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Triassic carbonate rocks in the Phatthalung area, Peninsular Thailand

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Abstract—Carbonate rocks in the Phatthalung area and others in Peninsular Thailand have been known as the Permian Rat Buri Limestone. The study area is characterized by several isolated limestone mountains and is located in Phatthalung province. Micropaleontological study of these carbonate rocks indicates that they should be assigned a late Early to Late Triassic age. The Chaiburi Formation is newly proposed and divided into three members: the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone in ascending order. The Phukhaothong Dolomite consists of thickly bedded to massive dolomite and yields *Neospathodus kummeli* Sweet, *N. waageni* Sweet, N. cfr. *waageni* Sweet and other conodonts that indicate Dienerian to Smithian (Early Triassic). The Chiak Limestone Member consists of bedded and laminated limestone with intercalated thin chert layers and nodules. This limestone commonly yields Early Triassic to Middle Triassic conodonts such as *Neospathodus timorensis* (Nogami) and *Neospathodus kockeli* (Tatge), both reliable indicators of latest Spathian to early Anisian, and rare occurrences of *Neogondolella bulgarica* (Budurov and Stefanov), an indicator of the middle Anisian. The Phanomwang Limestone Member is mostly massive limestone with intercalated reef limestone (coral buildups) and yields abundant fossils that indicate Carnian (Late Triassic). Microfacies analysis and stratigraphic sequences of carbonate rocks in this area show the gradual change of depositional environment from low to high energy conditions.

Introduction

The Phatthalung area is located in the southeastern part of Peninsular Thailand (Fig. 1) and geologically belongs to Shan-Thai (Bunopas, 1981; Bunopas and Vella, 1983; Mitchell, 1992) or Sibumasu (Metcalfe, 1988, 1989) cratons. In the study area, there are several isolated limestone mountains in the Quaternary plain. All the limestones were formerly included in the Permian Rat Buri Limestone (Yaemniyom, 1977; Vimuktanandana, 1984), which is widely distributed throughout Thailand as long, narrow and isolated belts of mountain chains. Its thickness is about 1000 m in the peninsula and 3000–4000 m in the north (Brown *et al.*, 1951; Ridd and Wainwright, 1969).

Triassic rocks in Thailand are distributed in five regions (Bunopas, 1976; Chonglakmani, 1983): north, northwest, northeast, west and Peninsular Thailand. However, Triassic strata in Peninsular Thailand are poorly known. The Na Thawi Formation at Na Thawi, Songkhla province (Grant-Mackie *et al.*, 1980) is one of the representatives that yields *Daonella* from siltstones (Kobayashi and Tokuyama, 1959; Grant-Mackie *et al.*, 1980). The Khlong Kon limestone is also one of the lithostratigraphic units at Amphoe Sabi Yoi, Songkhla province, that was introduced for marine Triassic sediments (Grant-Mackie *et al.*, 1980). The Phatthalung Group (Ridd and Wainwright, 1969) exposed in the east of Phatthalung consists of the Mesozoic sandstone and conglomerate. Recently, Igo *et al.* (1988) and Sashida and Igo (1992) discovered Triassic conodonts and radiolarians from limestones at Khao Chiak, Phatthalung, also previously considered a part of the Permian Rat Buri Limestone. An ichthyosaur in a dolomite near Amphoe Khuan Khanun, 14 km north of Phatthalung has been considered probably Early Triassic in age (Fontaine *et al.*, 1993). In the Phangnga area, Peninsular Thailand, *Daonella* has been found northwest of Khao Thao and in the nearby locality Permian fossils have also been found (Fontaine and Tantiwanit, 1992). Formerly, both of those localities were included in the Permian Rat Buri Limestone. These discoveries inspire reexamination of the age of carbonate rocks in the Phatthalung area. The geological setting of the Permian Rat Buri Limestone and Triassic limestone suggests that the Permo-Triassic boundary can be settled in the Phatthalung area.

Lithostratigraphical and micropaleontological studies of this area indicate that the carbonate formation is Early to Late Triassic in age. The Chaiburi Formation is newly proposed and subdivided into the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone Members in ascending order.

Methodology

This study has included three parts: field work, laboratory work and interpretation. In field work, about 140 carbonate rock samples were taken from six stratigraphic sections of carbonate mountains around Phatthalung City, namely: Khao Phanomwang (Sections A and B), Khao Chiak (Section C), Khao Thong (Section D), Khao Thammalai (Sections E and F), Khao Tubun, and Khao Chaiburi (Fig. 1).

Laboratory work involved microfacies analysis of carbonate rocks and micropaleontological study of conodonts and other microfossils. Dunham's (1962) classification of limestone was used for identifying microfacies of carbonate rocks. The microfacies analysis method (Wilson, 1975; Flügel, 1978) was applied to reconstruct the depositional environment. Staining using Alizarin Red S and potassium ferricyanide (Adams, 1984) distinguished calcite from dolomite and ferroan from non-ferroan minerals. Twenty-four samples were treated with 15% acetic acid for conodont and other microfossil extraction.

