibashi *et al.*, 1994, 1996, 1997) (Fig. 2). These ammonoids coexist occasionally with fusulinids, smaller foraminifers, bryozoans, and brachiopods.

The ammonoid fossils are very useful to correlate one region with others, and to determine the geological age of carbonate and non-calcareous sediments. Therefore the paleontological study of Paleozoic ammonoids is very important. The purpose of this paper is to report some new Carboniferous cephalopods and to construct the biostratigraphy of Carboniferous and Permian on the basis of ammonoid fossils.

OUTLINE OF GEOLOGY IN LOEI AREA

The Paleozoic deposits are distributed in several districts of Thailand, except the western part, named as the Khorat Plateau (Fig. 2). The Carboniferous and Permian systems are classified in some stratigraphic belts (Kobayashi, 1964; Bunopas, 1994) and are distributed along these belts from north to south in Loei area.

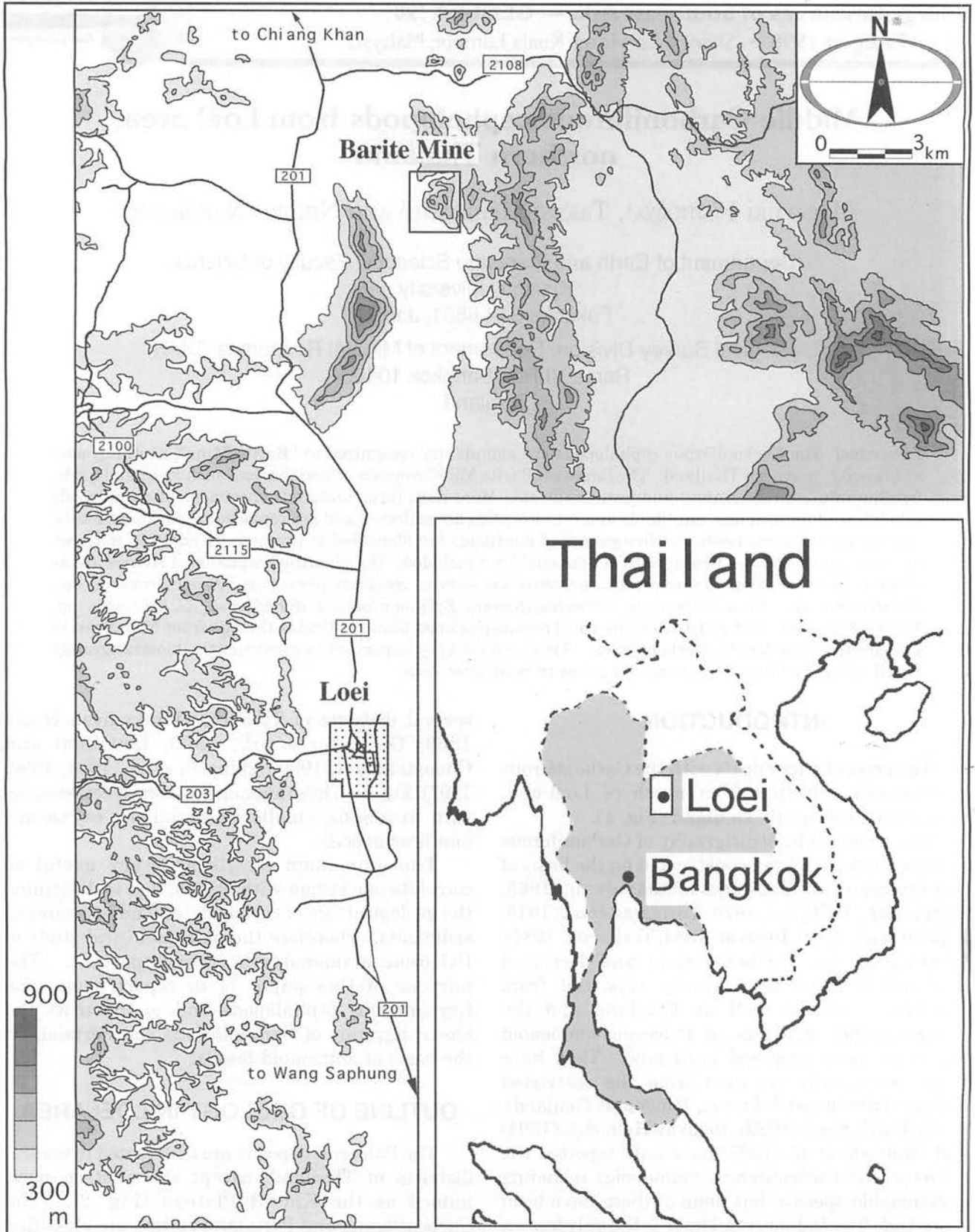


Figure 1. Index map showing the surveyed region in North Thailand.

