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THE MARINE MESOZOIC STRATIGRAPHY OF THAILAND

Chongpan Chonglakmani
Geological Survey Division,
Department of Mineral Resources,
Bangkok 10400, Thailand

ABSTRACT. The marine Mesozoic sediments are distributed extensively in Thailand. They consist of Triassic and Jurassic strata the latter of which is relatively more limited in distribution. The Triassic sequence has been recorded from Northern, Northwestern, Westcentral, Southeastern and Southern Thailand. Biostratigraphic subdivision based upon bivalves and ammonoids in the Lampang area proves the existence of Upper Griesbachian, Lower and Upper Anisian, Upper Ladinian, Lower-Upper Karnian, and Lower Norian sediments in Northern Thailand. The Jurassic sequence is only known in Northwestern, Westcentral and Southern regions. The ammonites and foraminiferas recorded from this sequence suggest that the marine sedimentation was almost complete from Lower to Upper Jurassic.

INTRODUCTION

The Mesozoic sediments are rather widespread in Thailand and may be roughly separated into northeastern continental (Khorat Group) and western marine facies. The marine facies consists of Triassic and Jurassic sediments and contains, in some places, rather rich faunas that prove the existence of almost complete succession from Lower Triassic up to Upper Jurassic. The marine Jurassic sediments, however, are more limited in distribution comparing to the Triassic. No marine sediments younger than the Upper Jurassic have been recorded so far. Correlation of the Triassic and Jurassic formations in various regions of Thailand is presented in Table 1.

