

Ostracods (Crustacea) of the Early-Middle Permian from Central Thailand (Indochina block). Part I. Order Palaeocopida

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ABSTRACT

Early to Middle Permian ostracods of the Indochina block were reported from Central Thailand. Twelve Permian localities spreading in the Loei, Phetchabun, and Nakhon Sawan-Lopburi areas were investigated and limestone samples were collected. Out of 135 samples collected, 82 yielded ostracods. In this paper, 39 species of 20 genera belonging to Order Palaeocopida, families Aparchitidae, Kloedenel-

KEY WORDS

Ostracoda,
Palaeocopida,
Permian,
Thailand,
Indochina block,
new species.

lidae, Knoxitidae, Paraparchitidae, Kirkbyidae, Amphissitidae, Youngiellidae, Hollinellidae, and Coelonellidae are identified; species of Order Podocopida will be described in a second paper. Eight species are newly described: *Langdaia meesooki* Chitnarin n. sp., *Sargentina chantarameei* Chitnarin n. sp., *Geffenina posterodorsospina* Chitnarin n. sp., *Geffenina mariebeatriceae* Chitnarin n. sp., *Samarella sonei* Chitnarin n. sp., *Samarella viscusforma* Chitnarin n. sp., *Microcoelonella takliensis* Chitnarin n. sp., and *Microcoelonella takfaensis* Chitnarin n. sp. This paper presents the first intensive systematics treatment of Permian ostracods of the Indochina block. Detailed analysis of the fauna recovered Palaeocopida and Podocopida, facilitates and will contribute to a palaeoenvironmental and palaeobiogeographical reconstruction.

RÉSUMÉ

Ostracodes (Crustacea) du Permien inférieur et moyen de Thaïlande Centrale (Bloc Indochine). Première partie. Ordre des Palaeocopida.

Des ostracodes du Permien inférieur et moyen du bloc d'Indochine ont été découverts dans le centre de la Thaïlande. Douze localités situées dans les régions de Loei, Phetchabun et Nakhon Sawan-Lopburi présentant des affleurements permien ont été étudiées et des échantillons de calcaires collectés. Parmi les 135 échantillons recueillis, 82 ont fourni des ostracodes. Les faunes retrouvées sont abondantes et riches : la systématique de l'ordre des Palaeocopida est présentée ici, les Podocopida seront décrits dans un article à venir (partie II). Trente-neuf espèces appartenant à vingt genres de l'ordre des Palaeocopida (familles Aparchitidae, Kloedenellidae, Knoxitidae, Paraparchitidae, Kirkbyidae, Amphissitidae, Youngiellidae, Hollinellidae et Coelonellidae) ont été identifiées. Huit espèces nouvelles sont décrites ici : *Langdaia meesooki* Chitnarin n. sp., *Sargentina chantarameei* Chitnarin n. sp., *Geffenina posterodorsospina* Chitnarin n. sp., *Geffenina mariebeatriceae* Chitnarin n. sp., *Samarella sonei* Chitnarin n. sp., *Samarella viscusforma* Chitnarin n. sp., *Microcoelonella takliensis* Chitnarin n. sp., and *Microcoelonella takfaensis* Chitnarin n. sp. Cet article présente la première étude systématique des ostracodes du Permien du Bloc d'Indochine. L'analyse détaillée des faunes retrouvées, Palaeocopida et Podocopida, permettra une reconstruction paléoenvironnementale et paléobiogéographique.

MOTS CLÉS

Ostracoda,
Palaeocopida,
Permien,
Thaïlande,
Bloc d'Indochine,
espèces nouvelles.

INTRODUCTION

Ostracods (Crustacea) are microfossils which play an important role in palaeoenvironmental interpretations and palaeobiogeography analyses (Crasquin-Soleau & Baud 1998; Crasquin-Soleau *et al.* 1999). Permian ostracods from Southeast Asia are poorly known. Only a few studies have been carried out in this region, such as in Timor (Bless 1987) and Central Thailand (Chitnarin *et al.* 2008). The lack of knowledge of ostracods is significant since the

fauna could provide additional information on the very complex tectonic history of this region. Accordingly, several field investigations were conducted during 2007-2008 in the central region of Thailand in order to investigate Permian rocks and collect limestone samples for ostracod studies. Many ostracod specimens were recovered in this study; they belong to Aparchitidae Jones, 1901, Kloedenellidae Ulrich & Bassler, 1908, Knoxitidae Egorov, 1950, Paraparchitidae Scott, 1959, Kirkbyidae Ulrich & Bassler, 1906, Amphissitidae Knight, 1928, Young-

iellidae Kellett, 1933, Hollinellidae Bless & Jordan, 1928, Coelonellidae Sohn, 1971, Cytherideidae Sars, 1925, Cavellinidae Egorov, 1950, Geroiidae Grundel, 1962, Pachydomellidae Berdan & Sohn, 1961, Bairdioidae Sars, 1888, and Polycopidae Sars, 1866. The nine first families which belong to Order Palaeocopida Henningsmoen, 1953 are presented in this article; the others will be described in a second article. The discovery provides the missing Permian ostracod information for Central Thailand and the mainland of Southeast Asia (Indochina block).

GEOLOGICAL SETTING

Thailand and neighbouring countries were formed by amalgamation of several terranes after closure of the Palaeo-Tethys, possibly during Permian to Triassic time. It is accepted that the geotectonics of the region is complicated by presence of time-related sutures/fault zones (e.g., Metcalfe 1990, 2002; Ueno 1999, 2002, 2003; Ueno & Hisada 1999). The mainland of Thailand comprises four geotectonic units (Fig. 1), namely the Indochina block (I), the Sukhothai zone (II), the Intanon zone (III), and the Sibumasu block (IV), from east to west (Ueno 2002, 2003). These blocks are bounded by three major tectonic lines: the Nan-Uttaradit Suture (line 1 on Fig. 1) which extends to the Sa Kaeo-Chanthaburi Suture (line 2 on Fig. 1), the Chiang Rai Tectonic line (line 3 on Fig. 1), and the Mae Yum Fault (line 4 on Fig. 1). The region has been affected by younger tectonic activity as represented by the Mae Ping and Three Pagodas faults (MPF and TPF) and is dislocated from its original position. Details of the lithology and palaeontology of the Indochina and the Sibumasu blocks, and the tectonic evolution were reviewed by Ueno (2002). According to this author, the boundary between the Indochina and Sibumasu blocks was designated. Therefore, the present study has focused on limestones of the Indochina block (see Fig. 1).

Permian rocks of Thailand are predominantly carbonates with minor clastics. They usually overlie conformably on Carboniferous sedimentary rocks, and are overlain by either Triassic sedimentary rocks or Permian-Triassic volcanic and volcano-

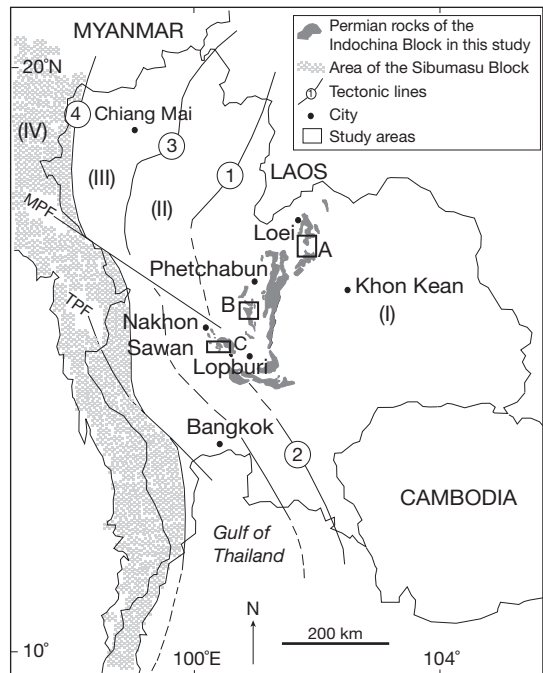


FIG. 1. — Geotectonic map of mainland Thailand, with distribution of Permian rocks of the Indochina block relevant to this study, and the studied areas (modified after Ueno 2002 – see text for explanation): **A**, Loei area; **B**, Phetchabun area; **C**, Nakhon Sawan-Lopburi area; **(I)**, Indochina block; **(II)**, Sukhothai zone; **(III)**, Intanon zone; **(IV)**, Sibumasu block; **MPF**, Mae Ping Fault; **TPF**, Three Pagodas Fault.

clastic rocks. Generally, the Permian rocks of the Indochina block exposed in the central region are known as the Saraburi Group (Bunopas 1981, 1992). Besides, the Permian lithostratigraphy of these rocks has been studied by many geologists (Charoenprawat & Wongwanich 1976; Nakornsri 1977, 1981; Chonglakmani & Sattayalak 1979; Hinthong 1981). According to these authors, numbers of rock formations have been proposed.

This study was conducted in three geographic sub-areas; the Loei, the Phetchabun, and the Nakhon Sawan-Lopburi areas (Fig. 1A-C, respectively). Brief descriptions of the rocks relevant to this study are given here.

The Permian rocks exposed northward to the Loei area (Figs 1A; 2A; 3C) are subdivided into the Nam Maholan (limestones with nodular cherts and shales), the E-Lert (argillites, shales, cherts, lime-

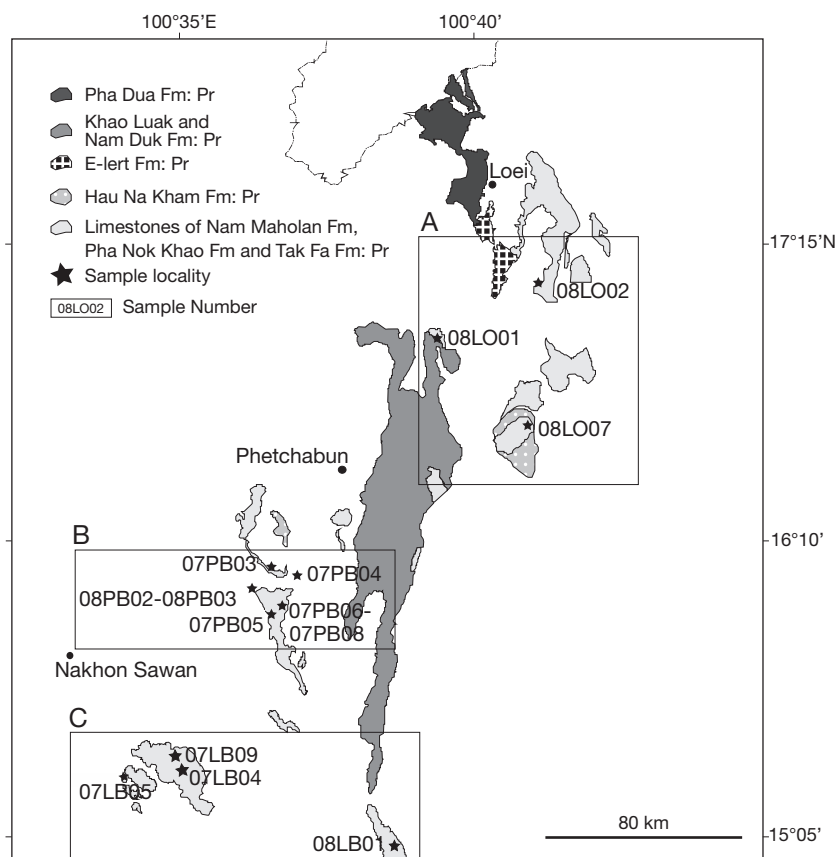


FIG. 2. — Geological map and localities (stars) of the studied sections in: **A**, Loei area; **B**, Phetchabun area; **C**, Nakhon Sawan-Lopburi area.

stone lenses, sandstones and tuffaceous sandstones) and the Pha Dua Formations (sandstones, siltstones and shales) according to Charoenprawat & Wongwanich (1976). The age of these rocks ranges from Early Permian to late Middle Permian according to fusulinaceans, ammonoids, and plants (Asama *et al.* 1968; Altermann 1989; Charoentitirat & Ueno 1999).

Chonglakmani & Sattayalak (1979) investigated the geology of the Phetchabun-Udonthani area and subdivided the Permian rocks exposed in the Phetchabun area into the Pha Nok Khao (limestones with nodular cherts and shales), the Hua Na Kham (shales, sandstones, limestones), and the Nam Duk Formations (black shales, sandstones and allodapic limestones) (Figs 1B; 2B; 3B). The age of

the formations ranges from Early Permian to late Middle Permian with reference to fusulinaceans and corals (Altermann 1989; Fontaine *et al.* 1999). Chonglakmani & Fontaine (1990) investigated carbonate strata in the Phetchabun-Lam Narai area; Carboniferous and Permian corals and fusulinaceans suggest deposition on a shallow marine platform during the Carboniferous to Middle Permian.