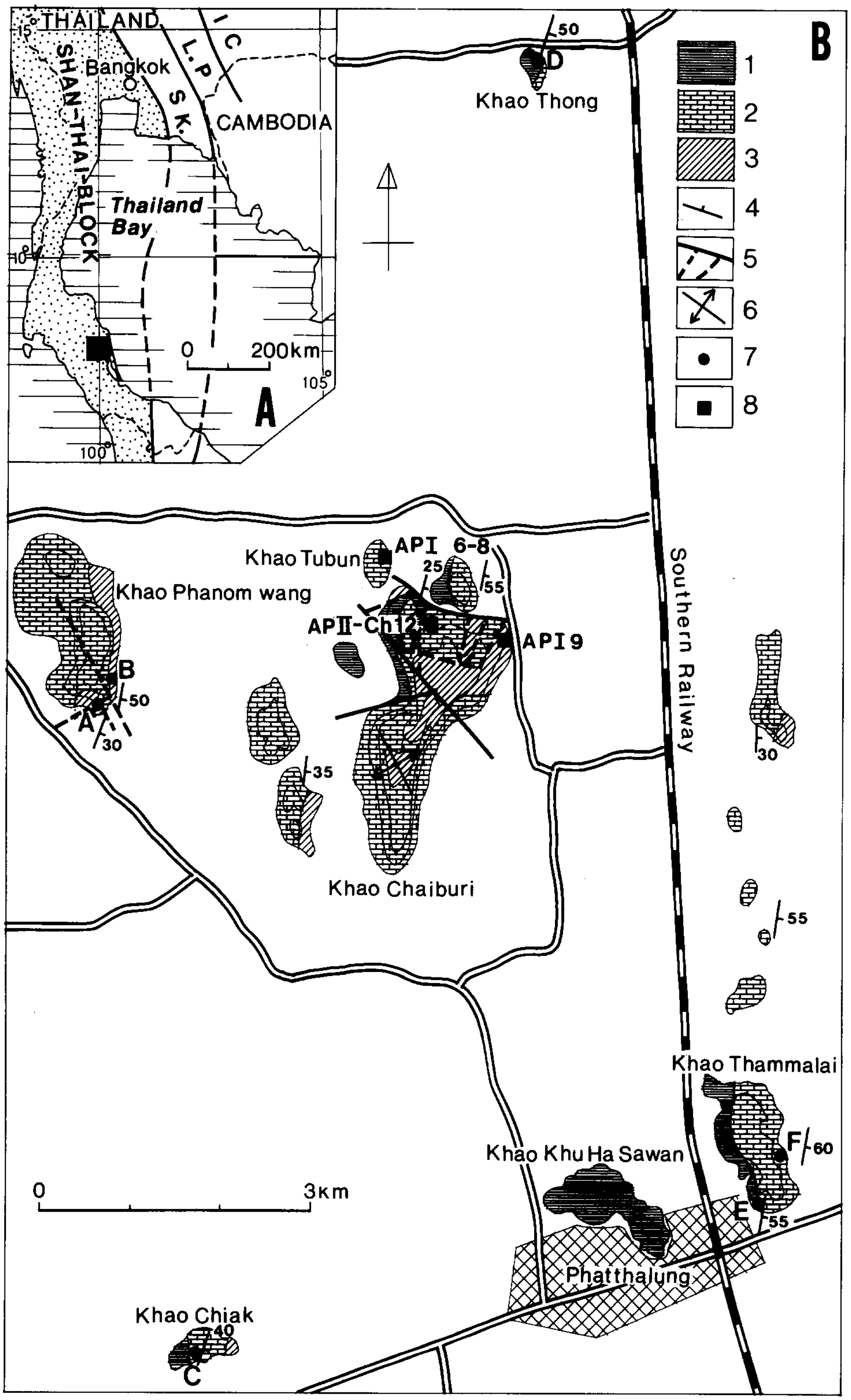

Fig. 1. Simplified geologic map of the Chaiburi Formation in the Phatthalung area, Peninsular Thailand. (1) Phukhaothong Dolomite Member, (2) Chiak Limestone Member, (3) Phanomwang Limestone Member, (4) strikes and dips, (5) faults, (6) anticline, (7) stratigraphic sections A–F, (8) additional carbonate samples.

The results of microfacies analysis of each section were interpreted and correlated to the lithostratigraphic sections using the age indications of conodonts and other paleontological evidence.

Measured Sections

The Phatthalung area is located at approximate latitude 7° 7′N and longitude 100° 10′E. There exist several isolated limestone mountains in the Quaternary plain. I measured a total of six sections, A–F, and supplementarily collected two point samples from Khao Tubun and Khao Chaiburi (Fig. 1). "Khao" means mountain in Thai.

Section A is located at the south quarries of Khao Phanomwang, about 9 km northwest of Phatthalung City. Its total thickness is about 90 m. Sixteen samples (API 84–99) were collected from very thick-bedded to massive limestone with abundant fossils. Limestone at these outcrops commonly trends N20°E and dips 30°E.

Section B is located at a southeast quarry of Khao Phanomwang and is about 60 m thick. Twenty-four samples (API 100–123) were taken from the lower part, bedded limestone with chert nodules, and the upper massive limestone. The general trend of these limestones is N10°E, and dips are 50°E.

Section C is located at a quarry on the south flank of Khao Chiak, about 6 km west of Phatthalung City. I collected a total of 47 rock samples (API 11–57) from this section, which in its lower part is composed mainly of dolomite. The middle part is bedded limestone with chert nodules and layers, and the upper part is massive limestone with abundant fossils. The total thickness of this section is about 530 m. The general trend of strata is N5°E, and dips are 40°E.

Section D is located in the monastery area of Wat Phukhaothong, northeast of Khao Thong, Amphoe Khuan Khanun, about 14 km north of Phatthalung. This section is about 65 m thick and the general trend of the carbonate rocks is N20°E, with dips of 50°E. Twenty-two samples (API 124–145) were collected from light grey dolomite with intercalated nodular layers and thin cherts. An ichthyosaur, probably indicating Early Triassic has been found in a dolomite of the lower part of this section (Nikorn Nakornsri verbal communication, 1991; Fontaine *et al.*, 1993).

Section E is located in the monastery (Sal Chaomaeruedee) area on the southwest side of Khao Thammalai, about 1 km northeast of Phatthalung City. Twelve samples (API 72–83) were collected from dolomite in the lower part and bedded limestone in the upper. The total thickness is about 60 m and these strata show a general trend of N10°W and dips of 55°E.

Section F is located in a quarry, on the east flank of Khao Thammalai. Fourteen samples (API 58–71) were collected from 40 m of bedded limestone with chert nodules. The strata in this outcrop strike N10°W and dip 60°E.

Additional carbonate samples were collected from Khao Chaiburi and Khao Tubun (Fig. 1). Khao Chaiburi is located at about 7 km northwest of Phatthalung City. These carbonate rocks were previously studied by Udomratn and Dhramadusdee (1979). They subdivided them into three parts, dolomite, bedded limestone and massive limestone, in ascending order. In this study, two samples from the massive limestone (API 9), and bedded limestone (APII–Ch12), which trend N20°E and dip 25°E, were taken from Khao Chaiburi. Khao Tubun is located about 500 m northwest of Khao Chaiburi. Three samples (API 6–8) were taken from bedded limestone. The general trend of this strata is N40°E, and dips are 45°E. This bedded limestone is correlated with that of Khao Chaiburi.

Stratigraphy of the Chaiburi Formation

The Chaiburi Formation is named after the largest carbonate mountain in the Phatthalung area, and is subdivided into the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone Members, in ascending order. Each member is characterized by its microfacies. The Chaiburi Formation includes five microfacies (Fig. 2). The microfacies of carbonate rocks in

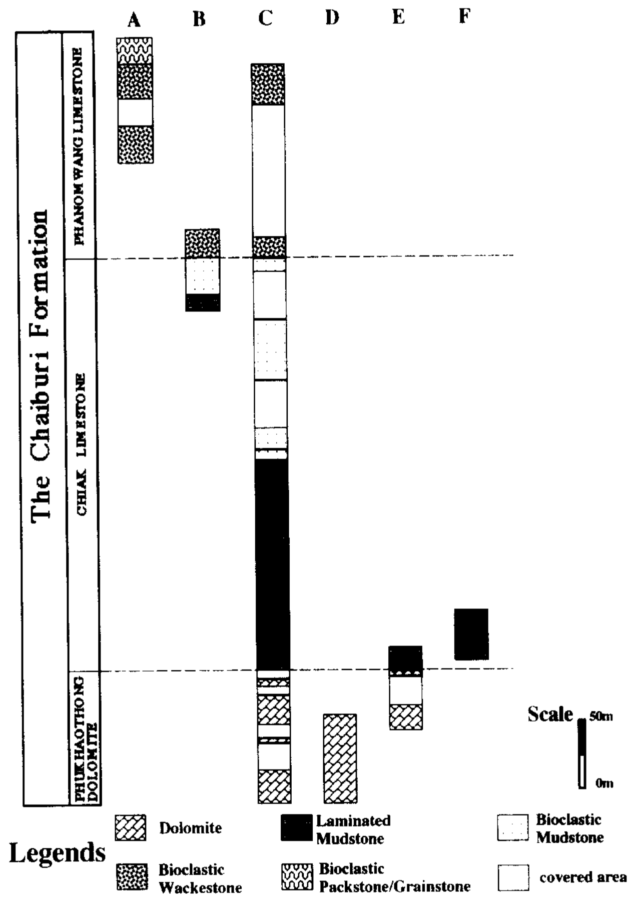

Fig. 2. The Chaiburi Formation includes five microfacies in each section.