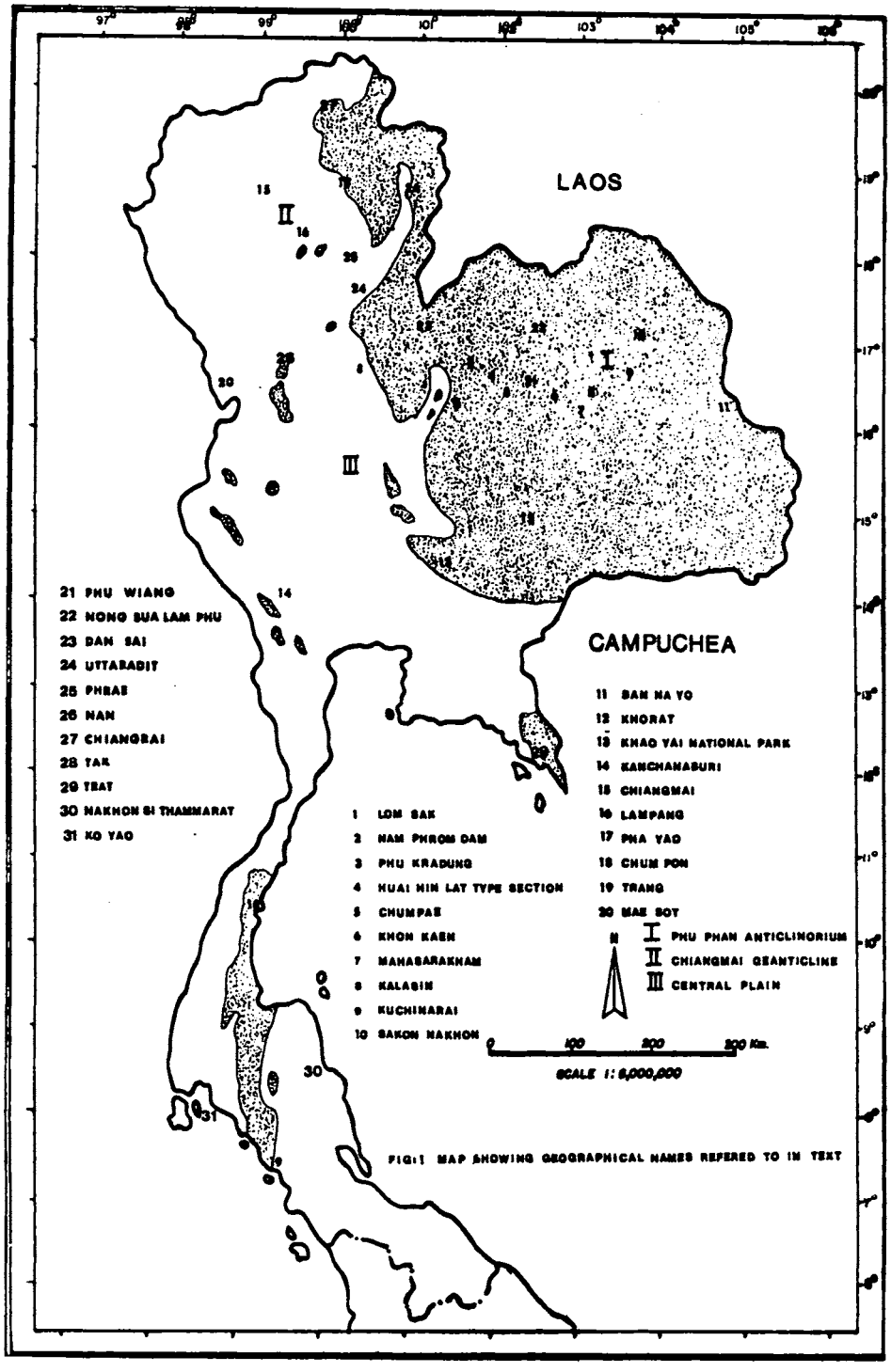
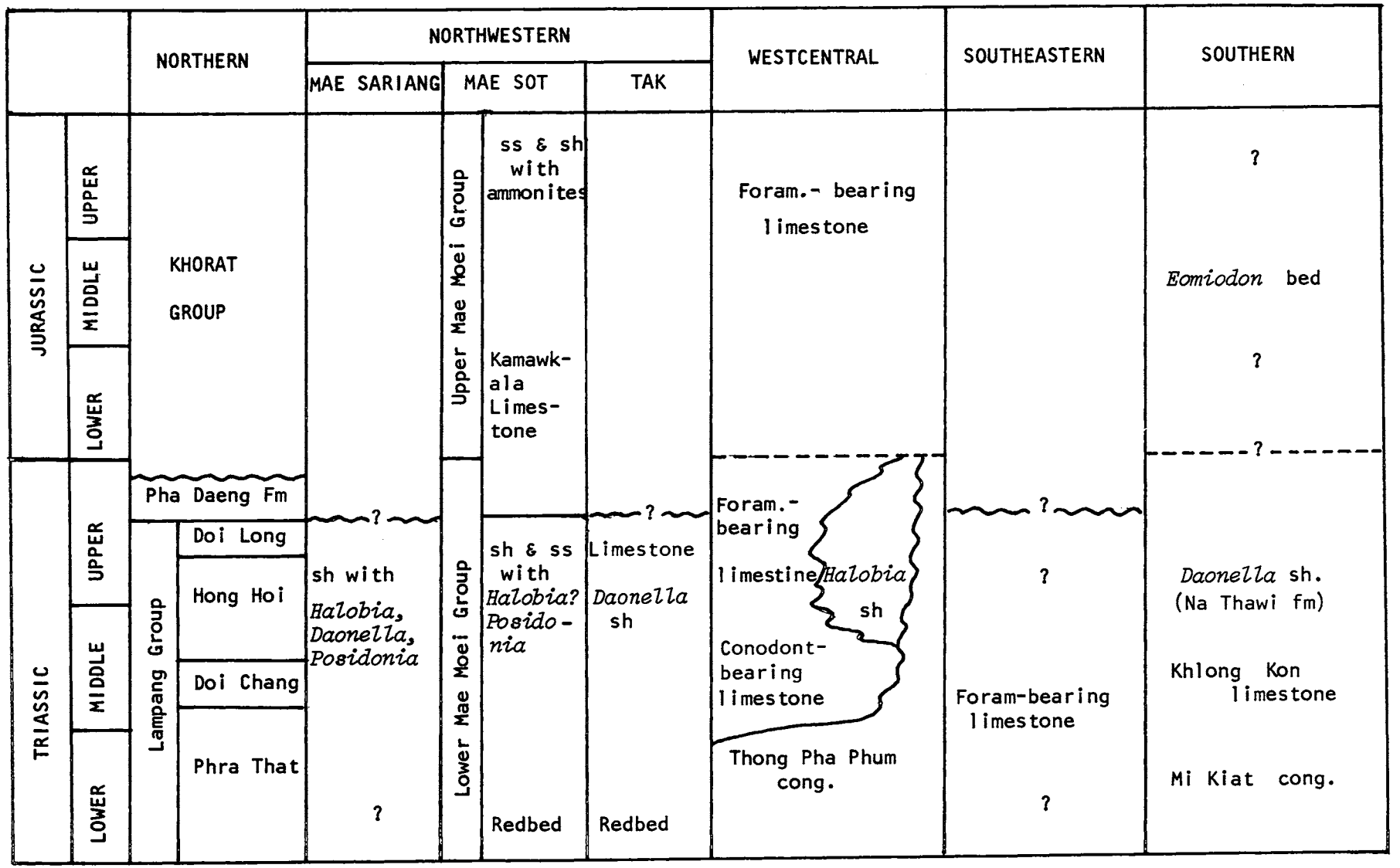


FIG:1 MAP SHOWING GEOGRAPHICAL NAMES REFERED TO IN TEXT

Table 1 Correlation of marine Mesozoic formations in Thailand



THE MARINE TRIASSIC

Marine Triassic strata in Thailand are rather widely distributed and contain a large and diversified fauna. Early identifications of marine Triassic strata were based on the few scattered faunas collected during reconnaissance geological surveys in Northern Thailand by Högbom (1914), Lee (1923), and Heim and Hirschi (1939). Gregory (1930), Weir (1930), Trauth (1930), and Pia (1930) were the first to describe the Triassic fossils found in the Kamawkala Limestone exposed along the Thai-Burmese border in Northwestern Thailand. These fossils include Upper Triassic (possibly Norian) algae, corals, brachiopods, bivalves and ammonoids.

As a result of the reconnaissance geologic investigation of the mineral deposits of Thailand conducted jointly by geologists of the United States Geological Survey and the Thai Department of Mineral Resources (formerly known as Royal Department of Mines), the first geological map of Thailand was published (Brown and others, 1951) on a scale of 1:2,500,000, with a description of the general stratigraphy. However, the marine Triassic strata including the Kamawkala Limestone were at that time included in the "Khorat series", now the Khorat Group (Ward & Bunnag, 1964), consisting mainly of continental red clastic sediments of Mesozoic age. These marine Triassic strata were subsequently separated as a distinct stratigraphic unit in the revised geological map of Thailand on a scale of 1:1,000,000 (Javanaphet, 1969).