Nakornsri (1977, 1981) divided the Permian rocks in Nakhon Sawan-Lopburi area into the Khao Luak (shales, sandstones, limestones, tuffaceous sandstones) and the Tak Fa Formations (limestones with nodular cherts and shales) (Figs 1C; 2C; 3A). Fossils found in limestones of both formations such as fusulinaceans, corals, conodonts, brachiopods and bryozoans indicate the Early to late Middle

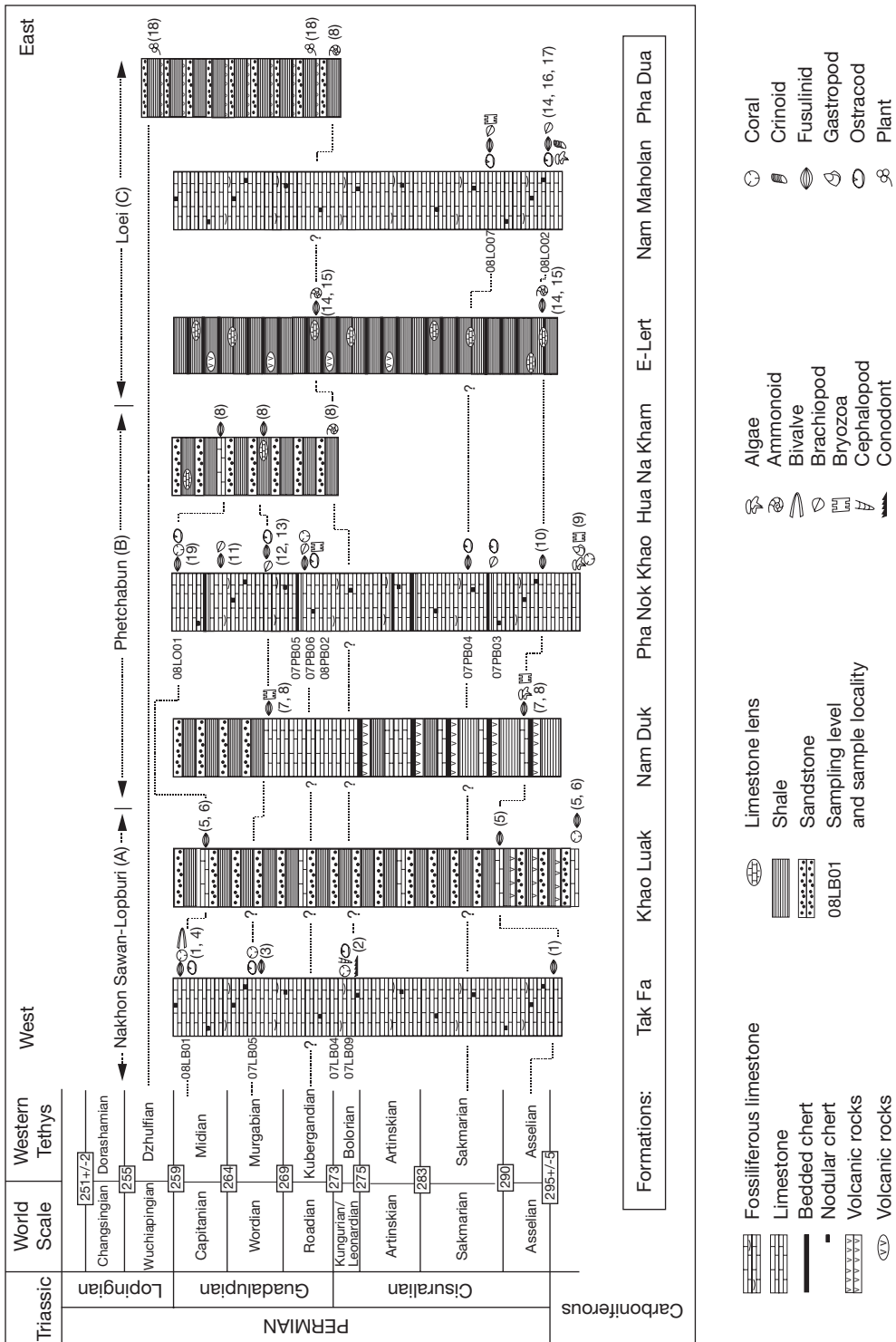


Fig. 3. — Lithostratigraphic columns and correlations of the Permian strata relevant to this study. Data from: 1, Wielichowski & Young 1985; 2, Metcalfe & Some 2008; 3, Assawa- patchara 2001; 4, Udchachon *et al.* 2007; 5, Nakornsi 1981; 6, Fontaine *et al.* 1999; 7, Chonglakmani & Sattayalak 1979; 8, Altermann 1989; 9, Chonglakmani & Fontaine 1990; 10, Yanagida 1988; 11, Yanagida 1964; 12, Perez-Huerta *et al.* 2007; 13, Chitnarin *et al.* 2008; 14, Charoenprawat & Wongwanich 1976; 15, Ishibashi *et al.* 1996; 16, Igo 1972; 17, Yanagida 1966, 1976; 18, Asama *et al.* 1968; 19, Fontaine *et al.* 2002.

Permian (Asselian to Capitanian age) according to Wielchowsky & Young (1985), Udchachon *et al.* (2007) and Metcalfe & Sone (2008). Fontaine *et al.* (1999) reported Middle Carboniferous corals from limestones at Ban Bo Nam, South of the Khao Luak Formation in Lopburi province.

SAMPLE LOCALITIES

Twelve localities were investigated in three sub-study areas: three in the Loei, five in the Phetchabun and four in the Nakhon Sawan-Lopburi areas (Fig. 2). Informations sections and sampling points are summarised in Table 1. The lithostratigraphy and the proposed correlation between sections are presented in Figure 3. It should be noted that all samples were collected from limestones of Nam Maholan, Pha Nok Khao, and Tak Fa formations.

ABBREVIATIONS

AB	anterior border;
ACA	anterior cardinal angle;
DB	dorsal border;
H	height;
L	length;
L1	anterior lobe;
L2	median lobe;
L3	posterior lobe;
LV	left valve;
PB	posterior border;
PCA	posterior cardinal angle;
RV	right valve;
S1	anterior sulcus;
S2	median sulcus;
S3	posterior sulcus;
VB	ventral border;
W	width.

MATERIAL AND METHODS

In total, 135 limestone samples were collected and processed by hot acetolysis (Lethiers & Crasquin-Soleau 1988; Crasquin-Soleau *et al.* 2005); 82 samples yielded ostracods. 103 species belonging to 41 genera have been recovered. In this paper, the Order Palaeocopida is presented. 39 species of 20 genera belonging to families Aparchitidae, Kloedenellidae, Knoxitidae, Paraparchitidae, Kirk-

byidae, Amphissitidae, Youngiellidae, Hollinellidae, and Coelonellidae are identified. Eight new species are described (Table 2). All specimens are deposited in Suranaree University of Technology collection (numbers SUT-09-1xxx).

SYSTEMATICS

The classification used in this paper follows Moore (1961), Lethiers (1981) and Horne *et al.* (2002).

Class OSTRACODA Latreille, 1802
 Order PALAEOCOPIDA Henningsmoen, 1953
 Suborder BEYRICHICOPINA Scott, 1961
 Superfamily APARCHITOIDEA Jones, 1901
 Family APARCHITIDAE Jones, 1901
 Genus *Cyathus* Roth & Skinner, 1930

TYPE SPECIES. — *Cyathus ulrichi* Roth & Skinner, 1930.

Cyathus caperata (Guan, 1978) (Fig. 4A-D)

Sinocoelonella caperata Guan in Guan, Sun, Jiang, Li, Zhao, Zhang, Yang & Feng, 1978: 149, pl. 37, fig. 17; pl. 38, fig. 1.

Cyathus caperata – Shi & Chen 1987: 32, pl. 10, figs 10-18. — Yuan 2008: 47-48, pl. 2, figs 4-6. — Yuan *et al.* 2009: pl. 1, fig. 15. — Crasquin *et al.* 2010a: 332-334, figs 3A-D.

MATERIAL. — 46 complete carapaces and 8 valves.

OCCURRENCES. — Wugang, Hunan Province, Early Permian (Guan *et al.* 1978); Saiwa section, Guizhou Province, latest Permian (Yuan 2008; Yuan *et al.* 2009); Meishan section, Baoqing and Meishan members (Shi & Chen 1987; Crasquin *et al.* 2010a);

northeastern Thailand, Sak Chai Quarry section, Pha Nok Khao Formation, Chaiyaphum Province, Early Permian (sample 08LO07-1);

central Thailand, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample nos 07PB04-2, 07PB04-5); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-A3, 07LB05-B2, 07LB05-D2, 07LB05-D3).

DIMENSIONS. — H = 0.26-0.43 mm, L = 0.44-0.73 mm.

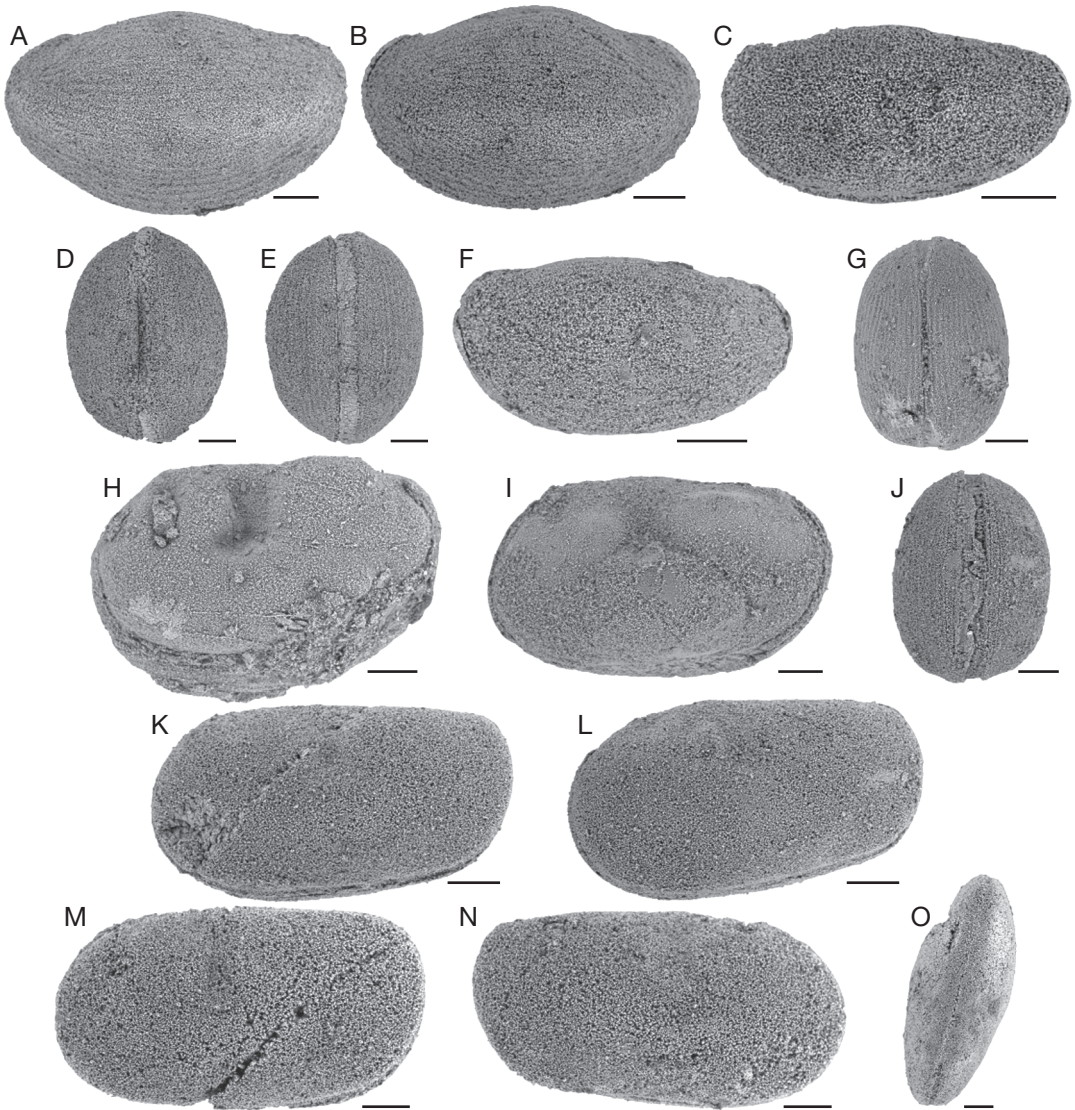


FIG. 4. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-D**, *Cyathus caperata* (Guan, 1978); **A**, left lateral view, SUT-09-1345, sample 07PB04-2; **B**, left lateral view, SUT-09-1346, sample 07PB04-2; **C**, dorsal view, SUT-09-1347, sample 07PB04-2; **D**, ventral view, SUT-09-1348, sample 07PB04-2; **E-H**, *Cyathus elliptica* Shi, 1987; **E**, left lateral view, SUT-09-1352, sample 07PB04-2; **F**, left lateral view, SUT-09-1353, sample 07PB04-5; **G**, dorsal view, SUT-09-1350, sample 07LB05-D2; **H**, ventral view, SUT-09-1351, sample 07LB05-D2; **I**, *Knoxiella* sp. 1, left lateral view, SUT-09-1436, sample 07LB05-D1; **J**, *Knoxiella* sp. 2, left lateral view, SUT-09-1437, sample 07PB03-5; **K-O**, *Langdaia meesooki* Chitnarin n. sp. (see Fig. 6); **K**, holotype, left lateral view of the complete carapace, SUT-09-1457, sample 08LB01-3; **L**, paratype, left lateral view of the complete carapace, SUT-09-1458, sample 08LB01-1; **M**, paratype, left lateral view of the complete carapace, SUT-09-1459, sample 08LB01-1; **N**, left lateral view of the complete carapace, SUT-09-1461, sample 08LB01-1; **O**, dorsal view of the complete carapace, SUT-09-1460, sample 08LB01-1. Scale bars: 100 µm.