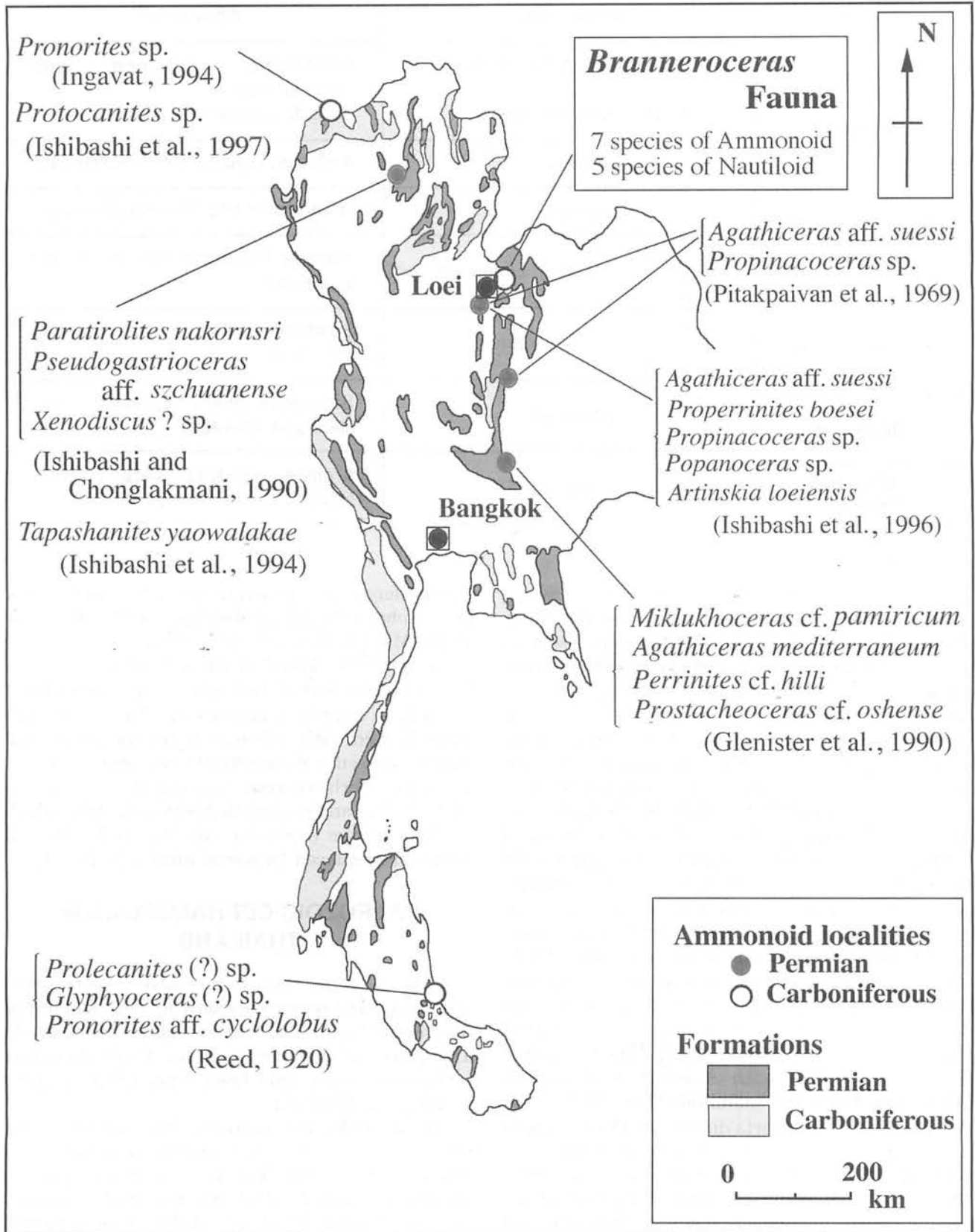


Figure 2. Carboniferous and Permian ammonoid localities in Thailand.