A number of well-preserved Triassic ammonoids were discovered by members of the Geological Survey during investigation in the Mae Mo area and as a result Pitakpaivan (1955) conducted a detalied survey of the fossiliferous strata to collect more material. He recorded the Triassic sequence and proposed several informal rock units as a result of this study. The ammonoids were subsequently described by Kummel (1960) who concluded on an age-range of Anisian to Karnian for this sequence. Apart from these, Kobayashi and Tokuyama (1959) recorded a few halobiids from Northern and Southern Thailand, but no detailed stratigraphy of the fossil-bearing strata was given. Late Middle to Upper Triassic corals (*Thecosmilia, Margarosmilia, Montlivaltia, Conophyllia* and others) were also reported from a limestone lens at Pha Khan, Northern Thailand by Buravas (1961).

Pitakpaivan and others (1969) in their compilation work on fossils of Thailand added the description of some Triassic corals and an indeterminate *Posidonia* from northwestern and northern parts of the country.

In 1964, a regional geologic mapping project to produce geological maps on a scale of 1:250,000 was started in Northern Thailand. The distribution of Triassic strata was mapped and a considerable number of macrofossils collected (Piyasin, 1972 & 1975; Bunopas, 1976). Many

new Triassic stratigraphic units were also proposed (Piyasin, 1971). Concurrently, joint geological investigation with the German Geological Mission was carried out in the northern and northwestern parts, with more Triassic strata and fauna, including microfossils (conodonts and foraminiferas), being recorded (Baum and others, 1970; Koch, 1973, von Braun & Jordan, 1976; Hagen & Kemper, 1976; Kemper, Maronde, and Stoppel, 1976). In conjunction with this mapping project, a detailed study of the Triassic stratigraphy of the Lampang Basin was conducted (Chonglakmani,1972).

Reviews of the knowledge of the Triassic stratigraphy and fauna of Thailand have been compiled by Piyasin (1973), Tamura and others (1975), Ridd (1978), Junhavat and Piyasin (1978) and Hahn (1982).

Northern Region

General The marine Triassic succession in Northern Thailand east of Chiang Mai consists of more than 3,000 m of gray to greenish gray shales, sandstones, limestones, and conglomerates, for which the term Lampang Group was named by Piyasin (1971). This sequence conformably or disconformably overlies the Permo-Triassic volcanic formation, Permian or older (Carb.-Sil.) strata, and underlies the Pha Daeng Formation (Redbed facies)disconformably.

The Lampang Group is well exposed in Changwat Chiang Rai, Nan, Lampang, Phrae, and Sukhothai. Strata in Changwat Phetchabun attributed to the Lampang Group in the Geological Map of Thailand, scale 1:1,000,000 (Javanaphet, 1969) are now placed in the Huai Hin Lat Formation, Khorat Group (Chonglakmani and Sattayarak, 1980)

Lithostratigraphy of the Lampang Group. The revised classification of the Lampang Group in ascending order is as follows : Phra That, Doi Chang, Hong Hoi, and Doi Long Formations.

Phra That Foramtion

The Phra That Formation was named by Piyasin (1971) to include the basal clastic sediments that lie between the volcanic formation or the Permian strata and the Doi Chang Formation. The type locality is at Phra That Muang Kham, 11 km southeast of Changwat Lampang. An additional reference section was subsequently designated along the Ngao-Song Highway (M. Liengsakul, unpublished data; Piyasin, 1980).

The formation is from 100 to 840 m thick and consists of sandstones, siltstones, conglomerates, breccias, and limestones. These rocks are generally coarse grained and red in color at the base, and gradually become finer grained and green to grey in color upwards. They are believed to have been deposited in near-shore and partly continental environments. The formation commonly overlies the Permo-Triassic volcanic rocks or Permian strata with disconformity and conformably underlies the Doi Chang Formation. It contains bivalves, ammonoids, and brachiopods which indicate an age-range from Lower Triassic (Upper Griesbachian) to Middle Karnian.

Doi Chang Formation

The Doi Chang Formation was named by Pitakpaivan (1955) for a limestone in the Mae Mo area which he believed to overlie the Hong Hoi Formation. However, it is now known to underlie the Hong Hoi Formation. Piyasin (1971 & 1972) introduced the name Pha Kan for the same unit at Ban Tha Si and employed the name Doi Chang for this upper limestone unit. Chonglakmani (1981) redefined the Doi Chang Formation as a unit lying between the Phra That Formation (below) and the Hong Hoi Formation. It consists predominantly of grey limestones with minor grey to green shales and sandstones. The Pha Kan Formation (Piyasin, 1972; Chonglakmani, 1972) is therefore a synonym of the Doi Chang Formation. Units referred to Doi Chang shale and sandstone, Limestone conglomerate, Fossiliferous limestone, Calcareous sandstone and oolite and Pha Kap limestone (Pitakpaivan, 1955) are all included in this formation.

The type locality is at Doi Chang, Tam Bon Mae Mo, Changwat Lampang. The formation is 80 to 500 m thick and conformbly underlies the Hong Hoi Formation. It contains a characteristic fauna of ammonoids, bivalves, and brachiopods which show an age-range from Upper Anisian to Upper Karnian.