TABLE 1. — Information on the studied sections.

Area	Section number	Section Name	Formation	Age of the section	Geographic position	Provincial boundary	Thickness	Lithology	Limestone classification	Number of samples & sample No.
Loei	08LO01	Khao Tham Yai	Pha Nok Khao	Capitanian	16°56'22"N, 101°23'37"E	Nam Nao District, Phetchabun Province	2 m	drak gray, argillaceous limestones	wackestone-packstone	4 (08LO01-1 to 4)
	08LO02	Tham Nam Maholan	Nam Maholan	Asselian	17°06'23"N, 101°52'48"E	Wang Saphung District, Loei Province	40 m	light gray, micritic limestones	wackestone-packstone	12 (08LO02-1 to 12)
	08LO07	Sak Chai Quarry	Pha Nok Khao	Sakmarian?	16°35'07"N, 101°52'38"E	Khon San District, Chaiyaphum Province	90 m	drak gray, argillaceous limestones	wackestone-packstone	12 (08LO07-1 to 12)
Phetchabun	07PB03	Khao Kana	Pha Nok Khao	Asselian-Sakmarian	16°04'12"N, 100°54'20"E	Chon Dan District, Phetchabun Province	15 m	dark gray, micritic limestones	wackestone-packstone	7 (07PB03-1 to 7)
	07PB04	Nong Phai	Pha Nok Khao	Asselian-Sakmarian	16°01'06"N, 100°58'59"E	Nong Phai District, Phetchabun Province	30 m	gray-light gray, micritic limestones	wackestone-packstone	7 (07PB04-1 to 7)
	07PB05	Ban Naen Sawan I	Tak Fa	Roadian?	15°54'11"N, 100°53'36"E	Bung Sam Phan District, Phetchabun Province	30 m	dark gray, argillaceous limestones	mudstone-wackestone	7 (07PB05-1 to 7)
	07PB06-07PB08	Ban Naen Sawan II	Tak Fa	Roadian?	15°55'08"N, 100°55'46"E	Bung Sam Phan District, Phetchabun Province	90 m	light gray, micritic-crystalline limestones	mudstone-wackestone	21 (07PB06-1 to 8) (07PB07-1 to 4) (07PB08-1 to 9)
	08PB02-08PB03	Phu Phra That	Tak Fa	Roadian?	15°58'22"N, 100°52'21"E	Chon Dan District, Phetchabun Province	70 m	dark gray-gray, micritic limestones	wackestone-packstone	19 (08PB02-1 to 13) (08PB03-1 to 6)
Nakhon Sawan-Lopburi	07LB04	Phu Lam Yai	Tak Fa	Kungurian?	15°20'21"N, 100°36'15"E	Tak Fa District, Nakhon Sawan Province	30 m	gray, micritic limestones	mudstone-wackestone	18 (07LB04-1 to 18)
	07LB05	Ta Kli	Tak Fa	Wordian	15°19'05"N, 100°22'46"E	Ta Kli District, Nakhon Sawan Province	50 m	dark gray, argillaceous limestones	wackestone-packstone	20 (07LB05-1 to 5) (07LB05-A1 to A3, B1 to B3, D1 to D3)
Lopburi	07LB09	Khao Phu Chongkho	Tak Fa	Kungurian?	15°22'45"N, 100°35'12"E	Tak Fa District, Nakhon Sawan Province	1 m	light gray, micritic limestones	wackestone-packstone	2 (07LB09-1 to 2)
	08LB01	Khao Somphot	Tak Fa	Capitanian	15°11'16"N, 101°31'10"E	Lam Sonthi District, Lopburi Province	15 m	dark gray, micritic-argillaceous limestones	wackestone-packstone	6 (08LB01-1 to 6)

TABLE 2. — Stratigraphic distribution of Permian ostracod species from Central Thailand (Indochina block).

Species	Samples: 08LO02 08LO07 07PB03 07PB04 07LB09 07LB04 07PB05 07PB08 08PB03 07LB05 08LO01 08LB01
<i>Knoxia</i> sp. 2	
<i>Microcoelonea takliensis</i> n. sp.	
<i>Microcoelonea takfaensis</i> n. sp.	
<i>Microcoelonea</i> ? sp.	
<i>Knightina</i> ? sp.	
<i>Shemonaella</i> sp. 2	
<i>Samarella</i> sp. 3	
<i>Samarella sonoi</i> n. sp.	
<i>Eukloedenella</i> ? sp.	
<i>Knoxia</i> sp. 1	
? <i>Hollinella</i> (<i>Hollinella</i>) sp.	
<i>Reviva subsompongensis</i> Chitnarin, 2008	
<i>Shleesha</i> sp.	
<i>Kloedcytherella oertii</i> Kozur, 1985	
<i>Geffenina mariebeatriceae</i> n. sp.	
Paraparchitiidae sp.	
<i>Langdaia meesooki</i> n. sp.	
<i>Samarella</i> sp. 1	
<i>Knightina</i> cf. <i>ultima</i> (Kozur, 1985)	
<i>Shishaella</i> sp.	
<i>Samarella</i> sp. 2	
<i>Hollinella</i> (<i>Hollinella</i>) <i>martensiformis</i> Crasquin, 2010	
<i>Hollinella</i> (<i>Hollinella</i>) <i>herrickana</i> (Girty, 1909)	
<i>Hollinella</i> (<i>Hollinella</i>) <i>herrickana</i> ? (Girty, 1909)	
<i>Kirkbya</i> sp. 1	
<i>Kirkbya</i> sp. 2	
<i>Sargentina chantarameei</i> n. sp.	
<i>Geffenina postedorospina</i> n. sp.	
<i>Geisina</i> sp.	
<i>Polytylites</i> sp.	
<i>Samarella viscusforma</i> n. sp.	
<i>Cyathus caperata</i> (Guan, 1978)	
<i>Cyathus elliptica</i> Shi, 1987	
<i>Permoyoungiella</i> sp.	
<i>Knightina</i> sp.	
<i>Kirkbya</i> sp. 3	
<i>Shemonaella</i> sp. 1	
Paraparchites <i>chenshii</i> Crasquin, 2010	
Kloednellidae indet.	

DISCUSSION

Specimens of the genus *Cyathus* are easily recognised by the small carapace, elliptical shape in lateral view, and inflation of the median part. Hoare (2004) described a new genus and species, *Simulatus adornatus* from the Pennsylvanian of Idaho, USA, assigned with doubt to family Quasilitidae. According to description and figures, the *Simulatus* is considered here as junior synonym of the *Cyathus*. *Cyathus caperata* is characterised by its fine striation on the carapace surface which extends almost equally to the dorsal and ventral margins. In dorsal view, the carapace is long and subelliptical in shape. DB of both valves is convex, hinge line straight and channelled. The specimens here are assigned to *C. caperata* by their lateral view and H/L ratio, but they have a more rectangular carapace in dorsal view than the specimens from remote areas. This variability is possibly due to geographical variation.

Cyathus elliptica Shi, 1987
(Fig. 4E-H)

Cyathus elliptica Shi in Shi & Chen, 1987: 32, pl. 10, figs 20-23; pl. 17, figs 5, 6. — Crasquin *et al.* 2010a: 334, fig. 3E-H.

MATERIAL. — 40 complete carapaces.

OCCURRENCES. — Meishan section, Baoqing and Meishan members (Shi & Chen 1987; Crasquin *et al.* 2010a); **northeastern Thailand**, Sak Chai Quarry section, Pha Nok Khao Formation, Chaiyaphum Province, Early Permian (sample 08LO07-1); **central Thailand**, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample nos 07PB04-2, 07PB04-5); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-A3, 07LB05-B2, 07LB05-D2, 07LB05-D3).

DIMENSIONS. — H = 0.23-0.31 mm, L = 0.52-0.61 mm.

DISCUSSION

Cyathus elliptica is recognised by fine striation on the carapace surface, a long carapace in lateral view, and slightly convex DB. In dorsal view, the carapace is tumid and subrectangular in shape. *Cyathus elliptica* differs from *C. caperata* found in South

China (Shi & Chen 1987; Crasquin *et al.* 2010a) by its more slender carapace in lateral view, more rectangular outline in dorsal view.

Suborder KLOEDENELLOCOPINA

Scott, 1961

Superfamily KLOEDENELLOIDEA

Ulrich & Bassler, 1908

Family KNOXITIDAE Egorov, 1950

Genus *Knoxiella* Egorov, 1950

TYPE SPECIES. — *Knoxiella semilukiana* Egorov, 1950.

Knoxiella sp. 1
(Fig. 4I)

MATERIAL. — One complete carapace.

OCCURRENCE. — Sample 07LB05-D1, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Central Thailand, Middle Permian.

DIMENSIONS. — H = 0.49 mm, L = 0.66 mm, H/L = 0.74.

DISCUSSION

Based on the presence of bulbous L2 and small spine on posteroventral part of the carapace this specimen could be assigned to *Knoxiella*. The most conspicuous characters of *Knoxiella* sp. 1 are distinct S1, wide S2, bulbous L2 and L3, postero-ventral spines at both valves, and wide overlap of RV on LV along free margins. The present species is close to *K. ventrispinosa* Crasquin, 2008 from Late Permian of Bulla section, northern Italy (Crasquin *et al.* 2008) in the presence of posteroventral spine on LV. The two taxa differ in the presence of a more weakly developed spine in *Knoxiella* sp. 1.

Knoxiella sp. 2
(Fig. 4J)

MATERIAL. — 2 complete carapaces.

OCCURRENCES. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample no. 07PB03-5); Ban Naen Sawan I sec-

tion, Tak Fa Formation, Phetchabun Province, Middle Permian (sample no. 07PB05-6).

DIMENSIONS. — H = 0.39-0.46 mm, L = 0.71-0.79 mm, H/L = 0.55-0.58.

DISCUSSION

Knoxiella sp. 2 is characterised by a subelliptical carapace in lateral view, wide and shallow S2, and moderate overlap of RV over LV along free margins. This species is similar to *K. oblonga* Wang, 1978 from Early Triassic of Western Guizhou and north-eastern Yunnan in China (Wang 1978). However, they are not conspecific because the maximum convexity of the PB is located higher in *K. oblonga* than in *Knoxiella* sp. 2.

Genus *Langdaia* Wang, 1978

TYPE SPECIES. — *Langdaia suboblonga* Wang, 1978.

Langdaia meesooki Chitnarin n. sp. (Figs 4K-O; 6)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 4K), SUT-09-1457.

Paratypes, complete carapace (Fig. 4L), SUT-09-1458; complete carapace (Fig. 4M), SUT-09-1459.

ETYMOLOGY. — In honour of Dr Assanee Meesook, Department of Mineral Resources, Thailand.

MATERIAL. — Nine complete carapaces.

DIMENSIONS. — H = 0.34-0.42 mm, L = 0.64-0.85 mm

TYPE HORIZON. — Sample 08LB01-1, Khao Som Phot section, Tak Fa Formation, Capitanian, Middle Permian.

TYPE LOCALITY. — Khao Som Phot section (15°11'16"N, 101°31'10"E), Lopburi Province, Central Thailand.

OCCURRENCES. — Central Thailand, Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, late Early Permian (sample 07LB04-13); Khao Som Phot section, Tak Fa Formation, Lopburi Province, Late Middle Permian (sample 08LB01-3).

DIAGNOSIS. — Species of *Langdaia* with long, subrectangular carapace in lateral outline, smooth surface, subvertical PB, and faint S2.