the studied area gradually changes from dolomite, laminated mudstone, bioclastic mudstone, bioclastic wackestone and bioclastic packstone/grainstone in ascending order. The microfacies and the age identifications of conodonts of each section in the studied area can be correlated. Conodonts indicate Early Triassic for the Phukhaothong Dolomite and late Early to Middle Triassic for the Chiak Limestone. Schleractinian corals, foraminifers, and some mollusks collected from the Phanomwang Limestone, a fossil horizon near the top of the Chaiburi Formation, indicate a Carnian age (early Late Triassic). Its total thickness is at least 400–500 m. The studied sections and localities are correlated with the ages as indicated in Fig. 3.

Phukhaothong Dolomite Member

The Phukhaothong Dolomite Member consists of bedded to massive, light grey dolomites with some chert nodules. Their original sedimentary fabric was mostly obliterated by secondary dolomitization (Fig. 4a). There are some bioclast ghost textures, lamination fabric, zoned crystals and some parts are filled with calcite cement. This unit occupies the lower part of Sections C and E and the whole of Section D. Its type section is Section D located in the Wat Phukhaothong area and its thickness is 66 m. I obtained such conodonts as *Neospathodus kummeli* Sweet (Fig. 5:3,7,9) and *Neospathodus waageni* Sweet (Fig. 5:2,5,6) from sample nos API 142 and 129 (Fig. 6); they indicate a Dienerian to Smithian (late Early Triassic) age.

The lithostratigraphy in each section of the Phukhaothong Dolomite Member is shown in Fig. 6. In

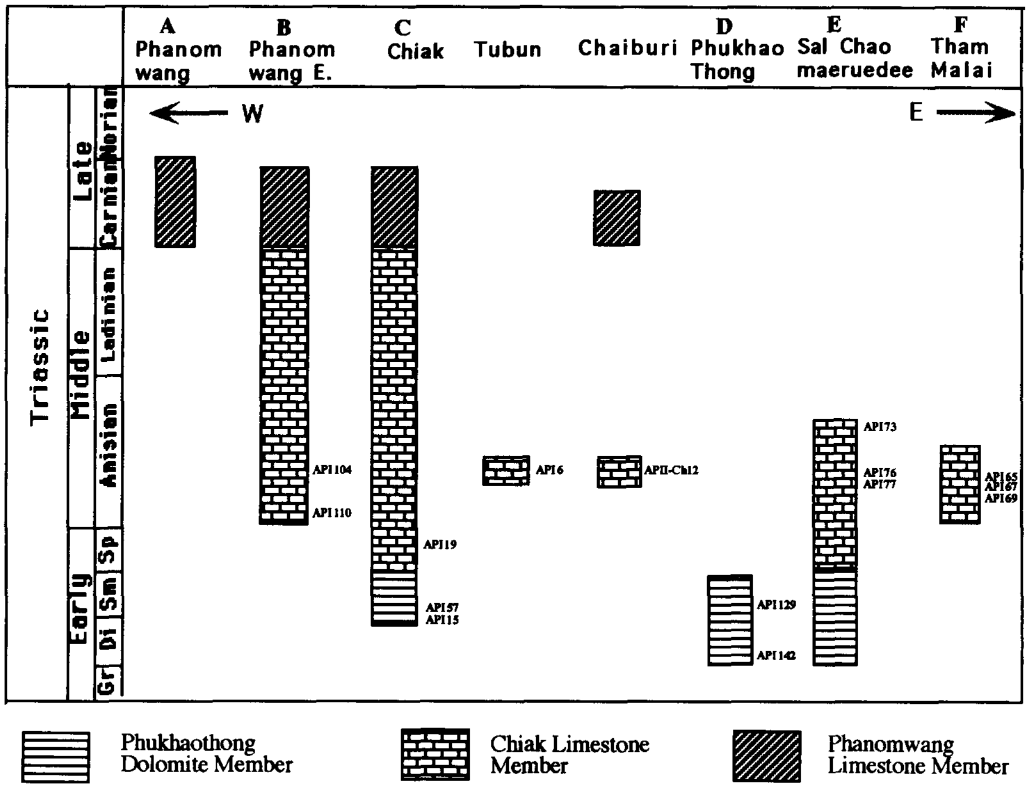

Fig. 3. The lithology and age correlation of each section (A–F) and other samples in the study area (not to scale). The numbers show the conodonts samples that indicated the ages.

Section C, only the lower part is completely replaced by dolomite and it gradually changes into bedded limestone towards the top. Dolomite samples in Section C, sample nos API 15 and 57 (Fig. 6) also yield *Neospathodus kummeli* Sweet (Fig. 5:10) and *Neospathodus* cfr. *waageni* Sweet (Fig. 5:1). In Section E, dolomite in the lower part is correlated with that of Sections C and D by its lithology and the stratigraphic relationship of Anisian conodont-bearing bedded limestone in the upper part (API 73, 76, 77). Lithology of Section E gradually changes from dolomite to bedded limestone. In the lower part of Section E, the original sediment was completely replaced by dolomite but the replacement decreased upward. It can be observed at the boundary between the Phukhaothong Dolomite Member and the Chiak Limestone Member in Section E that some parts of the original sediments were replaced by dolomite.

Chiak Limestone Member

The Chiak Limestone Member conformably overlies the Phukhaothong Dolomite Member. This member is observed in Sections B, C, E and F (Fig. 7). The type section is the middle part of Section C measured along the southern part of Khao Chiak. The thickness of this member in its type section is about 300 m. It is composed of grey to dark grey, thinly to thickly bedded limestone; the thickness of each bed ranges from 1 to 90 cm. Some beds are laminated and many chert layers, nodules and lenses are intercalated. This unit also contains some fossils such as radiolarians, ostracods, gastropods, echinoderms etc.