Table 1. Paleozoic stratigraphy of northeastern Thailand of Jacobson *et al.* (1969) with some modification.

| Age | Rock Unit | | Character |
|--------------------|-----------------------|-------------------|--|
| Triassic | Phu Khadung Formation | | Sandstone, siltstone and conglomerate (including basal conglomerate) |
| | Nam Phong Formation | | |
| | unnamed | | Andesite, rhyolite, tuff, agglomerate |
| | unnamed | | Granodiorite and other intrusive rocks |
| Permian | Kanchanaburi Series | Ratburi Limestone | Massive limestone with shale and sandstone |
| Carboniferous | | unnamed | Sandstone, siltstone, shale, tuff and limestone |
| Devonian | unnamed | | Sandstone, quartzite, phyllitic shale, slate and limestone |
| Silurian and older | unnamed | | Argillite, quartzite, slate, phyllite, schist |

A great deal of effort has been made on paleontological study in Loei area by many paleontologists. Paleontological studies in Loei area are as follows; Igo (1972) reported the Carboniferous fusulinaceans collected from the Wang Saphung-Loei area of Thailand for the first time. Igo *et al.* (1993) and Toriyama (1982) have also reported the occurrence of the Permian fusulinacean fossils. Kobayashi and Sakagami (1989a) reported Silurian trilobite associated with corals, brachiopods, etc. from Ban Nang near Loei. They also described Carboniferous trilobites from Loei-Ban Sup area in the same year (Kobayashi and Sakagami, 1989b). Not only trilobites but also many kinds of fossils such as brachiopods, bryozoans, corals, ammonoids, gastropods, etc. were found in this area. The Middle Carboniferous brachiopods were described from Ban Sup (Yanagida, 1974). The Permian trilobites were described at Tham Nam Maholam, Loei district (Kobayashi and Hamada, 1979; Kobayashi and Sakagami, 1989c) with Asselian brachiopods (Yanagida, 1967) and fusulinids (Igo, 1972).

There are few reports discussing the geology of Loei area until now. The authors mentioned many previous studies, as mentioned above, however, there were no description about geological setting around Loei at all. Jacobson *et al.* (1969) proposed the geological data in northern part of Loei-city, and prepared the geological map and the stratigraphic chart (Table 1) around Loei-city. The paleontological evidences indicate an early

Carboniferous age for strata in the hills just east of Loei [Kobayashi (Ed.), 1964] and the Devonian age at the Mekong River (Saurin, 1963).

The "Barite Mine" is situated at the top of a hill, northern part of Loei-city. The lower part of the hill is mainly composed of shale, tuff beds subordinated with dolomite of the Devonian and with the presence of some brachiopods and trilobites. The lower Carboniferous cephalopods occur in the barite bodies and residue deposits in fissures which weathered from limestone and impure barite. All fossils are replaced by barite minerals (BaSO_4).

PALEOZOIC CEPHALOPODS IN THAILAND

The Paleozoic cephalopods have been reported from restricted regions not only in Thailand but in Southeast Asia. The Carboniferous cephalopods are particularly few. The Carboniferous cephalopods have only been reported from three localities in Thailand.

Reed (1920) has reported *Prolecanites*(?) sp., *Glyphoceras*(?) sp. and *Pronorites* aff. *cyclolobus* (Phillips) from Hat Yai area, southern part of Thailand. Ingavat (1994) has reported *Pronorites* sp. and Ishibashi *et al.* (1997) has reported *Protocanites* sp. from Ban Mae Lana near Mae Hong Song, northwest Thailand. Ishibashi *et al.* (1997) have reported four species of ammonoids as follows; *Branneroceras* sp., *Syngastrioceras* sp.,