DESCRIPTION

Carapace long, subrectangular in lateral outline; DB straight; ACA = 135-145°, PCA = 110-130°; AB bluntly rounded, maximum convexity located at mid H; ventral outline broadly convex; VB straight; PB subvertical, maximum convexity located above mid H; S2 faint and located on dorso-median part of carapace; surface smooth; greatest height located in front of mid L; RV larger and slightly overlaps LV on free margins; dorsal view narrowly biconvex; sexual dimorphism recognised by inflated posterior part of carapace in females; H/L = 0.46-0.56.

DISCUSSION

Two species of the genus *Langdaia* were described from the Early Triassic: *L. suboblonga* (western Guizhou and northeastern Yunnan, China; Wang 1978), and *L. laolongdongensis* Crasquin-Soleau & Kershaw, 2005 (from the Laolongdong section, southeastern Sichuan, South China; Crasquin-Soleau & Kershaw 2005). Two species found in the Permian are *L. hornei* Crasquin-Soleau, 1999 from the Middle Permian of the Khuff Formation of the Sultanate of Oman (Crasquin-Soleau *et al.* 1999) and *L. cf. suboblonga* Wang from latest Permian of Saudi Arabia (Crasquin-Soleau *et al.* 2005). The discovery of the *L. meesooki* n. sp. confirms that this genus is known from the Late Early Permian (this study) to Middle Permian (Crasquin-Soleau *et al.* 1999)-Late Permian (Crasquin *et al.* 2010a) and crossed the P-T boundary to the Early Triassic (Wang 1978; Crasquin-Soleau & Kershaw 2005). *Langdaia meesooki* n. sp. is similar to *L. suboblonga* Wang, 1978 from latest Permian and Early Triassic of Western Guizhou and Northeastern Yunnan (Wang 1978) in lateral outline but differs in more elongate carapace and faint S2. *Langdaia meesooki* n. sp. differs from *L. laolongdongensis* Crasquin-Soleau & Kershaw, 2005 by a smooth surface and a smaller H/L.

Genus *Sargentina* Coryell & Johnson, 1939

TYPE SPECIES. — *Sargentina allani* Coryell & Johnson, 1939.

Sargentina chantarameei Chitnarin n. sp.
(Figs 5A-G; 7)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 5B), SUT-09-1445.

Paratypes, complete carapace (Fig. 5A), SUT-09-1444; complete carapace (Fig. 5C), SUT-09-1446; complete carapace (Fig. 5D), SUT-09-1447; complete carapace (Fig. 5E), SUT-09-1448.

ETYMOLOGY. — In honour of Associate Professor Sompong Chantaramee, Chiang Mai University, Thailand.

MATERIAL. — 18 complete carapaces and 8 incomplete carapaces.

DIMENSIONS. — H = 0.44-0.73 mm, L = 0.65-1.13 mm.

TYPE HORIZON. — Sample number 07PB03-3, Khao Kana section, Pha Nok Khao Formation, Sakmarian? Early Permian.

TYPE LOCALITY. — Khao Kana section (16°04'12"N, 100°54'20"E), Phetchabun Province, Central Thailand.

OCCURRENCES. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (samples 07PB03-3, 07PB03-07); Khao Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Kungurian? (sample 07LB04-17).

DIAGNOSIS. — Species of *Sargentina* with subelliptical carapace in lateral view, long and narrow S2 located in dorsomedian part, wide overlap of RV on LV at DB and VB.

DESCRIPTION

Carapace outline subelliptical in lateral view, RV subelliptical, LV subrectangular; DB straight at LV, convex at RV; ACA = 130-140°, PCA = 135-145°; S2 long and narrow, located on dorsomedian part, round and shallow in short specimens; AB broadly rounded, maximum convexity located just below mid H; VB convex in RV, slightly concave in LV; PB more narrowly rounded, maximum convexity located at or above mid H; surface smooth to punctuate; greatest height located at mid L; RV larger than LV with wide overlap all around the carapace, RV overreaches along the dorsum; sexual dimorphism recognised by inflation of posterior part of the carapace in females; H/L = 0.61-0.70.

DISCUSSION

The specimens are assigned to the genus *Sargentina* by the important overlap of RV over LV all around the carapace, and with presence of S2. Heteromorphs (Fig. 5A-C) differ from tecnomorphs by having a wider posterior part of the carapace and a narrower median sulcus. In contrast, the tecnomorphs (Fig. 5D, E) have a narrower posterior part of the carapace with a more rounded S2. ACA and PCA of tecnomorphs vary from 130-135° and 130-135°. *Sargentina chantarameei* n. sp. is similar to *S. postacuta* (Zalányi, 1974) from the Late Permian of Bükk Mountains, Hungary (Zalányi 1974) and the Late Permian of Bulla section, northern Italy (Pasini 1981; Crasquin *et al.* 2008). *Sargentina chantarameei* n. sp. has rounded AB and PB at RV whereas they are angular in *S. postacuta*.

Genus *Eukloedenella* Ulrich & Bassler, 1923

TYPE SPECIES. — *Eukloedenella umbilicata* Ulrich & Bassler, 1923.

Eukloedenella? sp. (Fig. 5J, K)

MATERIAL. — 3 complete carapaces.

OCCURRENCE. — Sample 07LB05-C1, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Central Thailand, Middle Permian.

DIMENSIONS. — H = 0.16-0.25 mm, L = 0.34-0.44 mm, H/L = 0.49-0.57.

DISCUSSION

Eukloedenella? sp. is assigned with doubt to the genus, based on its general shape, and AB wider than PB. However, the sulcus is very faint or possibly absent.

Genus *Geisina* Johnson, 1936

TYPE SPECIES. — *Beyrichiella gregaria* Ulrich & Bassler, 1906.

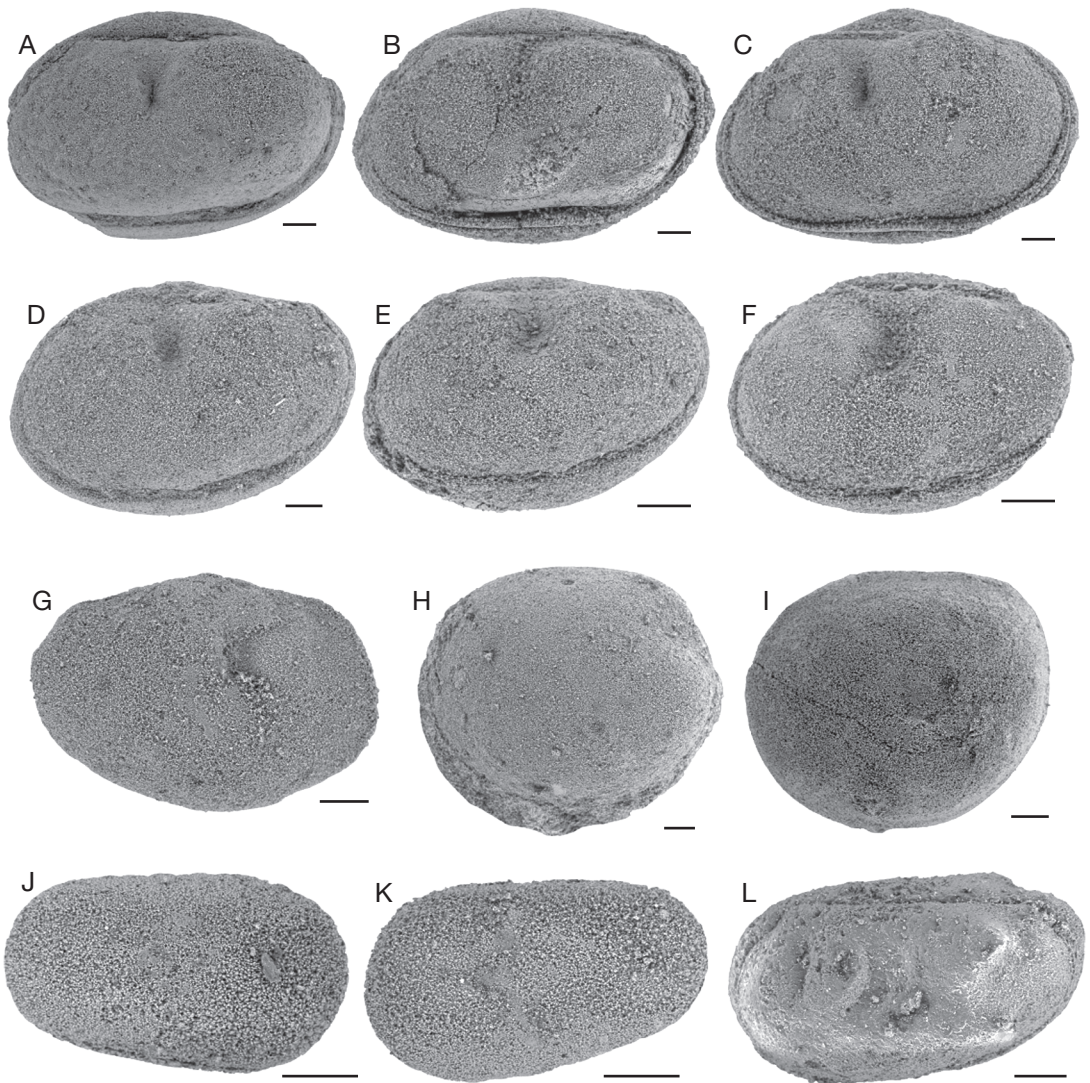


FIG. 5. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-G** *Sargentina chantarameei* Chitnarin n. sp. (see Fig. 7) ; **A**, left lateral view of the incomplete carapace, SUT-09-1444, sample 07PB03-3; **B**, holotype, left lateral view of the complete carapace, SUT-09-1445, sample 07PB03-3; **C**, paratype, left lateral view of the complete carapace, SUT-09-1446, sample 07PB03-3; **D**, paratype, left lateral view of the complete carapace, SUT-09-1447, sample 07PB03-3; **E**, paratype, left lateral view of the complete carapace, SUT-09-1448, sample 07PB03-3; **F**, left lateral view of the complete carapace, SUT-09-1449, sample 07PB03-3; **G**, right lateral view of the complete carapace, SUT-09-1450, sample 07PB03-3; **H**, Kloedenellidae indet., left lateral view of the complete carapace, SUT-09-1446, sample 07PB03-3; **I**, *Shemonaella* sp. 1, left lateral view, SUT-09-1405, sample 08LO02-2. **J, K**, *Eukloedenella*? sp.; **J**, right lateral view of the complete carapace, SUT-09-1465, sample 07LB05-C1; **K**, left lateral view of the complete carapace, SUT-09-1466, sample 07LB05-C1; **L**, *Geisina* sp., left lateral view, SUT-09-1440, sample 07LB05-B1. Scale bars: 100 μ m.

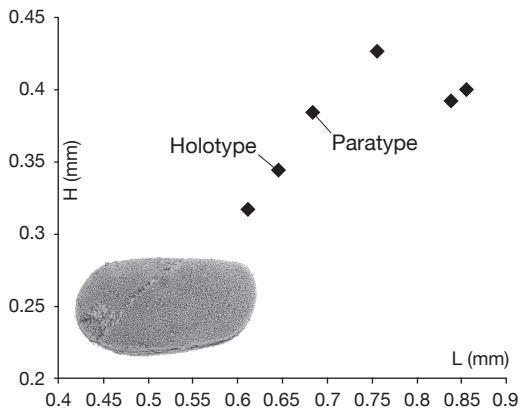


FIG. 6. — Height-length graph of *Langdaia meesooki* Chitnarin n. sp. Holotype, SUT-09-1457, sample 08LB01-3.

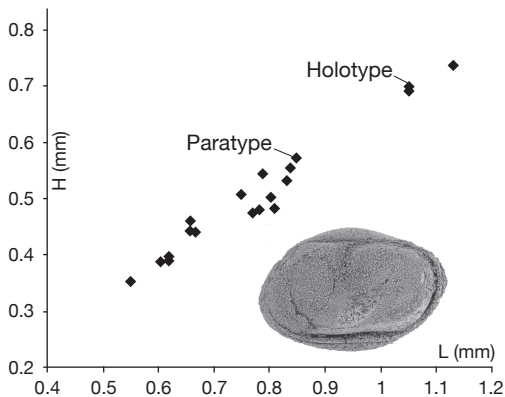


FIG. 7. — Height-length graph of *Sargentina chantarameei* Chitnarin n. sp. Holotype, SUT-09-1445, sample 07PB03-3.

Geisina sp. (Fig. 5L)

MATERIAL. — 13 complete carapaces and one valve.

OCCURRENCES. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB03-3); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (sample 07LB05-B1).

DIMENSIONS. — H = 0.37-0.40 mm, L = 0.64-0.66 mm, H/L = 0.56-0.61.