Microfacies of this member is laminated mudstone and bioclastic mudstone. Laminated mudstone consists of fine-to coarse-grained bioclasts and shells of radiolarians, ostracods, and gastropods with sparite pore filling or geopetal fabrics which are partly cemented with light grey to dark grey micritic matrix (Fig. 4b,c). Some parts include chalcedonic quartz and chert layers. Lamination fabrics are almost clearly rhythmites and gradually decrease in the upper part. Radiolarians are abundant and concentrated near laminations in some levels. The bioclastic mudstone consists of light grey to grey micritic matrix, fine-to coarse-grained bioclasts such as echinoderms and shells of radiolarians and ostracods. Some bioclasts are filled with clear calcite cement (Fig. 4d) and show geopetal fabrics. A bioturbated fabric is found in some upper levels.

The Chiak Limestone Member yields many conodonts, such as: *Neospathodus timorensis* (Nogami) (Fig. 5:12,15) in Section C (API 19); *Neospathodus kockeli* (Tatge) (Fig. 5:4,8,11,13,14,16,17,18,20,21,22) in Sections B (API 104,110), C (API 19), E (API 77), F (API 65,67,69) and Khao Tubun (API 6–7); *Neohindeodella aequiramosa* Kozur and Mostler in Sections B (API 104,110), E (API 76,77), F (API 69); *Neogondolella bulgarica* (Budurov and Stefanov) (Fig. 5:19) in Section F (API 73), etc. They have been recovered from the lower part, laminated mudstone, of the Chiak Limestone Member. These conodonts indicate the interval of Spathian to middle Anisian (latest Early to Middle Triassic).

The stratigraphic correlation of each section in the Chiak Limestone Member is shown in Fig. 7. The microfacies and the age of conodonts of Sections B, C, E and F can be correlated. The dolomite in the lower part of Sections C and E are overlain by the Chiak Limestone Member. The microfacies of laminated mudstone and bioclastic mudstone in the Chiak Limestone Member gradually changes to bioclastic wackestone in

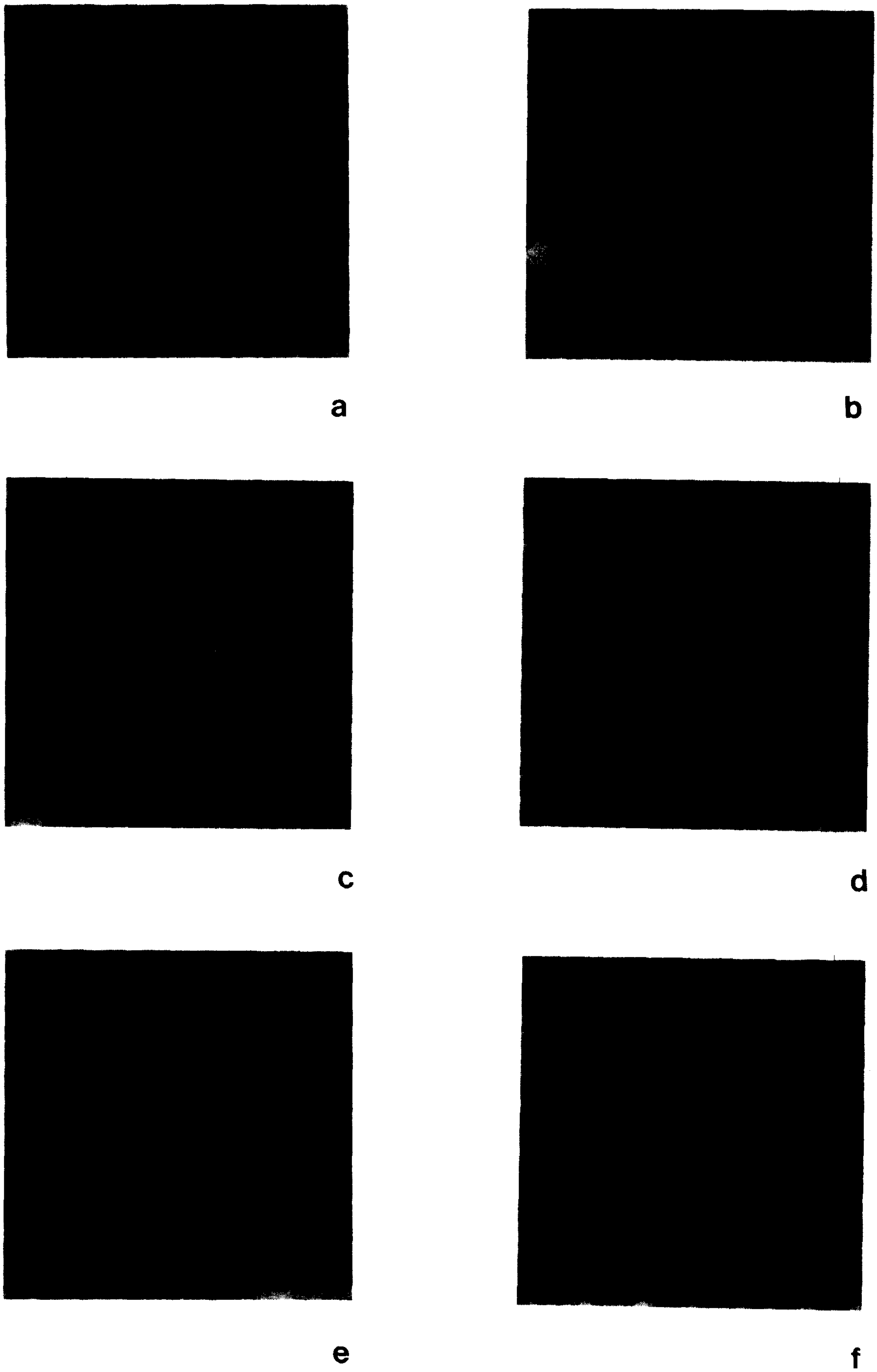

Fig. 4. (a) Ghost texture of foraminifer in dolomite, Section D, Phukhaothong Dolomite Member, × 188, PPL, staining thin section. (b) Lamination and calcite pore-filling in bioclasts, laminated mudstone, Section F, Chiak Limestone Member, × 72, PPL. (c) Geopetal fabrics in gastropod, laminated mudstone, Section C, the Chiak Limestone Member, × 72, PPL. (d) Bioclast of ostracode with calcite pore filling, bioclastic mudstone, Section C, Chiak Limestone Member, × 72, PPL. (e) A brachiopod fragment, bioclastic wackestone, Section B, Phanomwang Limestone Member, × 72, PPL. (f) Sparry grain support between bioclasts (foraminifer and ostracode), bioclastic packstone/grainstone, Section A, Phanomwang Limestone Member, × 72, PPL.