Hong Hoi Formation

The Hong Hoi Formation was proposed by Pitakpaivan (1955) for a sequence of greenish grey shales and sandstone characterized by *Joannites*. The name is derived from Huai Hong Hoi, a small stream east of Ban Dong, which also serves as the type locality.

Pitakpaivan (1955) thought that the formation was the basal unit of the Triassic sequence which was overlain by the Doi Chang limestone. However, Chonglakmani (1981) has demonstrated that the Hong Hoi Formation has a younger fauna than the Doi Chang Formation in all sections where both occur and therefore must overlie the Doi Chang Formation. It underlies the Doi Long Formation conformably.

The Hong Hoi Formation consists of a flysch sequence with predominantly grey to greenish grey shales, sandstones, siltstones, and conglomerates, and minor interbedded argillaceous limestones, These lithologies are commonly thinly bedded to 10-40 cm, occasionally reaching 2-3 m. in thickness. The formation is the most widespread unit and occurs in almost all Triassic exposures in the Lampang Basin. A thickness of 100 m for a portion of the formation was recorded at the type locality (Pitakpaivan, 1955). At Ban Tha Si, a complete section of 1,900 m was measured containing numerous marine bivalves and ammonoids (Chonglakmani, 1972). This formation based on the macrofauna ranges in age from Scythian (Upper Griesbachian) to Lower Norian.

Doi Long Formation

The Doi Long Formation was proposed by Piyasin (1971) for the upper limestone unit which lies between the Pha Daeng Formation (above) and the Hong Hoi Formation (below). Its type locality is at Doi Huai Long, east of Ban Tha Si.

Piyasin's (1972) correlation of this unit with the Doi Chang limestone was erroneous and is here discontinued.

The Doi Long Formation is 230 m thick and consists of grey to light grey finely crystalline limestones. It is predominantly massive, but gradually becomes well-bedded near the base and the top. The lower boundary of the formation is transitional and is drawn at the base of the lowest limestone bed which is about 10 cm thick and overlies predominantly grey shales and sandstones of the Hong Hoi Formation. The upper boundary, apparently a disconformity, is located at the top of grey limestones below a 35 cm thick limestone conglomerate at the base of the Pha Daeng Formation.

The Doi Long Formation has a limited geographic distribution. It is exposed only around the flanks of the Doi Pha Daeng syncline in Ban Tha Si area covering Doi Huai Long and the eastern foot of Doi Pha Khong and Doi Pha Mong.

The unit contains an indeterminate fauna of bivalves, serpulid worms, brachiopods, and gastropods (Piyasin, 1972; Chonglakmani, 1972). However, the formation is considered to be Middle Karnian on stratigraphic grounds.

Biostratigraphy of the Lampang Group. Although the Lampang Group possesses a diverse bivalve fauna and a few brachiopods, ammonoids are generally uncommon. The only ammonoids that have zonal importance are from Anisian and Lower Karnian strata. Most bivalves have a rather more extended vertical range than that of the ammonoids and are not suitable for refined zoning. The genera *Claraia*, *Posidonia*, *Daonella* and *Halobia* however, have restricted vertical ranges and wide geographic distribution and form definite faunal zones. These bivalves are employed for subdivision of the scythian, Ladinian, Middle-Upper Karnian, and Lower Norian stages where diagnostic ammonoids are rare or absent (Chonglakmani, 1981).

The biostratigraphic subdivision of the marine Triassic sequence is presented in Table 2 representing an age-range from Lower Triassic (Upper Griesbachian) to Upper Triassic (Lower Norian). It consists of *Claraia* - *Ophiceras* (Upper Griesbachian), *Costatoria* and *Hollandites* - *Leiophyllites* (Lower Anisian), *Hollandites* - *Balatonites* (Upper Anisian), *Daonella* (Ladinian), *Halobia* (Karnian - Lower Norian), and *Indopecten* (Lower norian) faunas respectively in ascending order. The component taxa of these assemblages are presented in Table 3-8.

Table 2 Biostratigraphic and ecologic classification of the Triassic System in Northern Thailand

<table>
<tr><td rowspan="2"></td><td colspan="3">SHALLOW WATER FACIES</td><td rowspan="2">DEEP WATER FACIES
(Halobia-Daonella facies)</td></tr>
<tr><td>Near-shore neritic
(Benthic bivalve facies)</td><td colspan="2">Off-shore neritic
(Cephalopod facies)</td></tr>
<tr><td rowspan="2">Norian</td><td></td><td colspan="2" rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Indopecten beds</td></tr>
<tr><td rowspan="5">Karnian</td><td rowspan="4">Trigonodus beds</td><td rowspan="4">NGAO - SONG</td><td>H. distincta beds</td><td rowspan="4">LONG - THUNG LAENG</td></tr>
<tr><td>H. parallela beds</td></tr>
<tr><td>H. charlyana beds</td></tr>
<tr><td>H. styriaca beds</td></tr>
<tr><td rowspan="3">Ladinian</td><td rowspan="3"></td><td colspan="2" rowspan="3"></td><td>Paratrachyceras beds</td></tr>
<tr><td>Daonella indica beds</td></tr>
<tr><td rowspan="3"></td></tr>
<tr><td rowspan="2">Anisian</td><td></td><td colspan="2">Hollandites-Balatonites beds</td></tr>
<tr><td>Costatoria beds</td><td colspan="2">Hollandites-Leiophyllites beds</td></tr>
<tr><td rowspan="2">Scythian</td><td rowspan="2"></td><td colspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="2">Claraia-Ophiceras beds</td></tr>
</table>

Table 3 Component taxa of the *Claraia - Ophiceras* zone (Lower Triassic)

Ophiceras (Lytophiceras) cf. *chamunda* Diener
O. (Discophiceras) sp. nov. cf. *subkyokticum* Spath
Claraia cf. *ovata* (Schauroth)
C. stachei (Bittner)
C. cf. *stachei* (Bittner)
C. intermedia (Bittner)
C. radialis (Leonardi)
C. chakkapasi sp. nov.
C. concentrica Yabe
C. cf. *zhenanica* Chen & Liu
C. aff. *punjabiensis* (Wittenburg)
Unionites fassaensis (Wissmann)
U. sp. indet.