DISCUSSION

Species of the genus *Geisina* are characterised by a bisulcate carapace, incised hinge and presence of a

postero-dorsal spine. *Geisina* sp. has small spines protruded from the postero-dorsal part of both valves. S1 and S2 are long and narrow. LV overlaps RV along free margins. Sexual dimorphism is observed by inflation of the ventromedian part of the carapace in the heteromorphs. At present, this species cannot be compared to any known species.

Genus *Geffenina* Coryell & Sohn, 1938

TYPE SPECIES. — *Geffenina marmorata* Coryell & Sohn, 1938.

Geffenina posterodorsospina Chitnarin n. sp.
(Fig. 8A)

TYPE MATERIAL. — **Holotype**, complete carapace, (Fig. 8A), SUT-09-1451.

Paratypes, complete carapace (Fig. 8B), SUT-09-1452, complete carapace (Fig. 8C), SUT-09-1453.

ETYMOLOGY. — From the presence of a single postero-dorsal spine on the LV.

MATERIAL. — 118 complete carapaces and 13 incomplete carapaces.

DIMENSIONS. — H = 0.36-0.49 mm, L = 0.59-0.77 mm.

TYPE HORIZON. — Sample number 07PB03-3, Khao Kana section, Pha Nok Khao Formation, Sakmarian? Early Permian.

TYPE LOCALITY. — Khao Kana section (16°04'12"N, 100°54'20"E), Phetchabun Province, Central Thailand.

OCCURRENCE. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample nos 07PB03-1, 07PB03-3, 07PB03-5, 07PB03-07).

DIAGNOSIS. — Species of *Geffenina* with a small postero-dorsal spine on the LV, S2 shallow in its dorso-median part, and faint, rounded L2 and L3.

DESCRIPTION

Carapace tumid, semicircular; DB straight; ACA = 135-155°, PCA = 130-135°; AB broadly rounded, maximum convexity located at mid height; VB convex; PB rounded, maximum convexity located above mid height; surface in the anterior and posterior parts

of the carapace flat; faint S1, shallow S2 located on dorso-median part of carapace; L2 and L3 faint; surface smooth; a small postero-dorsal spine developed in LV; greatest height located in front of mid length; RV larger and overlaps LV on free margins; sexual dimorphism recognised by inflation of postero-ventral part of carapace in females; H/L = 0.58-0.63.

DISCUSSION

Geffenina posterodorsospina n. sp. is characterised by faint S1, wide and faint S2 in dorsomedian part of LV, faint and round L2 and L3. RV overlaps LV moderately along the free margins. Dimorphism is recognised by more inflated posterior part of the carapace in the heteromorphs. *Geffenina posterodorsospina* n. sp. is closed to *G. bungsamphanensis* Chitnarin, 2008 described from Middle Permian of Tak Fa limestones from Phetchabun area, central Thailand (Chitnarin *et al.* 2008). The carapace of *G. posterodorsospina* is more tumid than that of *G. bungsamphaensis* (higher H/L ratio). They differ also in the wide and faint S2, and with presence of the postero-dorsal spine in *G. posterodorsospina* n. sp.

Geffenina mariebeatriceae Chitnarin n. sp. (Figs 8D-F; 11)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 8D), SUT-09-1454.

Paratypes, one complete carapace (Fig. 8E), SUT-09-1455 and one complete carapace (Fig. 8F), SUT-09-1449.

ETYMOLOGY. — In honour of Dr Marie-Beatrice Forel, China University of Geosciences (Wuhan), China.

MATERIAL. — 13 complete carapaces.

DIMENSIONS. — H = 0.30-0.37 mm, L = 0.57-0.74 mm.

TYPE HORIZON. — Sample 07LB04-17, Khao Phu Lam Yai section, Tak Fa Formation, Kungurian? Early Permian.

TYPE LOCALITY. — Khao Phu Lam Yai section (15°20'21"N, 100°36'15"E), Nakhon Sawan Province, Central Thailand.

OCCURRENCE. — Central Thailand, Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (samples 07LB04-13, 07LB04-17).

DIAGNOSIS. — Species of *Geffenina* with long carapace, H/L less than 0.5, long S2, and faint L2 and L3.

DESCRIPTION

Carapace long, subrectangular in lateral view; DB straight; ACA = 125-135°, PCA = 125-135°; AB broadly rounded, maximum convexity located at mid H; VB straight in RV, slightly concave in LV; PB rounded, maximum convexity located above mid height; long S2 located at dorso-median part of carapace; L2 and L3 faint; surface smooth; greatest height located in front of mid L; RV larger and overlaps LV along free margins, moderate overlap in VB; sexual dimorphism recognised by inflation of postero-ventral part of carapace in females; H/L = 0.48-0.55.

DISCUSSION

The specimens are assigned to the genus *Geffenina* based on their long carapaces, wide S2 in dorso-median part, rounded and faint L2. Dimorphism is recognised by wider PB in heteromorphs. *Geffenina mariebeatriceae* n. sp. can be compared to *G. bungsamphanensis* Chitnarin, 2008 described from Middle Permian of central Thailand (Chitnarin *et al.* 2008) but can be differentiated by a more elongate carapace, as well as a narrower overlap of RV on LV in *G. mariebeatriceae* n. sp.

Genus *Kloedcytherella* Kozur, 1985

TYPE SPECIES. — *Kloedcytherella oertlii* Kozur, 1985.

Kloedcytherella oertlii Kozur, 1985 (Fig. 8G, H)

Kloedcytherella oertlii Kozur, 1985: 10, pl. 2, figs 3, 4.

MATERIAL. — Five complete carapaces.

OCCURRENCES. — Bükk Mountains, Hungary, Early Late Permian (Kozur 1985);

central Thailand, Phu Phra That section, Pha Nok Khao Formation, Phetchabun Province, Middle Permian (sample 08PB02-4); Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (samples 07LB04-14, 07LB04-10); Khao Som Phot section, Tak Fa Formation, Lopburi Province, Late Middle Permian (sample 08LB01-1).

DIMENSIONS. — H = 0.23-0.24 mm, L = 0.53-0.56 mm, H/L = 0.42-0.44.

DISCUSSION

The specimens are not well preserved; however, such characters as general outline with flat marginal rim and two horizontal ridges characterise *Kloedcytherella oertlii* Kozur, 1985.

Family KLOEDENELLIDAE Ulrich & Bassler, 1908

KLOEDENELLIDAE indet.

(Fig. 5H)

MATERIAL. — 2 complete carapaces.

OCCURRENCES. — Sample number 08LO02-11, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, northeastern Thailand, Early Permian.

DIMENSIONS. — H = 0.74 mm, L = 0.89 mm, H/L = 0.83.

DISCUSSION

The specimens are assigned to Kloedenellidae based on straight DB and faint median sulcus. Kloedenellidae indet. has subround carapace, straight hinge line without invagination, and inflated mid-posterior parts of both valves. At present, more precise determination cannot be made.

Superfamily PARAPARCHITOIDEA Scott, 1959

Family PARAPARCHITIDAE Scott, 1959

Genus *Paraparchites* Ulrich & Bassler, 1906

TYPE SPECIES. — *Paraparchites humerosus* Ulrich & Bassler, 1906.

Paraparchites chenshii Crasquin, 2010

(Fig. 8J-L)

Paraparchites chenshii Crasquin in Crasquin, Forel, Feng, Yuan, Baudin & Collin, 2010a: 338, fig. 4M-S. — Crasquin *et al.* 2010b: 25, pl. 1, fig. 12.

Paraparchites kamsasensis – Chen & Shi 1982: 116, pl. 3, figs 1-3. — Shi & Chen 1987: 34-35, pl. 11, figs 1-4; 2002: 62, pl. 1, figs 26-30.

MATERIAL. — 12 complete carapaces and 6 incomplete carapaces.

OCCURRENCES. — Meishan section, Meishan Member, Changxing Formation, Late Permian (Shi & Chen 1987; Crasquin *et al.* 2010a); Pingding section, central Guangxi, Wuchiapingian (Shi & Chen 2002); Wantong section, Jiangsu, Mianyang, Hubei (Chen & Shi 1982); Komirić section, NW Serbia, Changhsingian (Crasquin *et al.* 2010b);

central Thailand, Khao Tham Yai locality, Pha Nok Khao Formation, Phetchabun Province, Late Middle Permian (sample 08LO01-3); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-D3).

northeastern Thailand, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, Early Permian (samples 08LO02-1, 08LO02-10).

DIMENSIONS. — H = 0.37-0.83 mm, L = 0.51-1.18 mm, H/L = 0.66-0.76.

DISCUSSION

Paraparchites chenshii can be recognised by shape of carapace, smooth surface, preplete carapace outline in lateral view. LV overlaps RV along free margins. Dimorphism may be recognised by the more inflated posterior part and the rounder carapace of the heteromorphs. Specimens from Thailand assigned to *Paraparchites chenshii* can be compared to juvenile specimens of types described from latest Permian of Meishan section in South China (Crasquin *et al.* 2010a: fig. 4M-S). Slight differences are in more rectangular carapace, and the maximum curvature of PB located above mid H in the specimens from Thailand.

Genus *Shemonaella* Sohn, 1971

TYPE SPECIES. — *Shemonaella dutroi* Sohn, 1971.

Shemonaella sp. 1

(Fig. 5I)

MATERIAL. — 2 complete carapaces.

OCCURRENCE. — Northeastern Thailand, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, Early Permian (sample 08LO02-2).

DIMENSIONS. — H = 0.58-0.68 mm, L = 0.73-0.82 mm, H/L = 0.80-0.83.

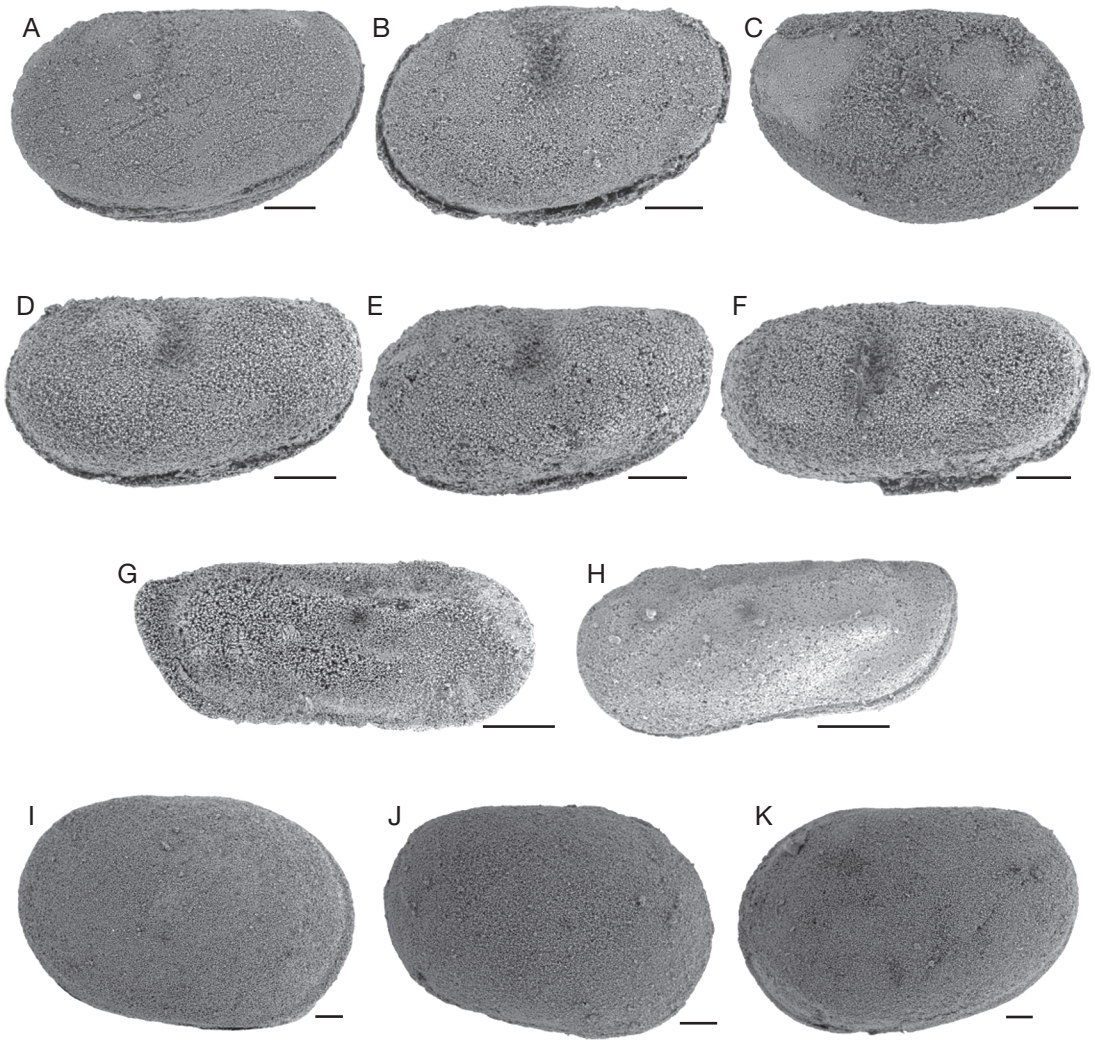


FIG. 8. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-C**, *Geffenina posterodorsospina* Chitnarin n. sp. (see Fig. 10); **A**, holotype, left lateral view of the complete carapace, SUT-09-1451, sample 07PB03-3; **B**, paratype, left lateral view of the complete carapace, SUT-09-1452, sample 07PB03-7; **C**, paratype, right lateral view of the complete carapace, SUT-09-1453, sample 07PB03-5; **D-F**, *Geffenina mariebaectriceae* Chitnarin n. sp. (see Fig. 11); **D**, holotype, left lateral view of the complete carapace, SUT-09-1454, sample 07LB04-17; **E**, left lateral view of the complete carapace, SUT-09-1455, sample 07LB04-17; **F**, left lateral view of the complete carapace, SUT-09-1456, sample 07LB04-17; **G, H**, *Kloedocytherella oertlii* Kozur, 1985; **G**, right lateral view, SUT-09-1471, sample 08PB02-4; **H**, left lateral view, SUT-09-1472, sample 08LB01-1; **J-L**, *Paraparchites chenshii* Crasquin, 2010; **J**, right lateral view of the complete carapace, SUT-09-1408, sample 08LO02-10; **K**, right lateral view of the complete carapace, SUT-09-1409, sample 08LO01-3; **L**, left lateral view of the complete carapace, SUT-09-1410, sample 08LO02-1. Scale bars: 100 μ m.