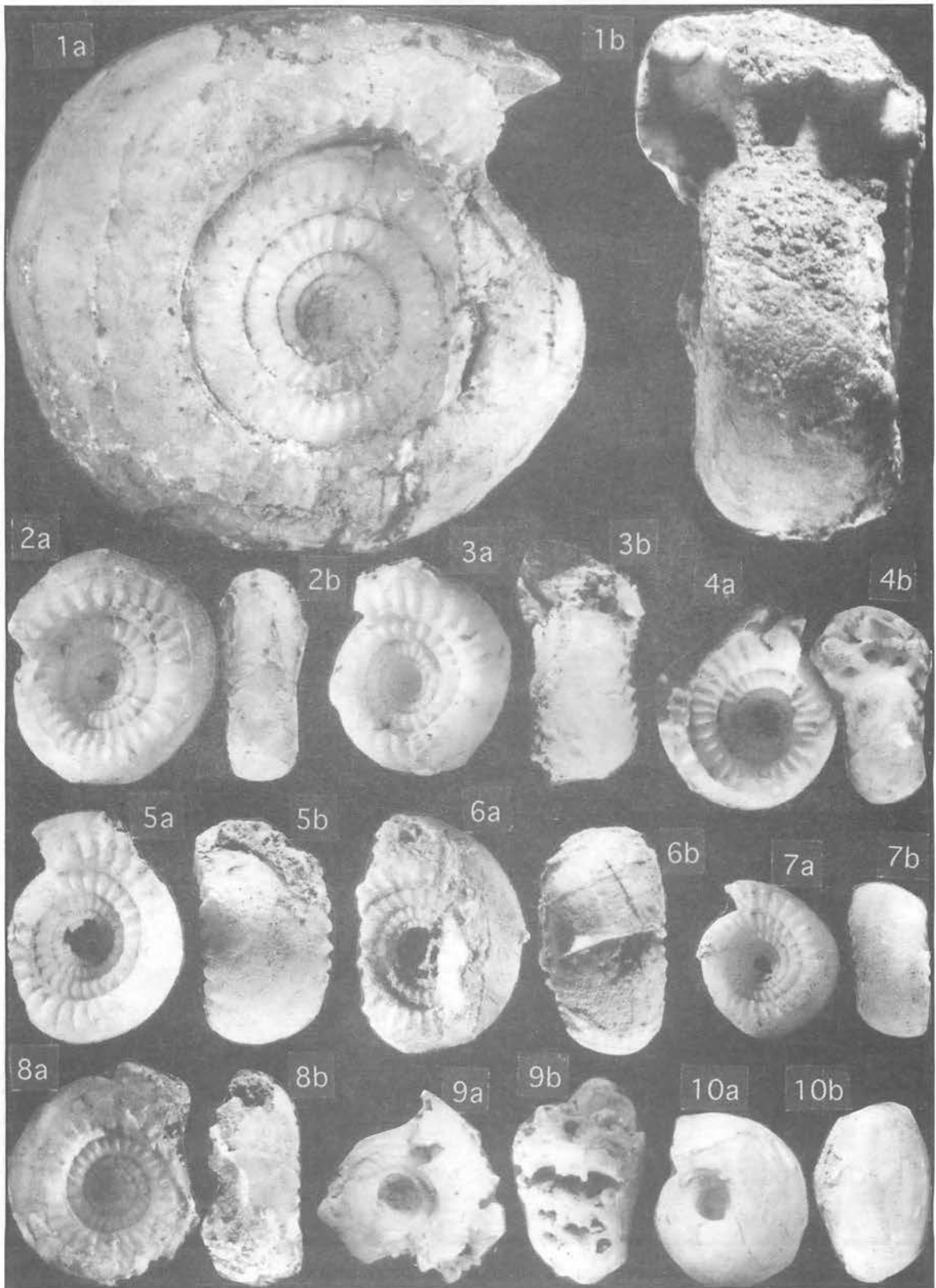


Plate 1. 1. *Diaboloceras involutum* Nassichuk (a: lateral view, b: ventral view) x 1.0
 2-8. *Branneroceras branneri* (Smith) (a: lateral view, b: ventral view) x 1.0
 9 & 10. *Syngastrioceras* sp. (a: lateral view, b: ventral view) x 1.0