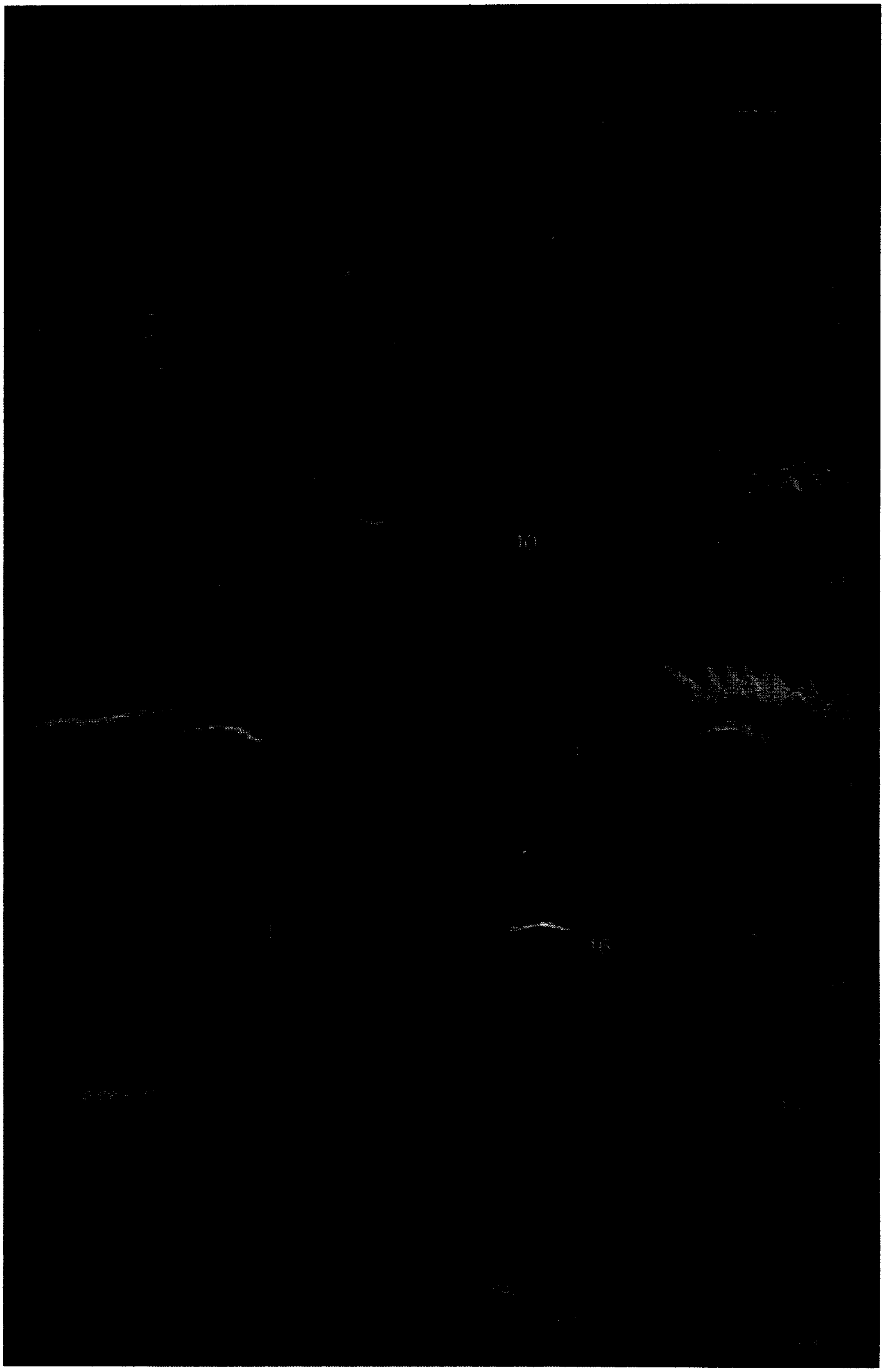

Fig. 5. 1: *Neospathodus* cfr. *waageni* Sweet from Section C, Phukhaothong Dolomite Member, × 100. 2, 5, 6: *Neospathodus waageni* Sweet from Section D, Phukhaothong Dolomite Member, × 75. 3, 7, 9, 10. *Neospathodus kummeli* Sweet. 3, 7, 9: from Section D, Phukhaothong Dolomite Member, × 75. 10: from Section C, Phukhaothong Dolomite Member, × 75. 4, 8, 11, 13, 14, 16, 17, 18, 20, 21, 22: *Neospathodus kockeli* (Tatge), Chiak Limestone Member; 4, 8, 11, 14: from Section B, × 100. 13: from Section F, × 100. 16, 18: from Section B, × 100. 17: from Section F, × 100. 20: from Khao Tubun, × 100. 21: from Section E, × 100. 22: from Section C, × 100. 12, 15: *Neospathodus timorensis* (Nogami) from Section C, Chiak Limestone Member, × 75. 19: *Neogondolella bulgarica* (Budurov and Stefanov) from Section E, Chiak Limestone Member, × 75.