DISCUSSION

Unspined carapaces without incised dorsum nor overlap in specimens from Thailand suggest that they belong to the the genus *Shemonaella*.

Shemonaella sp. 2
(Fig. 9C)

MATERIAL. — 13 complete carapaces and one incomplete carapace.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-2, 07LB05-B3).

DIMENSIONS. — H = 0.34-0.80 mm, L = 0.53-1.25 mm, H/L = 0.60-0.65.

DISCUSSION

Shemonaella sp. 2 is characterised by a long and preplete carapace with greatest H located in front of mid L.

Genus *Samarella* Polenova, 1952

TYPE SPECIES. — *Samarella crassa* Polenova, 1952.

Samarella sonei Chitnarin n. sp.
(Figs 9G-L; 12)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 9G), SUT-09-1386.

Paratypes, complete carapace (Fig. 9H), SUT-09-1387, complete carapace (Fig. 9I), SUT-09-1388.

ETYMOLOGY. — In honour of Dr Masatoshi Sone, University of Malaya, Kuala Lumpur, Malaysia.

MATERIAL. — 36 complete carapaces.

DIMENSIONS. — H = 0.36-0.85 mm, L = 0.47-1.12 mm.

TYPE HORIZON. — Sample number 07LB05-D3, Ta Kli section, Tak Fa Formation, Wordian, Middle Permian.

TYPE LOCALITY. — Ta Kli section (15°19'05"N, 100°22'46"E), Nakhon Sawan Province, Central Thailand.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-D2, 07LB05-D3).

DIAGNOSIS. — Species of *Samarella* with straight DB at LV, convex DB at RV; LV slightly overlaps RV along free margins, RV overreaches along DB, broadly rounded AB with maximum convexity located below mid H.

DESCRIPTION

Oval-shaped carapace in lateral view; DB straight in LV, convex in RV; ACA = 140-150°, PCA = 140-160°; AB round, maximum convexity located slightly below mid H; VB convex; PB narrowly rounded, maximum convexity located above mid H; greatest H located in front of mid L; LV larger and overlaps RV on free margins, RV overreaches along DB; dorsal view biconvex, greatest W at mid L; surface smooth; H/L = 0.72-0.81.

DISCUSSION

Sohn (1971) proposed the genus *Dorsoobliquella* for members of Paraparchitidae showing overreach above hinge line with strongly convex DB and without spine. Some of the study specimens have convex DB on RV which suits the *Dorsoobliquella*; however, intraspecific characters have been observed among them. In our opinion, the genus *Samarella* is preferred; the *Dorsoobliquella* is subset of the former one. *Samarella sonei* n. sp. differs from *S. meishanella* Crasquin, 2010 from latest Permian of Meishan section, South China (Crasquin *et al.* 2010a) by its distinct overreach of RV over LV on the DB, narrow posterior part of the carapace and PB located above mid H. Shorter hinge line, cardinal angles less marked, dorsal overlapping more regularly distributed on DB.

Samarella viscusforma Chitnarin n. sp.
(Figs 13A-E; 15)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 13A), SUT-09-1394.

Paratypes, complete carapace (Fig. 13B), SUT-09-1395, complete carapace (Fig. 13C), SUT-09-1396.

ETYMOLOGY. — From the heart-like shape of the carapace in which anterior and posterior corners raise above DB level.

MATERIAL. — 172 complete carapaces.

DIMENSIONS. — H = 0.25-0.51 mm, L = 0.37-0.69 mm.

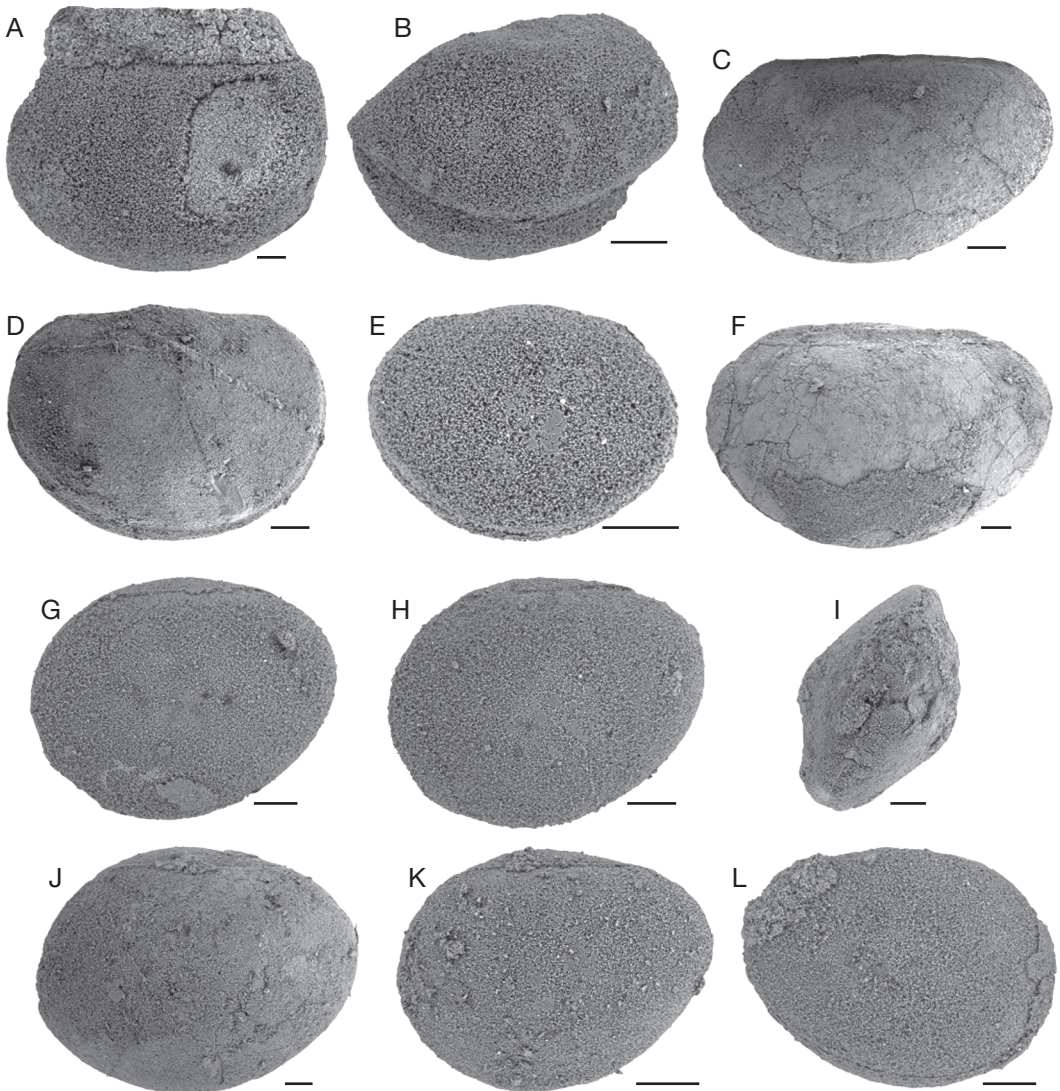


FIG. 9. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-B**, *Paraparchitidae* sp. ?; **A**, left lateral view of the complete carapace, SUT-09-1416, sample 07LB04-16; **B**, side-inclined view of the incomplete carapace, SUT-09-1417, sample 07LB04-16; **C, F**, *Shemonaella* sp. 2; **C**, left lateral view of the complete carapace, SUT-09-1406, sample 07LB05-2; **F**, left lateral view of the complete carapace, SUT-09-1407, sample 07LB05-2; **D, E**, *Samarella* sp. 1; **D**, right lateral view of the complete carapace, SUT-09-1383, sample 07LB05-2; **E**, right lateral view of the complete carapace, SUT-09-1384, sample 07LB09-2; **G-L**, *Samarella sonei* Chitnarin n. sp. (see Fig. 12); **G**, holotype, left lateral view of the complete carapace, SUT-09-1386, sample 07LB05-D3; **H**, paratype, left lateral view of the complete carapace, SUT-09-1387, sample 07LB05-D3; **I**, dorsal view of the complete carapace, SUT-09-1388, sample 07LB05-D3; **J**, paratype, left lateral view of the complete carapace, SUT-09-1389, sample 07LB05-D3; **K**, left lateral view of the complete carapace, SUT-09-1390, sample 07LB05-D2; **L**, right lateral view of the complete carapace, SUT-09-1391, sample 07LB05-D3. Scale bars: 100 μ m.

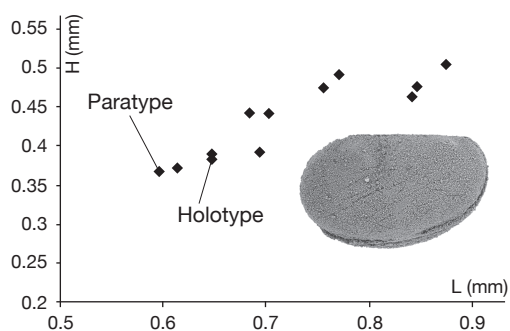


FIG. 10. — Height-length graph of *Gefferina posterodorsospina* Chitnarin n. sp. Holotype, SUT-09-1451, sample 07pb03-3.

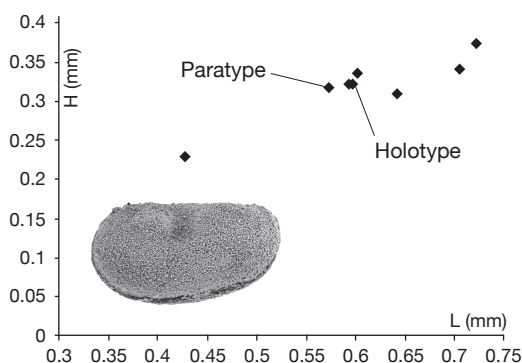


FIG. 11. — Height-length graph of *Gefferina mariebeatriceae* Chitnarin n. sp. Holotype, SUT-09-1454, sample 07lb04-17.

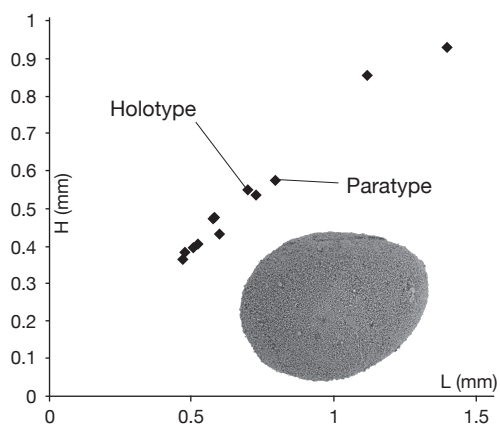


FIG. 12. — Height-length graph of *Samarella sonei* Chitnarin n. sp. Paratype, SUT-09-1387, sample 07LB05-D3.

TYPE HORIZON. — Sample number 07PB04-2, Nong Phai section, Pha Nok Khao Formation, Sakmarian?, Early Permian.