Table 4 Fauna of the *Costatoria*, *Hollandites - Leiophyllites*, and *Hollandites - Balatonites* zones (Lower - Upper Anisian)

Costatoria zone	*Hollandites-Leiophyllites* zone	*Hollandites-Balatonites* zone
Nuculana (Nuculana) cf. *sulcellata* Munster	*Hollandites* cf.*roxburghii* Diener	*Beyrichites* cf. *srikanta* (Diener)
Mytilus aff. *eduliformis praecursor* Frech	*Leiophyllites* cf. *pitamaha* (Diener)	*Hollandites* cf. *ravana* (Diener)
Pteria cf.*ussurica yabei* Nakazawa	*Beyrichites* ? sp.	*H.*cf. *roxburghii* (Diener)
Pteria sp. indet.	*Posidonia* cf. *pannonica* (Mojs.)	*H.*cf. *visvakarma* (Diener)
Pteria cf. *tofanae* (Bittner)	*P.* spp. A & B	*Balatonites* aff. *balatonicum* (Mojs)
Bakevellia cf. *exporrecta* (Lepsius)	*Mysidioptera* aff. *fassaensis* (salomon)	*Ptychites* cf. *rectangulatus* Kraus
Hoernesia pitakpaivani sp. nov.	*Siamopecten veeraburusi* gen & sp.nov.	*Sturia* sp. indet
Hoernesia trilobata sp. nov.	*Plagiostoma* aff. *subpunctata* d'Orb.	*Tropigymnites* cf. *chandra* (Diener)
Septihoernesia maethaensis sp. nov.		*Spiriferina* sp.
Entolium (Entolium) subdemissum(Munster)		*Athyris* cf. *stoliczkai* Bittner
Eopecten sp. nov.		*Mentzelia mentzeli* Dunker
Mysidioptera cf. *punctata* Chen & Liu		*Lingula* cf. *tenuissima* Bronn.
Mysidioptera cf. *cainelli* (Stoppani)		
Plagiostoma aff. *subpunctata* d'Orb.		
Trigonodus tonkinensis (Mansuy)		
Unionites subgriesbachi sp. nov.		
Costatoria goldfussi mansuyi (Hsu)		
Costatoria maethaensis sp. nov.		
*Neoschizodus (Eoschizodus)*sp. nov.		
Elegantinia elegan (Dunker)		

Table 5 Fauna of the *Daonella (Daonella) indica* zone (Ladinian)

Daonella (Daonella) indica Bittner
D. (D.) cf. *bulogensis* Kittl
D. (D.) sudasnai sp. nov.
Posidonia kedahensis Kobayashi

Table 6 Constituent taxa of the *Paratrachyceras* zone (Lower Karnian)

Posidonia wengensis (Wissmann)
P. cf. *cycloidalis* Kittl
P. lampangensis sp. nov.
P. maehuatensis sp. nov.
P. quadratovalis sp. nov.
P. panglaensis sp. nov.
P. cf. *gemmellaroi* (Lorenzo)
P. thailandica sp. nov.
Daonella (Daonella) Piyasini sp. nov.
D. (Retidaonella) lampangensis sp. nov.
D. (R.) cf. *malayensis* (Newton)
D. (R.) chaehomensis sp. nov.
Halobia cf. *subcomata* Kittl
Pachycardia rugosa Hauer
Trigonodus thailandica sp. nov.
Trachyceras cf. *aon* (Munster)
Sirenites (Sirenites) senticosus (Dittmar)
Protrachyceras cf. *longobardicum* (Mojs.)
Paratrachyceras cf. *regoledanum* (Mojs.)
P. sp. nov.
Clionites aff. *barwicki* Johnsion
Buchites sp. indet.
Lobites cf. *ellipticus* (Hauer)
Joannites maehuatensis sp. nov.
J. nonghoiensis sp. nov.
Sturia sp. indet.
Cladisciter cf. *beyrichi* Welter

Table 7 Fauna of the *Halobia stysiaca*, *H.charlyana*, *H.parallella*, and *H.distincta* zones. (Lower Karnian - Lower Norian)