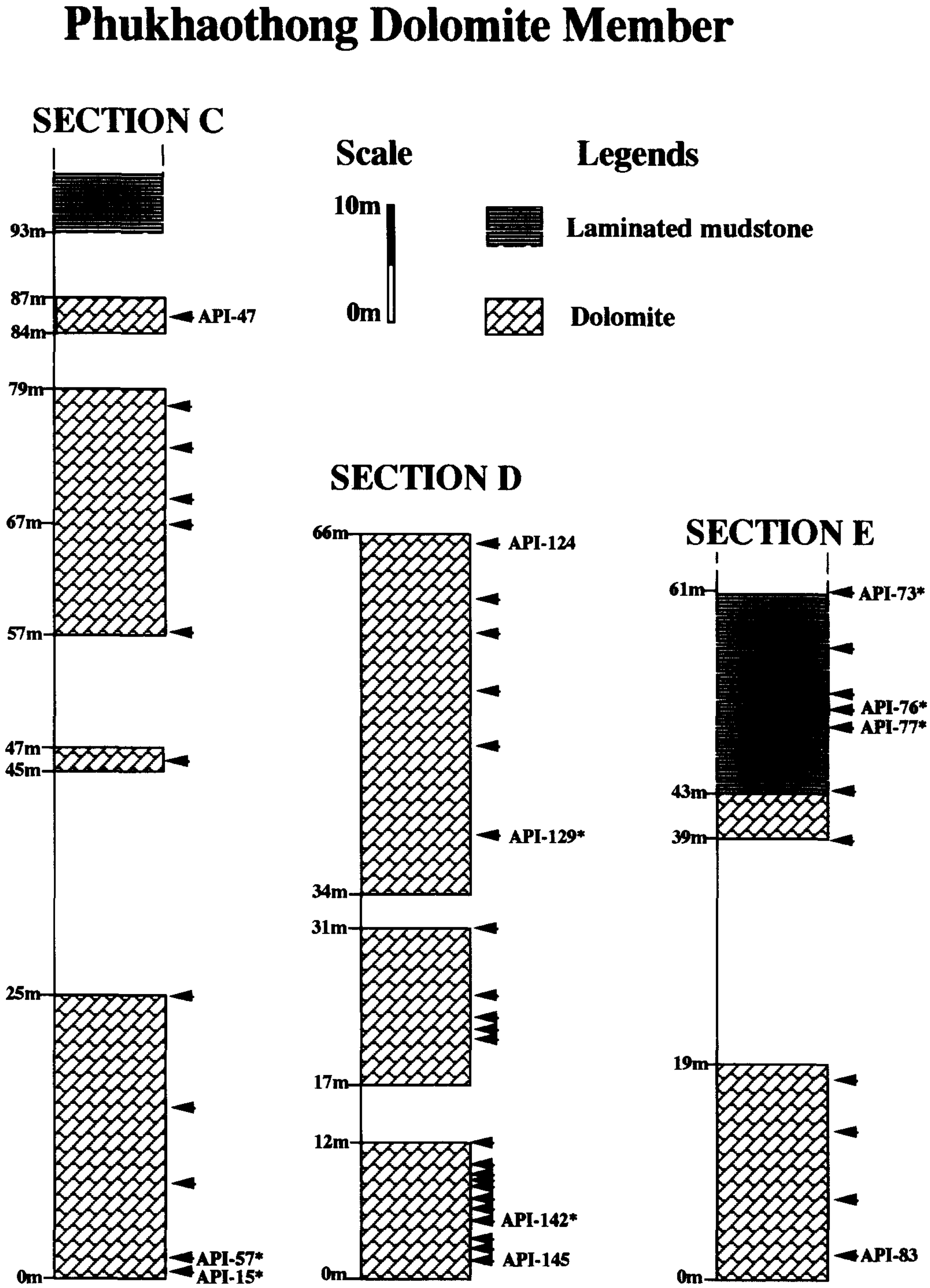

Fig. 6. Phukhaothong Dolomite Member in Sections C, D and E. *Remark*: (a) dotted lines show the other members; (b) * shows the samples that yield conodonts.

the Phanomwang Limestone Member that is observed in the upper part of Sections B and C. It indicates the gradual contact of the Chiak Limestone Member and the Phanomwang Limestone Member.

The age of the upper part, bioclastic mudstone of the Chiak Limestone Member in Section B and C has not yet been completely identified. The lower part of this member is continuous and yields Spathian and early to middle Anisian conodonts. The age of the upper part should be at least the same or younger. Hence the age of the upper part of this member is probably middle to late Anisian (early Middle Triassic) or up to the Ladinian (late Middle Triassic). Furthermore, this part underlies the Carnian Phanomwang Limestone Member.

Phanomwang Limestone Member

This member is composed mostly of massive limestone, about 90 m thick at the type section, Section A, on Khao Phanomwang. The Phanomwang Limestone is also exposed in the upper part of Sections B and C (Fig. 8). Limestone of this member is dark grey to grey, very thickly bedded to massive, and yields abundant fossils. It includes reef limestone (coral buildups) composed of calcisponges, scleractinian corals, mollusks, echinoids, crinoids, foraminifers, and others. These fossils indicate a Carnian age (early Late Triassic).

The microfacies of this member is bioclastic wackestone and bioclastic packstone/grainstone. The bioclastic wackestone is greenish to dark grey micrite with abundant fine- to coarse-grained bioclasts and shells of brachiopods, echinoderms, foraminifers, gastropods, ostracods and ammonoids (Fig. 4e). Bioclasts are filled with micritic sediments and partly with calcite cement. Particle contact is tangential, with point contact between bioclasts. There are some bioturbated fabrics which are indicated by differences of colour, grain size and mottling. Bioclastic packstone/grainstone is composed of very fine- to coarse-grained clasts of brachiopods, bry-

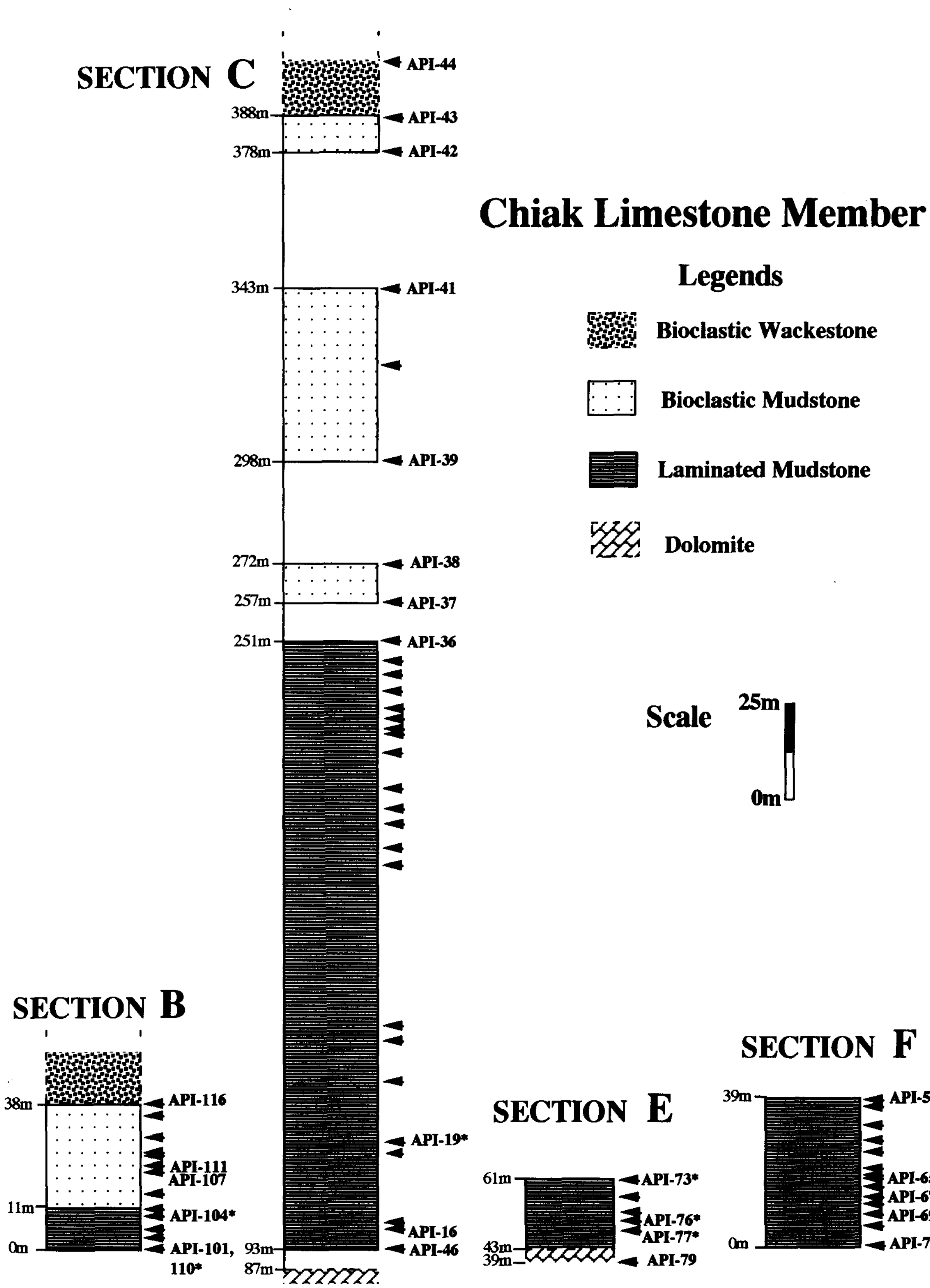

Fig. 7. Chiak Limestone Member in Sections B, C, E and F. *Remark*: (a) dotted lines show the other members; (b) * shows the samples that yield conodonts.