TYPE LOCALITY. — Nong Phai section (16°01'06"N, 100°58'59"E), Phetchabun Province, Central Thailand.

OCCURRENCES. — **Northeastern Thailand**, Sak Chai Quarry section, Pha Nok Khao Formation, Loei Province, Early Permian (sample 08LO07-1); **central Thailand**, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (samples 07PB04-2, 07PB04-5); Khao Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (sample 07LB04-17); Khao Phu Chongkho locality, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (07LB09-1); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-A2, 07LB05-A3, 07LB05-D2, 07LB05-D3).

DIAGNOSIS. — Species of *Samarella* with the heart-shape carapace, anterior and posterior corners raise above DB level and convex DB in RV.

DESCRIPTION

Carapace with the heart-like shape in lateral view; DB convex in both valves; ACA = 130-145°, PCA = 130-140°; anterior and posterior corners raise above DB; AB rounded, maximum convexity located at or above mid H; VB convex, maximum convexity located at mid L; PB rounded, maximum convexity located above mid H; greatest H located in front of mid L; LV larger and slightly overlaps RV along free margins, RV overreaches along DB; H/L = 0.69-0.87.

DISCUSSION

Samarella viscusforma n. sp. can be recognised by heart-shaped carapace in which anterior and posterior corners rise above DB, and maximum convexity of VB is located at mid length. Variability in carapace shape within the studied specimens is expressed in H/L ratio and rising degree of ACA and PCA which may be due to different instar stages. This species can be compared to *S. victori* Crasquin, 2010 from latest Permian of Meishan section, South China (Crasquin *et al.* 2010a) but can be differentiated by its heart-shape carapace, AB wider than PB and the maximum of curvature of both ends located above mid H.

Samarella sp. 1
(Fig. 9D-E)

MATERIAL. — Six complete carapaces.

OCCURRENCES. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-2); Khao Phu Chong Kho locality, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (sample 07LB09-2).

DIMENSIONS. — H = 0.31-0.61 mm, L = 0.40-0.86 mm, H/L = 0.70-0.75.

DISCUSSION. — Specimens of *Samarella* sp. 1 are characterised by semicircular and flat carapace. AB is round with large radius of curvature, maximum convexity is located at mid height. PB is round but narrower than AB, maximum convexity is located above mid H. The overlap and overreach are present.

Samarella sp. 2
(Fig. 13F, I)

MATERIAL. — Seven complete carapaces.

OCCURRENCES. — Central Thailand, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB04-2); Khao Phu Chongkho locality, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (samples 07LB09-1, 07LB09-2).

DIMENSIONS. — H = 0.38-0.45 mm, L = 0.51-0.61 mm, H/L = 0.75-0.84.

DISCUSSION

Samarella sp. 2 can be recognised by the convex DB in the anterior part and raised posterior conner. *Samarella* sp. 2 is similar to *S. victori* Crasquin, 2010 from the latest Permian of Meishan section, South China (Crasquin *et al.* 2010a: fig. 4T-X) in rounded AB with obscured ACA. *Samarella* sp. 2 differs from *S. victori* in maximum curvature of AB located above mid H. PB is narrower than AB, maximum of curvature of PB is located higher than that in *S. victori*. *Samarella* sp. 2 is more similar to *S. meishanella* Forel, 2010 from the latest Permian of the Meishan section, South China (Crasquin *et al.* 2010a: fig. 4Y-A') in high carapace and presence of dorsal shoulder, but the AB of *Samarella* sp. 2 has a larger radius of curvature and maximum of curvature located lower than that

of *S. meishanella*, antero-dorsal shoulder rounded, and posterior cardinal angle raised above DB level.

Samarella sp. 3
(Fig. 13G, H)

MATERIAL. — Three complete carapaces

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-D2, 07LB05-D3).

DIMENSIONS. — H = 0.47-1.07 mm, L = 0.57-1.26 mm, H/L = 0.81-0.84.

DISCUSSION

Samarella sp. 3 has a subcircular carapace and moderate overlap of RV over LV at DB. In lateral view, *Samarella* sp. 3 can be compared to adult specimens of *Paraparchites chenshii* Crasquin, 2010 (the latest Permian of Meishan section, South-East China; Crasquin *et al.* 2010a) but the overlap of RV over LV on DB is more important in *Samarella* sp. 3. The carapace of *Samarella* sp. 3 is very inflated in median part.

Genus *Shishaella* Sohn, 1971

TYPE SPECIES. — *Shishaella nicklesi* Sohn, 1971.

Shishaella? sp.
(Fig. 14A)

MATERIAL. — One right valve.

OCCURRENCE. — Central Thailand, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB04-5).

DIMENSIONS. — H = 0.42 mm, L = 0.60 mm, H/L = 0.70.

DISCUSSION

The genus *Shishaella* can be recognised by a single spine on the posterodorsal area of the right valve. However, a single valve is found and it is not possible to know if the other valve bears a spine or not; the specimen is assigned to *Shishaella* with doubt. *Shishaella?* sp. has a posterodorsal spine located just behind mid L of R the V. *Shishaella?* sp. could be compared to

S. hunanensis Guan, 1978 from Early Permian of Hunan Province in South China (Guan *et al.* 1978: pl. 36, fig. 6), but can be differentiated by the longer carapace and position of posterodorsal spine which is closer to mid L than that of previous species.

Paraparchitidae sp.
(Fig. 9A, B)

MATERIAL. — One complete carapace and two incomplete carapaces.

OCCURRENCE. — Central Thailand, Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (sample 07LB04-16).

DIMENSIONS OF THE COMPLETE SPECIMEN. — H = 0.40 mm, L = 0.62 mm.

DISCUSSION

Based on the lateral outline, the specimens illustrated could be assigned to Paraparchitidae. However, they show the inverse heart-shape carapace in anterior and posterior views, the ventral part of both valves are inflated, contact margins are located above VB level. With the specific characters mentioned above, the specimens are similar to *Chamishaella?* sp. *sensu* Sohn 1971: A13, pl. 5, fig. 31) from Late Mississippian of Alaska. The overreach of RV over LV, the specific character of *Chamishaella* is not observed in the studied specimens.

Superfamily KIRKBYOIDEA Ulrich & Bassler, 1906
Family KIRKBYIDAE Ulrich & Bassler, 1906

Genus *Kirkbya* Jones, 1859

TYPE SPECIES. — *Dithyrocaris permiana* Jones, 1850.

Kirkbya sp. 1
(Fig. 14K)

MATERIAL. — One complete carapace.

OCCURRENCE. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB03-5).

DIMENSIONS. — H = 0.33 mm, L = 0.57 mm, H/L = 0.59.

DISCUSSION

Kirkbya sp. 1 is characterised by a round the kirkbyan pit in the median part of the carapace, and slightly concave VB. The specimen is not well preserved and cannot be compared to any known species.

Kirkbya sp. 2
(Fig. 14L)

MATERIAL. — One complete carapace.

OCCURRENCE. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB03-5).

DIMENSIONS. — H = 0.36 mm, L = 0.55 mm, H/L = 0.64.

DISCUSSION

Kirkbya sp. 2 is assigned to the genus due to presence of faint kirkbyan pit in ventro-median part of the carapace.

Kirkbya sp. 3
(Fig. 14M)

MATERIAL. — One incomplete carapace.

OCCURRENCE. — Northeastern Thailand, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, Early Permian (sample 08LO02-10).

DISCUSSION

Kirkbya sp. 3 is identified by lobes and a shallow kirkbyan pit on the ventromedian part of the carapace.

Genus *Knightina* Kellett, 1933

TYPE SPECIES. — *Amphissites allorismoides* Knight, 1928.

Knightina cf. *ultima* (Kozur, 1985)
(Fig. 18C-E)

MATERIAL. — 12 complete carapaces and seven incomplete carapaces.

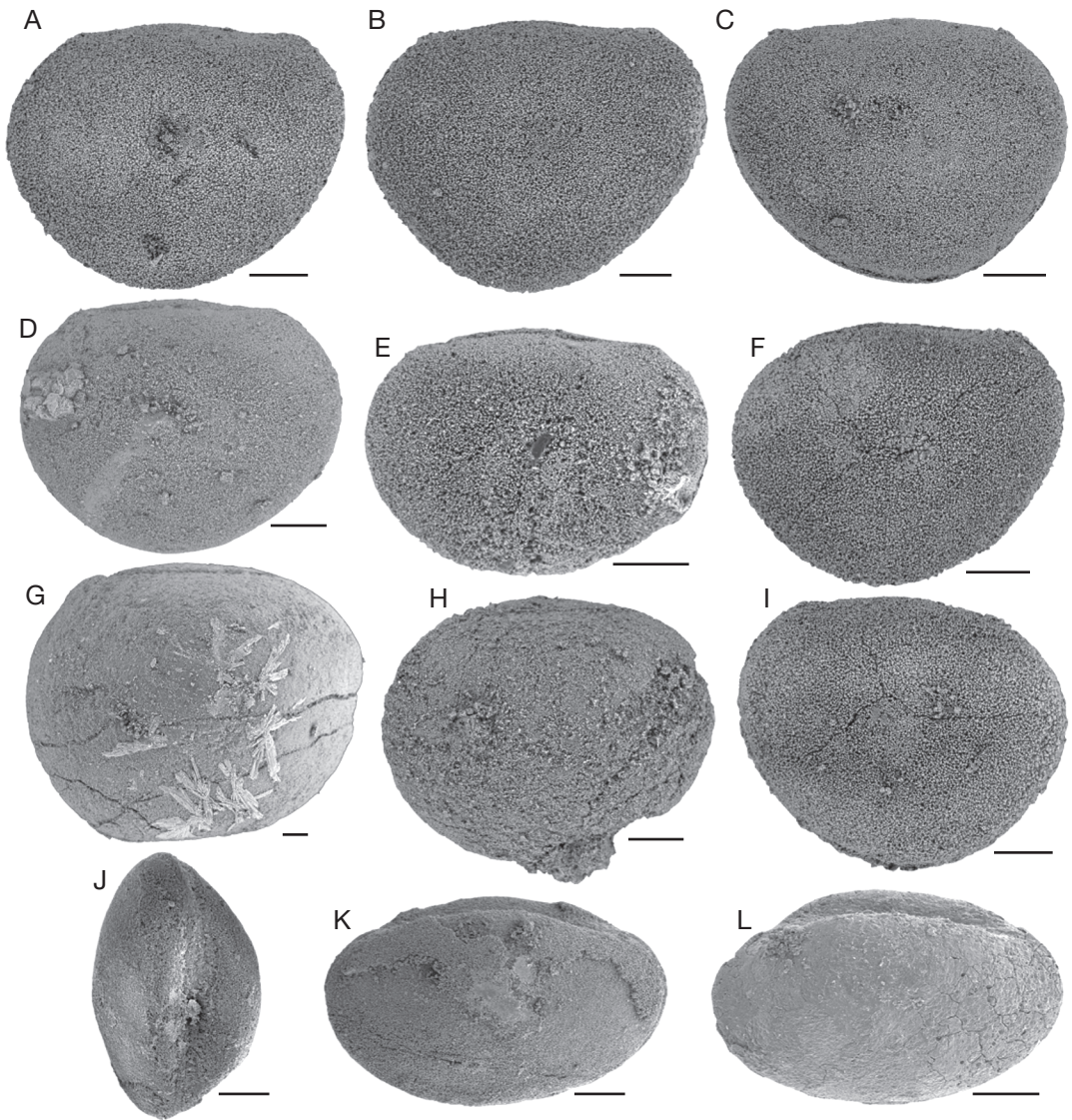


FIG. 13. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-E**, *Samarella viscusforma* Chitnarin n. sp. (see Fig. 15); **A**, holotype, left lateral view of the complete carapace, SUT-09-1394, sample 07PB04-2; **B**, paratype, left lateral view of the complete carapace, SUT-09-1395, sample 07PB04-2; **C**, paratype, right lateral view of the complete carapace, SUT-09-1396, sample 07PB04-5; **D**, left lateral view of the complete carapace, SUT-09-1397, sample 07LB05-A1; **E**, left lateral view of the complete carapace, SUT-09-1398, sample 07LB05-A1; **F, I**, *Samarella* sp. 2; **F**, left lateral view of the complete carapace, SUT-09-1400, sample 07PB04-2; **I**, right lateral view of the complete carapace, SUT-09-1401, sample 07PB04-2; **G-H**, *Samarella* sp. 3; **G**, left lateral view of the complete carapace, SUT-09-1402, sample 07LB05-D3; **H**, right lateral view of the complete carapace, SUT-09-1403, sample 07LB05-D2; **J-L**, *Microcoelonella takliensis* Chitnarin n. sp. (see Fig. 16); **J**, paratype, dorsal view of the complete carapace, SUT-09-1356, sample 07LB05-2; **K**, holotype, left lateral view of the complete carapace, SUT-09-1354, sample 07LB05-B2; **L**, paratype, left lateral view of the complete carapace, SUT-09-1355, sample 07LB05-2. Scale bars: 100 μ m.