Halobia stysiaca zone	*Halobia charlyana* zone	*Halaobia parallela* zone	*Halobia distincta* zone
Halobia styriaca Mojs. *H. cassiana* Mojs. *H. comata* Bittner *Daonella (Retidaonella) sumatrensis* Volz *D. (R.) multilineata* (Jones) *Cassianella tenuistria* Munster *C.* cf. *beyrichi* Bittner *Paleocardita singulasis* (Healey) *Schafhaeutlia* cf. *rostratus* (Munster) *Anatomites* aff. *rotundus* (Mojs.) *A.* sp. indet *Griesbachites* sp. indet.	*Halobia charlyana* Mojs. *H. talauna* Wanner *H. moluccana* Wanner *H. vangchinensis* sp. nov. *H. austriaca* Mojs. *H. deningeri* Krumb. *H. comata* Bittner *H. phraeensis* sp. nov. *Daonella (Daonella) phraeensis* sp.nov. *Juvavites* cf. *idenburgi* Welter *Anatomites* sp.	*Halobia parallela* Kob. *H.*cf. *yunnanensis* Reed *H.*cf. *pluriradiata* Reed *H.*cf. *cassiana* Mojs. *H. comata* Bittner *Modiolus* cf. *vozini* Tikhomi *Unionites* cf.*subgriesbachi* sp. nov. *Palaeocardita singularis* (Healey) *Spiriferina* sp. *Sakawairhynchia* sp. indet.	*Palaeoneilo* cf. *subtenella* Krumbeck *P.*cf. *whitchurchii* Healey *Bakevellia* sp. nov. *Halobia* cf. *simaimaiensis* Kob.& Mas. *H. suborbicularis* sp. nov. *H. saiamensis* sp. nov. *H. comata* Bittner *H. fallax* Mojs. *H.*aff. *superba* Mojs. *Unionites* cf. *subgriesbachi* sp.nov. *U.*cf. *muensteri* (Wissmann) *Palaeocardita singularis* Healey

Table 8 Fauna of the *Indopecten* zone (Lower Norian)

Indopecten seinaamensis (Krumb.)
Schafhaeutlia maemokensis sp. nov.
Palaeocardita trapezoidalis (Krumb.)

Northwestern Regions

The marine Triassic sediments crop out extensively in Northwestern Thailand covering Mae Sariang, Mae Sot, and Tak areas. They consist of gray shales, sandstones, conglomerates, chert, and limestones, and was named the Lower Mae Moei Group by von Braun and Jordan (1976). These strata overlie Permian or older rocks conformably or with a local disconformity.

Mae Sot area. The marine Triassic sediments have long been known to occur along the Thai-Burmese border. Cotter (1924) proposed the Kamawkala Limestone for these calcareous sediments which consist mainly of gray recrystalline limestone and dolomite, with minor interbedded shales and sandstones locally in the lower part. This unit was formerly included in the Mesozoic Khorat Group (Brown and others, 1951).

Von Braun and Jordan (1976) recently studied the Mae Sot area. At Kamawkala gorge, a section more than 900 m thick of greenish-gray shales and sandstones forms the lowest unit of the sequence. It contains *Halobia* sp., *Posidonia* sp., and ammonite. Conformably overlying this clastic unit is the Kamawkala Limestone in which the lower part (= Loc. K 21/417, K21/415, Gregory, 1930; Pia, 1930; Weir, 1930; Trauth, 1930) contains the Norian fauna listed in Table 9. The Kamawkala fauna differs from Lower Norian assemblages of the Lampang Group and appears to represent a younger horizon of Middle or Upper Norian age.

The upper part of the Kamawkala Limestone and the overlying gray to greenish-gray shales and sandy shales yield Lower to Upper Jurassic ammonites.

Table 9 Fauna from the Kamawkala Limestone on the Burmese-Thai border

Locality	K21/415	K21/416	K21/417
Algae:			
Holosporella siamensis Pia	x		
Sphaerocodium sp.	x		
Coelenterata:			
Stylina sp.	x		
Stylophyllopsis thaungyinensis Gregory	x		
Centrastraea cotteri Gregory	X		
Meandraraea orientale Gregory	x		
Thecosmilia sp.	x		
Isastraea (Latimaeandra) norica var. *minor* French	x		
Phyllocoenia cf. *incrassata* French	x		
Brachiopoda:			
Rhynchonella bambangensis Bittner	?	x	
R. cf. *fissicostata* Suess		x	
R. cf. *corcordioe* Bittner		x	
Bivalvia:			
Pecten sp.	x		
Ostrea sp.	x		
Chlamys aff. *valoniensis* Defrance	x		
Ammonoidea:			
Choristoceras ammonitiforme Gümbel			x
Trachyceras sp.			x

Mae Sariang area The area is located at about 130 km southwest of Changwat Chiang Mai. Gray shales bearing *Halabid comata* and *Posidonia* sp. have long been known approximately 20 km to the north of Amphoe Mae Sariang (Pitakpaivan and others, 1969, p. 29). Baum and others (1970) reported the sequence of shales, sandstones and conglomerates with intercalated chert and limestones in the middle part yielding *Daonella cf. sumatrensis* Volz., *D.* aff. *lommelli* (Wissman), and *Halobia styriaca* Mojs. The first and third of these, with *H. comata* have been collected at approximately the same horizon south of Amphoe Mae Sariang. These beds are thus readily correlated with the *H. styriaca* zone of the Lampang area.

Tak area. Marine Triassic strata have recently been recorded by Bunopas (1976) about 15 km west of Changwat Tak. They occur in a narrow belt of the Lansang fault zone trending northwest-southeast and about 3 km wide and 20 km long. These strata are 350-500 m thick and unconformably overlie the Permian limestones, shales, or sandstones. They consist of shales sandstones, conglomerates, chert, and limestones and contain *Daonella sumatrensis* Volz, *Halobia comata* Bettner, *H.* sp. A and *H.*sp.B (juvenile). However, on re-examination of this collection by the writer (Chonglakmani, 1981), only *Daonella sumatrensis* Volz can be recognized, suggesting a Middle Karnian age.