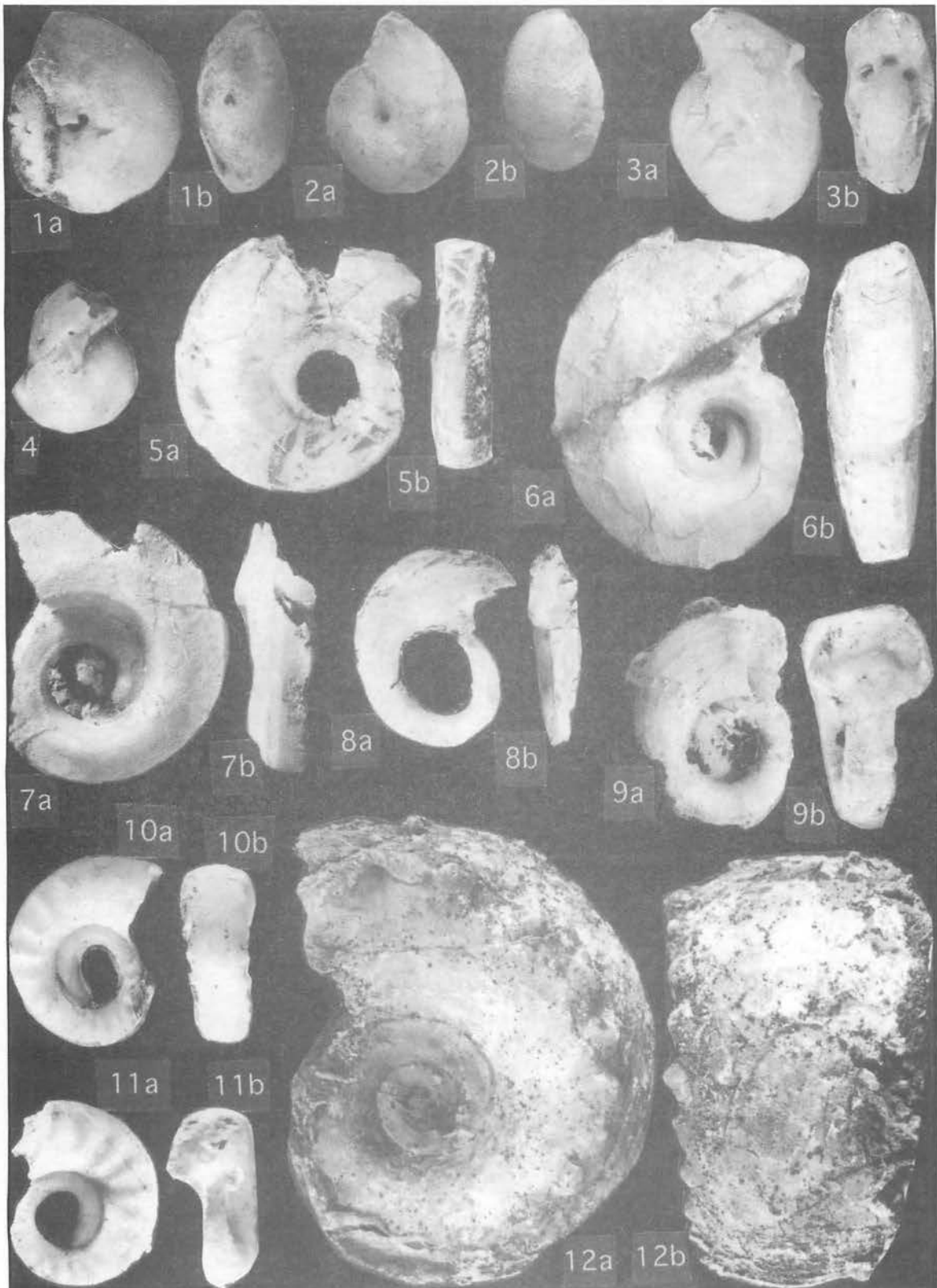


Plate 2. 1 & 2. *Neogastrioceras* sp. (a: lateral view, b: ventral view) x 1.5
 3 & 4. *Bisatoceras* sp. (a: lateral view, b: ventral view) x 2.0
 5 & 6. *Epidomatoceras doohylense* (Foord) (a: lateral view, b: ventral view) x 1.0
 7 & 8. *Catastroboceras subsulcatifomae* Shimansky (a: lateral view, b: ventral view) x 1.0
 9. *Epistroboceras* sp. (a: lateral view, b: ventral view) x 1.5
 10 & 11. *Gzheloceras* sp. (a: lateral view, b: ventral view) x 1.0
 12. *Temnocheilus* sp. (a: lateral view, b: ventral view) x 0.75

Table 2. Correlation chart of ammonoid and fusulinid zones in Thailand.