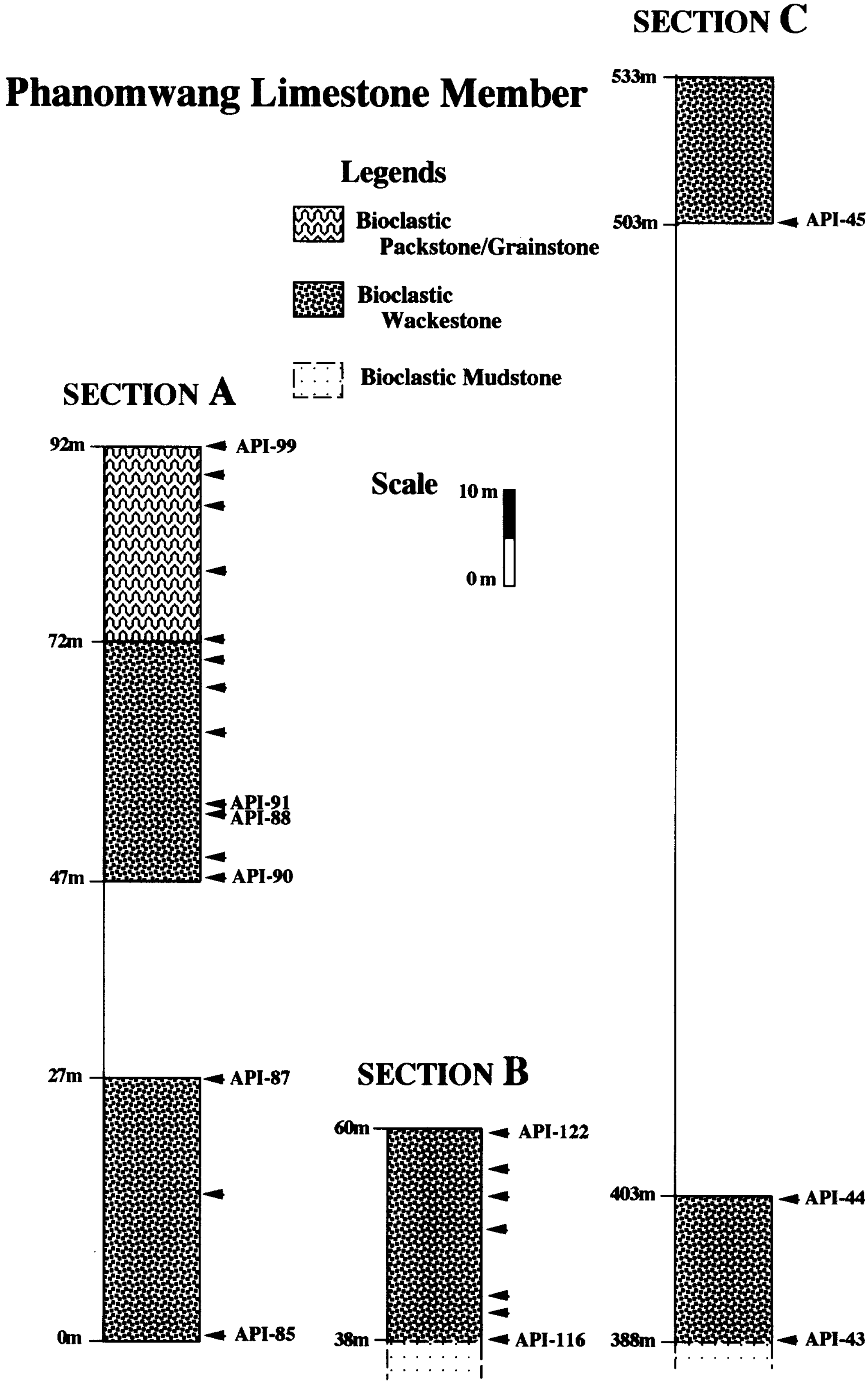

Fig. 8. Phanomwang Limestone Member in Sections A, B and C. *Remark*: dotted lines show the other members.

ozoans, echinoderms, foraminifers, algae, pelloids, and mollusks. Intragranular pores are filled with micrite and sparite (Fig. 4f).

Depositional Environment

Judging from the geological and microfacies described above, the Chaiburi Formation is considered as a single and continuous sequence. It includes five microfacies: dolomite, laminated mudstone, bioclastic mudstone, bioclastic wackestone, and bioclastic packstone/grainstone, in ascending order. The lower part of the formation, the Phukhaothong Dolomite Member, was almost completely replaced as a result of dolomitization and its primary lithology and structure could not be identified. According to Flügel (1978), the energy condition becomes higher and interstitial space changes from micritic to sparitic with decreasing water depth. The middle part of this formation, the Chiak Limestone Member, is laminated and bioclastic mudstone facies. The lithology and fabric of these two microfacies including micritic matrix, laminated to unlaminated fabric, indicate low energy depositional conditions. The upper part of the formation, the Phanomwang Limestone Member, is composed of bioclastic wackestone and bioclastic packstone/grainstone that indicate relatively high energy and shallow depositional conditions.

The change of microfacies observed in the Chaiburi Formation shows that the depositional environment shifted from low to high energy and from deep to shallow conditions. The Chiak Limestone Member, of low energy conditions, was deposited in a deeper depositional environment than the Phanomwang Limestone Member. The change of depositional environment observed in the Chaiburi Formation resulted from progradation of the carbonate platform during the Triassic.

The carbonate rocks of each section in the Phatthalung area monoclinically dip E. Ages indicate that the eastern sections are younger than those in the West. Section A appears to be the oldest and Sections B, C, D, E and F are younger in ascending order. According to the lithostratigraphic and biostratigraphic evidence, all sections can be correlated with the Chaiburi Formation and were deposited in almost the same interval of Triassic time. This indicates that the formation must be structurally repeated several times in this area by faulting, perhaps reflecting geotectonic development of the Shan-Thai terrain.