Westcentral Region

Marine Triassic sediments are exposed at Si Sawat and Thong Pha Phum approximately 100 and 140 kms respectively northwest of Changwat Kanchanaburi (Koch, 1973; Hagen and Kemper, 1976; Kemper, Maronde, and stoppel, 1976). They are mainly calcareous sediments lithologically inseparable from the well-known Permo-Carboniferous limestone of the Ratburi Group.

The Triassic section is 200-300 m thick and contains Anisian and Norian microfaunas. The following Lower Anisian conodonts occur at Huai Chong Krong, 6 km west of Si Sawat containing (Kemper, Maronde, & Stoppel, 1976) :

Cypridodella mediocris (Tatge)
C. mulleri (Tatge)
Enantiognathus cf. *incurvus* Kozur
E. petrae-viridis (Huckriede)
Gladiogondolella tethydis (Huckriede)
Gondollella cf. *constricta* (Mosher & Clark)
Hindeodella (Metaprioniodus) pectiniformis (Tatge)
H. (M.) multihamata (Huckriede)
Neogondolella mombergensis (Tatge)

A second Lower Anisian conodont fauna occurs in dark limestone (Kemper, Maronde & Stoppel, 1976) :

Neogondolella mombergensis (Tatge)
Neospathodus aegaeus (Bender)
N. timorensis (Nogami)

Conodonts, foraminifera, and calcareous algae occur in gray limestone from a higher horizon and are of Norian age containing (Kemper, Maronde & Stoppel, 1976) :

Epigondolella abneptis (Huckriede)
Involutina communis (Kristan)
I. tenuis (Kristan)
I.impressa (Kristan-tollman)
I.sinuosa (Weinschenk)
Boueina cf.*hochstetteri* Toula

Overlying the Norian limestone is a sequence of reddish shale and sandstone with limestone intercalations. It is unfossiliferous and tentatively assigned to the Uppermost Norian (= Rhaetian of former usage - Tozer, 1974) to Early Jurassic.

In the Kwae Yai south of Sri Sawat, *Halobia* and/or *Daonella* is reported to occur in gray to greenish shales and sandstones with interbedded limestones. It represents the lateral clastic facies of the Triassic section of the Ratburi Group, but its extent is presently unknown.

Southeastern Region

In southeastern Thailand, a sequence of rocks consisting of mudstones, siltstones and sandstones of presumed Triassic age has been recorded (Hughes and Bateson, 1967; Ridd, 1978). No definite marine Triassic fossils have been found so far in these clastic sediments. However, Fontaine and Vachard (1981) recently confirmed the presence of scytho - Anisian foraminifera in a limestone unit near Amphoe Klang, Changwat Rayong.

Southern Region

Marine Triassic sediments have long been known to occur near Songkhla yielding *Daonella sumatrenis* Volz. (Kobayashi & Tokuyama, 1959; Pitakpaivan and others, 1969). However, no detailed investigation or mapping has been conducted in this area. Recently, Grant-Mackie and others (1980) studied some of the strata in Amphoe Na Thawi and Amphoe Saba Yoi and introduced an informal lithostratigraphic scheme for different presumably Triassic units which appear to overlie Permian or older rocks, but with unobserved contact.

At Amphoe Saba Yoi, Grant-Mackie and others (1980) distinguished four lithostratigraphic units in descending order as follows :

4. *Sani formation,* c. 4,300 m thick, siltstone, siliceous or non - siliceous fine sandstone, black chert, and fine to medium conglomerate.
3. *Khlong Kon limestone,* up to 600 m thick, light to medium gray fine-grained massive limestone.
2. *Chedi conglomerate,* c. 250 m thick, massive quartzose conglomerate, with some medium sand lenses.

1. *Suan Cham formation,* c. 1,700 m of interbedded siltstone and graded sandstone.

No macrofossil was found in this sequence but Grant-Mackie and others (1980) correlated the Khlong Kon limestone on lithologic grounds with the "Pha Kan" Formation (= Doi Chang Formation) of the Lampang Basin.

At Amphoe Na Thawi, along Highway 42, they also established another Triassic sequence as follow in descending order :

_____ ? fault _____

4. *Lam Long sandstone,*c.3,700 m thick, thin bedded fine sandstone.
3. *Wang Yai siltstone,* c. 3 m thick, blue-gray laminated sandy siltstone.
2. *Na Thawi formation,* c. 3,000 m thick, interbedded siltstone and siliceous sandstone with *Daonella* at one locality.

_____ ? fault _____

1. *Mi Kiat conglomerate,* c. 500 m, quartzite conglomerate.

The Saba Yoi and Na Thawi sequences are dominated by similar lithologies of comparable rank, so they are both regarded as of Triassic age; in addition, Grant-Mackie and others (1980) correlate the Na Thawi formation with the Semanggol Formation of northwestern Malaysia. The characteristic *Daonella* occurring in the Na Thawi formation indicates a Middle Karnian age.

THE MARINE JURASSIC

The marine Jurassic strata have been identified in 3 areas, Mae Sot in the Northwest, Si Sawat in the Westcentral and Chumphon in the South. Only the sequences in the former two regions have been studied in some detail. The boundary between the Triassic and Jurassic, in most cases, has been put arbitrarily, as the marine facies extends through the presumed Triassic-Jurassic contact without significant lithological break. Review of the marine Jurassic formations and faunas in Thailand has been done by Sato (1975).