| Period | Stage (Leven 1992, Ingavat 1984) | Ammonoid Zone | | Fusulinid Zone (Ingavat et al. 1980, Ingavat 1984) | |
|---------------|--|---------------|--------------------------|--|---|
| | | N. America | Thailand (This study) | | |
| Permian | Late | Drashamian | <i>Xenodiscoceae</i> | <i>Paratiroilites- Tapashamites</i> <i>Palaeofusulina Colaniella Reichelina Lepidolina Yabeina Neoschwagerina Cancellina Misellina Chaiaroschwagerina Robustoschwagerina Paraschwagerina Pseudoschwagerina</i> <i>Codonofustella</i> | |
| | | Dzhulfian | <i>Cyclolobus</i> | | |
| | | Midian | | | |
| | Middle | Murgabian | <i>Timorites</i> | | |
| | | Kubergandian | <i>Waagenoceras</i> | | |
| | | Bolorian | <i>Glassoceras</i> | | |
| | Early | Yahtashian | <i>Perrinites</i> | | <i>Perrinites- Agathiceras</i> <i>Properrinites- Artinskia</i> <i>Popanoceras</i> |
| | | Sakmarian | <i>Properrinites</i> | | |
| | | Asselian | | | |
| | | | | | |
| Carboniferous | Late | Gzhelian | <i>Parashumardites</i> | <i>Parafusulina</i> <i>Pseudofusulina</i> <i>Fusulina-Fusulinella</i> <i>Profusulinella</i> <i>Millerella-Eostaffella</i> | |
| | | Kasimovian | <i>Boesites</i> | | |
| | | | <i>Paralegoceras</i> | | |
| | | Moscovian | <i>Winslowoceras</i> | | |
| | | | <i>Diaboloceras</i> | | |
| | | Bashkirian | <i>Axinolobus</i> | | |
| | Early | Namurian | <i>Branneroceras</i> | <i>Branneroceras fauna</i> <i>Pronorites- Protocanites</i> | |
| | | | <i>Bilinguides</i> | | |
| | | Viséan | <i>Beyrichoceras</i> | | |
| | | | <i>Ammonellipsites</i> | | |
| | | Tournaisian | <i>Winchelloceras</i> | | |
| | | | <i>Muensteroceras</i> | | |

 Unknown

Neogastrioceras sp., and *Bisatoceras* sp. from “Barite Mine”, northern Thailand.

The authors have reviewed these fossils and we have arrived at the conclusion that the cephalopod fossils from “Barite Mine” are identified as five genera of ammonoids and five genera of nautiloids. The names of cephalopods identified are as follows; ammonoids are: *Branneroceras branneri*, *Diaboloceras involutum*, *Syngastrioceras* sp. (Plate 1), *Neogastrioceras* sp. (Plate 2), and *Bisatoceras* sp. nautiloids are: *Catastroboceras subsulcatifomae*,

Epidomatoceras doohylense, *Gzheloceras* sp., *Temnocheilus* sp., and *Epistroboceras* sp. These cephalopod fauna indicates from Namurian to Moscovian of the Middle Carboniferous. These are known from Namurian of the Lower Carboniferous of North America, Russia, China, Australia, Europe and Japan (Table 2). All nautiloids and two of the ammonoids (*Branneroceras branneri*, *Diaboloceras involutum*) are reported from Southeast Asia for the first time. It may be worth pointing out, in passing, that this cephalopod fauna include one

new genus and new species of gastrioceratid and one new species which may belong to the genus *Diaboloceras*. These Carboniferous cephalopods are very precious because of their good preservation.

The reports of the Permian cephalopods in Thailand are slightly more than those of the Carboniferous, from five localities: Pitakpaivan *et al.* (1969) and Ishibashi *et al.* (1996) from Loei area, Ishibashi and Chonglakmani (1990) and Ishibashi *et al.* (1994) from Lampang area, Glenister *et al.* (1990) from Nakhon Ratchasima area (Fig. 2).

The occurrences of these cephalopod fossils follow that it may be possible to discuss about Paleozoic biostratigraphy and to establish the correlation chart on the basis of ammonoid fossils in Thailand. This paper proposes the correlation chart of Paleozoic ammonoid zones in Thailand based upon the ammonoid fossils reported until now (Table 2). The authors are collecting more specimens of Paleozoic cephalopods in some places such as Lampang area, Ban Mae Lana area, etc. The more detailed ammonoid zonation will be proposed in the future.

CONCLUDING REMARKS

Five genera of ammonoids and five genera of nautiloids are identified. These cephalopod fauna indicates from Namurian to Moscovian of the Middle Carboniferous. One new genus and new species of gastrioceratid and new species of *Diaboloceras* are included.

The ammonoid biostratigraphy of Carboniferous and Permian is tentatively proposed (Table 2). The Upper Carboniferous and Middle Permian ammonoids are lacking in the present data. Formations of these ages are widely distribute at North and South Thailand, and the authors can get more new data of these formations. It is very important to identify all faunas and to make detailed biostratigraphic column of Southeast Asia to correlate with other regions of the world.

This fauna can propose not only the Paleozoic ammonoid zone in Thailand but also the reports of one new genus and one new species ammonoid, respectively.

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