Correlations

The purpose of this paper is to introduce the continuous marine Triassic carbonate strata in the Phatthalung area, Peninsular Thailand. The Chaiburi Formation, which is at least 400–500 m thick, is proposed for these Triassic strata. The continuous Triassic carbonate strata are not commonly exposed in other parts of Thailand. Most of the marine Triassic strata consist of shale, siltstone, sandstone and conglomerate with intercalating limestone (Fig. 9). Therefore it is difficult to correlate the Chaiburi Formation with other marine Triassic strata in Thailand. The Lampang Group (Piyasin, 1971) in the northern part of Thailand intercalates with rather thick limestones. It is a conformable marine sequence of more than 3000 m thick of the Phra That, Doi Chang, Hong Hoi and Doi Long Formations, in ascending order (Chonglakmani, 1983). The Limestone strata are dominant in the Doi Chang and Doi Long Formations. The Doi Chang Formation or the Pha Kan Formation (Piyasin, 1972; Chonglakmani, 1972) yields many fossils of ammonoids, bivalves and brachiopods which indicate an interval of late Anisian to late Carnian. The Doi Long Formation contains an indeterminate fauna of bivalves, serpulid worms, brachiopods and gastropods (Piyasin, 1972; Chonglakmani, 1972), and is considered to be a middle Carnian age.

Most of the marine Triassic strata in Thailand consist of shale, siltstone, sandstone, chert, conglomerate and limestone, and have been correlated by the fauna of *Daonella*, *Halobia* and *Posidonia* (Fig. 9). The Triassic strata of the Mae Sot (Braun and Jordan, 1976), Mae Sariang (Baum *et al.*, 1970), and Tak (Bunopas, 1976) areas in the northwest of Thailand, can be correlated with the Lampang Group by the occurrence of the above mentioned Late Triassic pelecypods. In the Si Sawat area, Kanchanaburi, western part of Thailand, the limestone yields abundant conodonts including *Neospathodus timorensis* (Nogami). These conodonts indicate the interval of early Anisian to Norian (Kemper *et al.*, 1976). Shale beds exposed in some parts of the Si Sawat area yields *Halobia* and/or *Daonella*. A limestone unit exposed in Rayong southeastern part of Thailand

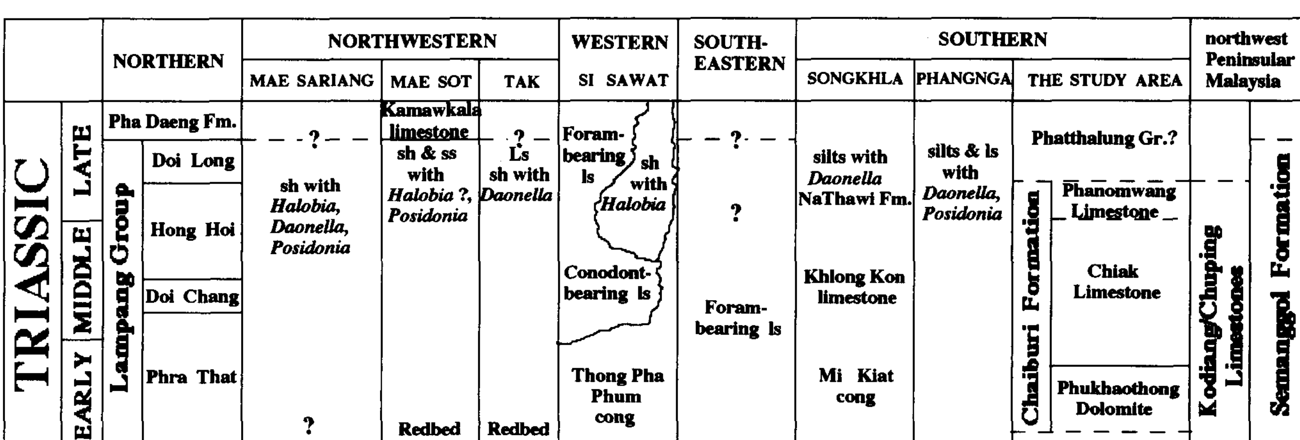

Fig. 9. The correlation of the marine Triassic in Thailand included the study area and northwest Peninsular Malaysia (modified after Chonglakmani, 1983; Metcalfe, 1990).

yields Scytho-Anisian foraminifers (Fontaine and Vachard, 1981).

The Na Thawi Formation (Grant-Mackie *et al.*, 1980), Songkhla, southern part of Thailand, a siltstone yields *Daonella* (Kobayashi and Tokuyama, 1959; Grant-Mackie *et al.*, 1980) that indicates a middle Carnian age. This formation is correlated with the Semanggol Formation of northwestern Malaysia (Grant-Mackie *et al.*, 1980). The Khlong Kon Limestone in Amphoe Saba Yoi, Songkhla, may be correlated with the limestone of the Pha Kan Formation in the Lampang Basin (Grant-Mackie *et al.*, 1980). At Khao Thao in the Phangnga area, the Triassic bedded black limestone is overlain by a thick massive limestone. The Late Triassic *Daonella* and *Posidonia* were reported in the bedded limestone (Fontaine and Tantiwanit, 1992).

A dolomite exposed near Amphoe Khuan Khanun, north of Phatthalung, yields an ichthyosaur probably indicating Early Triassic (Fontaine *et al.*, 1993). It can be correlated with Section D in the Phukhaothong Dolomite Member and may be situated between the dolomite beds of Dienerian (API 142) and Smithian (API 129), late Early Triassic (Figs 3 and 6). The Triassic conodonts and radiolarians from limestones of Khao Chiak (Igo *et al.*, 1988; Sashida and Igo, 1992) can be correlated with the Chiak Limestone Member of Section C. In the lake east of Phatthalung, sandstone and conglomerate have been grouped in the Mesozoic Phatthalung Group by Ridd and Wainwright (1969). They suggested that it is the equivalent of the Khorat, Surat Thani and Mau Yau Groups and unconformably overlies the Na Thawi Group.

Triassic parts of the Kodiang and Chuping Limestones in northwest Peninsular Malaysia (e.g. Nogami, 1968; Koike 1973, 1982; De Coo and Smit, 1975; Metcalfe 1984, 1990) are the direct equivalents of the Chaiburi Formation, but the detailed correlation, both in lithostratigraphy and faunas has yet to be done.

Conclusions

(1) Carbonate rocks exposed in the Phatthalung area previously included in the Permain Rat Buri Limestone are newly identified as Early to Late Triassic in age from micropaleontological evidence.

(2) The Chaiburi Formation is newly proposed for the Triassic carbonate sequence in the Phatthalung area, the eastern part of Peninsular Thailand. It consists of a conformable sequence at least 400–500 m thick of the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone Members in ascending order.

(3) Microfacies study shows that depositional environments gradually changed from lower to higher energy conditions as a result of progradation of a carbonate platform.

(4) Conformable relations indicate that no intense tectonic disturbance occurred during deposition of the Chaiburi Formation and no earlier than Norian times.

(5) The Chaiburi Formation monoclinally dips E, but biostratigraphic evidence shows that the formation is structurally repeated several times in this area. This faulting may reflect the geotectonic development of the Shan-Thai terrain.

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