Mae Sot Area

In Thailand, the occurrence of marine Jurassic strata was first recorded by Brown and others (1951) in the Mae Sot area, where Middle Jurassic ammonites *Erycites* sp., *Ludwigia* sp., and *Tmetoceras* sp. were found. Komalarjun and Sato (1964) studied in more detail the stratigraphy of the region and distinguished two calcareous beds (Ban Yang Puteh bed and Ban Huai Hin Fon bed) yielding Aalenian ammonites *(Tmetoceras regleyi*

Table 10 Jurassic ammonites and foraminiferas recorded from Northwestern and Northcentral Thailand

		Ammonites	Foraminiferas
JURASSIC	UPPER	*Epimayaites* cf. *falcoides* Spath *E.*sp. *Phylloceras* sp. *Glochiceras* ? sp.	*Kurnubia wellingsi* (Henson) *K.* cf. *jurassica* (Hensen) *Lenticulina* sp. *Höglundina* sp.
	MIDDLE	*Eudmetoceras (Planammatoceras)* sp. *Ludwigia* sp. *Graphoceras concavum* (Sowerby) *G.*sp. *Erycites* cf. *fallifax* Arkell *Tmetoceras dhanarajatai* Sato *T.* cf. *dhanarajatai* Sato *T. regleyi* Dumortier *Sonninia* ? sp. *Docidoceras (Docidoceras) longalvum* (Vacek)	*Lucasella kaempferi* Kemper *Mesendothyra croatica* Gusic *Haurania* sp., *H. pusilla* Kemper *Textularia* sp. *Haplophragmium* sp. *Trochammina* sp.
	LOWER	*Pseudolioceras* sp. *Lytoceras (Alocolytoceras) ophioneum* cf. *toarcense* Geezy *Onychoceras* sp. *Haugia* ? sp.	*Orbitopsella dubari* Hottinger *O.primaeva* (Henson) *Vidalina martana* Farinacci *Lituosepta* cf. *recoasensis* Cati *Mesendothyra croatica* Gusic *Haurania amiji* Henson *H.deserta* Henson, *H.thailandensis* Kemper *H. pusilla* Kemper

Dumortier, *T.dhanarajatai* Sato, *Graphoceras concavum* (Sowerby) and *Erycites* sp.) and bivalve (*Posidonia* sp. ex gr. *ornati* Quenstedt). Subsequently other ammonite genera have been reported, including the Early Jurassic *Pseudolioceras, Lytoceras, Onychoceras,* and *Haugia?;* the Middle Jurassic *Eudmetoceras* and *Docidoceras;* and the Late Jurassic *Epimayaites.*

Marine Jurassic strata in the Mae Sot area represent the upper part of the Mae Moei Group (von Braun and Jordan, 1976) which consists of Lower Jurassic shaly and marly rocks followed by more differentiated sandy-shaly and calcareous Middle Jurassic strata. The top portion of the Group is composed of Upper Jurassic sandstone and shale deposited closed to shore. The total thickness of the Jurassic sequence was recorded as more than 1,450 m. The Group is overlain with disconformity by clastic redbeds probably of Cretaceous age and comparable with parts of the Khorat Group of Northeastern Thailand or with the Kalaw redbeds of Burma.

Kanchanaburi Area

The marine Jurassic sediments, with the total thickness of 200-300 m in the Kanchanaburi Area, consist of light-colored limestone, predominantly oncoid-micrite which contains a rich foraminiferal fauna (Hagen and Kemper 1976; Kemper, Maronde, and Stoppel, 1976; Kemper, 1976).

At the end of the Triassic or beginning of the Jurassic, non-marine influence on sedimentation is indicated by the red-coloured clastic-limy sequence in the Si Sawat area. The up to 200 m thick red conglomerate near Thong Pha Phum (Hagen and Kemper, 1976) suggests an uplifted area from which at least Permian rocks were eroded. The Jurassic sediments and their contained faunas indicate sedimentation in a shallow sea although a locally present conglomerate documents the erosion of Permian limestone.

The foraminiferas recorded from this calcareous sequence indicate the deposition from Lower up to Upper Jurassic. The Middle Lias has been identified on the basis of *Orbitopsella* sp., Middle Jurassic *Lucasella* sp., and Upper Jurassic *Kurnubia* sp. Especially rich is the *Lucasella* association and particularly species-rich is the genus *Haurania* which ranged from the Middle Lias well up into the Middle Jurassic. The identified taxa is presented in Table 10.

Chumphon Area

Hayami (1960) recorded the occurrence of marine Jurassic sediments at the mouth of the Chumphon River, Southern Thailand. These sediments, which are suspected to be intercalated within the Khorat Group, consist of argillaceous sandstone bearing *Eomiodon chumphonensis* Hayami. Recent geological mapping conducted by the Department of Mineral Resources reveals the presence of similar facies containing Jurassic ammonites and bivalves in shaly lithology at Khao Lak, about 80 kms north of the Chumphon locality (A.Meesuk, unpublished data). These strata, unconformably underlying the redbeds of the Khorat Group, are approximately 100 m thick, and consist of interbedded sandstone and shale, with cherty limestone near the base.

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