OCCURRENCES. — Central Thailand, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB04-5); Ban Naen Sawan II section, Tak Fa Formation, Phetchabun Province, Middle Permian (sample 07PB08-2); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (sample 07LB05-B3).

DIMENSIONS. — H = 0.19-0.45 mm, L = 0.37-0.94 mm, H/L = 0.41-0.53.

DISCUSSION

Kozur (1985) described *Kellettina ultima* Kozur, 1985 from Bükk Mountains, Hungary, early Late Permian; the described specimens (Kozur 1985: 33, pl. 8, fig. 1) belong to the genus *Knightina* according to the presence of a kirkbyan pit. Specimens from Thailand are close to *Knightina ultima* (Kozur, 1985) in general shape of the carapace, but differ by the smaller antero-dorsal knob, the bigger postero-dorsal knob, the smaller size of the carapace, and H/L smaller than the types of Kozur (1985).

Knightina sp.
(Fig. 18B)

MATERIAL. — One incomplete carapace.

OCCURRENCE. — Northeastern Thailand, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, Early Permian (sample 08LO02-2).

DIMENSIONS. — H = 0.37 mm, L = 0.76 mm, H/L = 0.48.

DISCUSSION

Knightina sp. is characterised by a subrectangular carapace in lateral view, ACA and PCA are nearly 90°. Greatest L is located at DB, greatest H is located in front of mid L. This specimen is assigned to genus *Knightina* based on its faint kirkbyan pit. However, the postero-dorsal shoulder which is a specific character of the genus is not clear in this specimen.

Knightina? sp.
(Fig. 18A)

MATERIAL. — 4 complete carapaces.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-C1, 07LB05-D2).

DIMENSIONS. — H = 0.21-0.31 mm, L = 0.37-0.60, H/L = 0.53-0.56.

DISCUSSION

Knightina? sp. is characterised by obtuse ACA and PCA, well-developed posterior shoulder, and presence of marginal rim which suggest that the specimens of the Central Thailand may be congeneric with the genus *Knightina*. *Knightina?* sp. has subrectangular carapace, faint lobes, clear postero-dorsal shoulder, and possibly two marginal rims. Preservation is not good enough for more precise identification.

Genus *Reviya* Sohn, 1961

TYPE SPECIES. — *Amphissites? obesus* Croneis & Gale, 1939 by subsequent designation of Sohn (1961).

Reviya subsompongensis Chitnarin, 2008
(Fig. 18F)

Reviya subsompongensis Chitnarin in Chitnarin, Crasquin, Chonglakmani, Broutin, Grote & Thanee, 2008: 347, figs 3 (14-16).

MATERIAL. — 7 incomplete carapaces.

OCCURRENCES. — Tak Fa Formation, Bung Sam Phan District, Phetchabun Province, Central Thailand, Middle Permian (Chitnarin *et al.* 2008);

Central Thailand, Phu Phra That section, Pha Nok Khao Formation, Phetchabun Province, Middle Permian (samples 08PB02-6, 08PB02-4, 08PB03-3).

DIMENSIONS. — H = 0.37-0.41 mm, L = 0.67-0.70 mm, H/L = 0.55-0.59.

DISCUSSION

Reviya subsompongensis is recognised by thick and smooth marginal rim and distinct postero-dorsal shoulder. The specimens recovered in this study are not well preserved and not abundant.

Genus *Shleesha* Sohn, 1961

TYPE SPECIES. — *Kirkbya pinguis* Ulrich & Bassler, 1906.

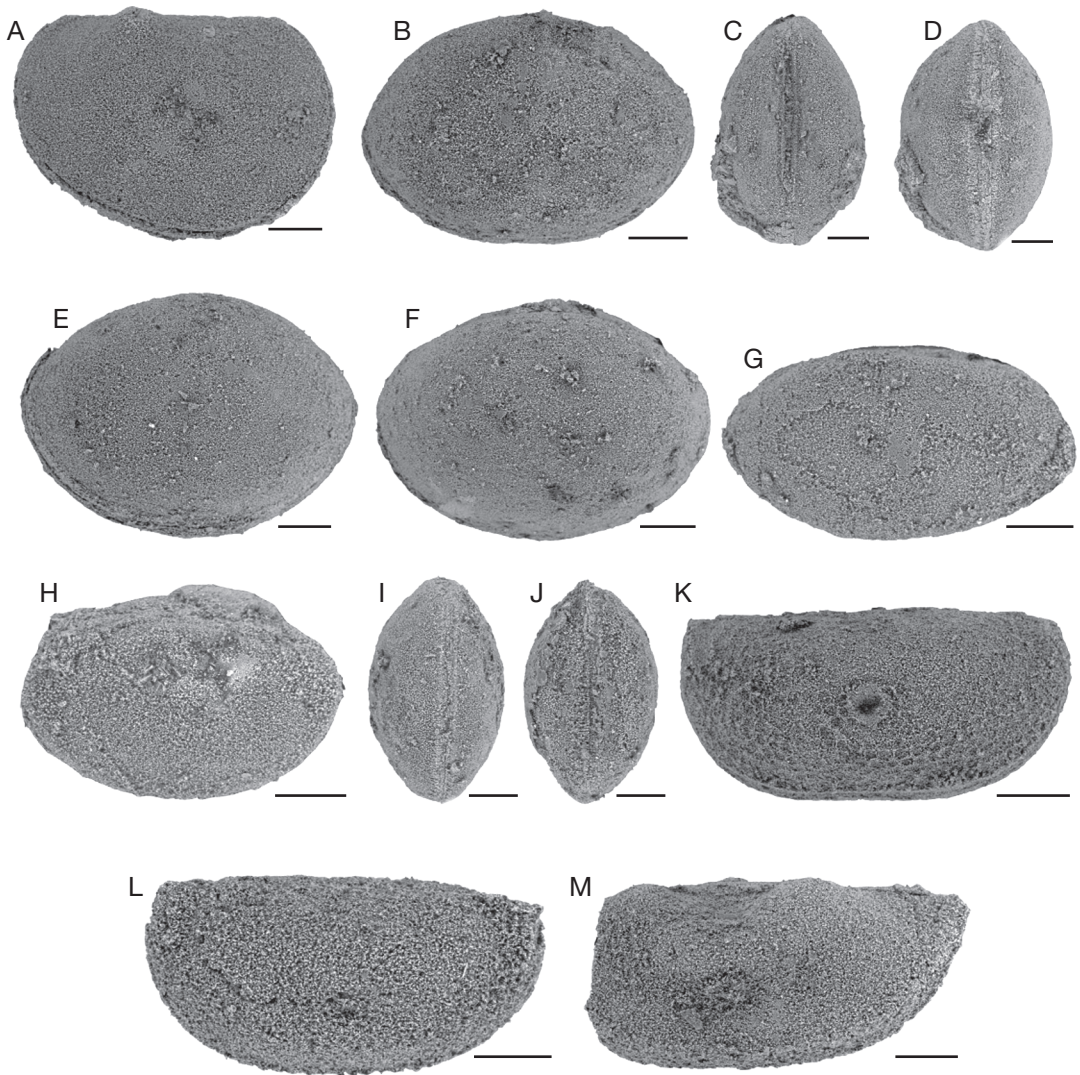


FIG. 14. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A**, *Shishaella?* sp., right lateral view of the complete carapace, SUT-09-1403, sample 07LB05-D2; **B-F**, *Microcoelionella takfaensis* Chitnarin n. sp. (see Fig. 17); **B**, holotype, left lateral view of the complete carapace, SUT-09-1357, sample 07LB05-A1 (see Fig. 16); **C**, dorsal view of the complete carapace, SUT-09-1359, sample 07LB05-D2; **D**, ventral view of the complete carapace, SUT-09-1360, sample 07LB05-D2; **E**, paratype, right lateral view of the complete carapace, SUT-09-1361, sample 07LB05-D2; **F**, paratype, left lateral view of the complete carapace, SUT-09-1362, sample 07LB05-D3; **G-J**, *Microcoelionella?* sp.; **G**, left lateral view of the complete carapace, SUT-09-1363, sample 07LB05-A1; **H**, right lateral view of the complete carapace, SUT-09-1364, sample 07LB05-A1; **I**, dorsal view of the complete carapace, SUT-09-1365, sample 07LB05-A1; **J**, ventral view of the complete carapace, SUT-09-1366, sample 07LB05-A1; **K**, *Kirkbya* sp. 1, left lateral view of the complete carapace, SUT-09-1419, sample 07PB03-5; **L**, *Kirkbya* sp. 2, left lateral view of the complete carapace, SUT-09-1420, sample 07PB03-5; **M**, *Kirkbya* sp. 3, left lateral view of the incomplete carapace, SUT-09-1421, sample 08LO02-5. Scale bars: 100 µm.

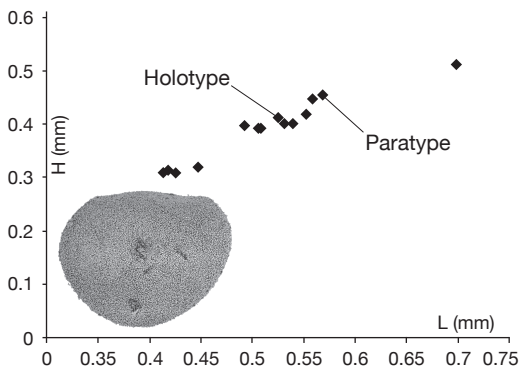


FIG. 15. — Height-length graph of *Samarella vicusforma* Chitnarin n. sp. Holotype, SUT-09-1394, sample 07PB04-2.

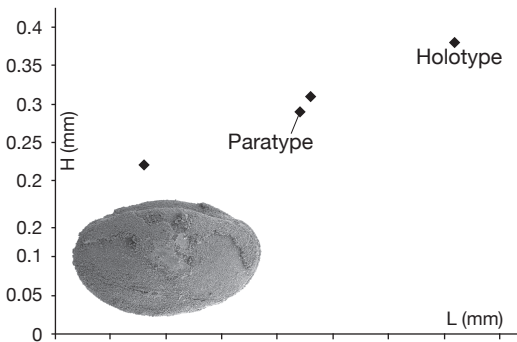


FIG. 16. — Height-length graph of *Microcoeloneilla takliensis* Chitnarin n. sp. Holotype, SUT-09-1357, sample 07LB05-A1.

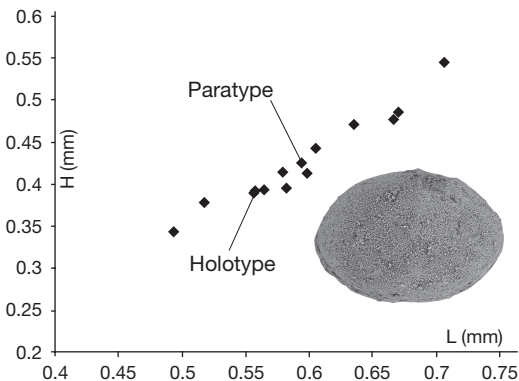


FIG. 17. — Height-length graph of *Microcoeloneilla takfaensis* Chitnarin n. sp. Holotype, SUT-09-1354, sample 07LB05-B2.

Shleesha sp.
(Fig. 18I)

MATERIAL. — One incomplete carapace.

OCCURRENCE. — Central Thailand, Phu Phra That section, Pha Nok Khao Formation, Phetchabun Province, Middle Permian (sample 08PB02-3).

DISCUSSION

This species is attributed to genus *Shleesha* by presence of distinct median node.

Family AMPHISSITIDAE Knight, 1928

Genus *Polytylites* Cooper, 1941

TYPE SPECIES. — *Polytylites geniculatus* Cooper, 1941.

Polytylites sp.
(Fig. 18G, H)

MATERIAL. — 6 complete carapaces and 3 incomplete carapaces.

OCCURRENCES. — **Northeastern Thailand**, Sak Chai Quarry section, Pha Nok Khao Formation, Loei Province, Early Permian (samples 08LO07-1, 08LO07-8); **central Thailand**, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (sample 07LB05-2).

DIMENSIONS. — H = 0.31-0.46 mm, L = 0.62-0.71 mm, H/L = 0.51-0.53.

DISCUSSION

Specimens from Thailand are assigned to *Polytylites* sp. based on features such as a large and distinct median node (about 1/3 of L), presence of a kirkbyan pit located just below the node, and of a postero-dorsal shoulder. However, reticulation of the surface is not preserved. *Polytylites* sp. differs from *P. sullivaensis* (Payne, 1937) described in the Late Pennsylvanian of Shelburn Group, Hayden branch Formation, United States of America (Payne 1937) by the larger and more distinct central node.

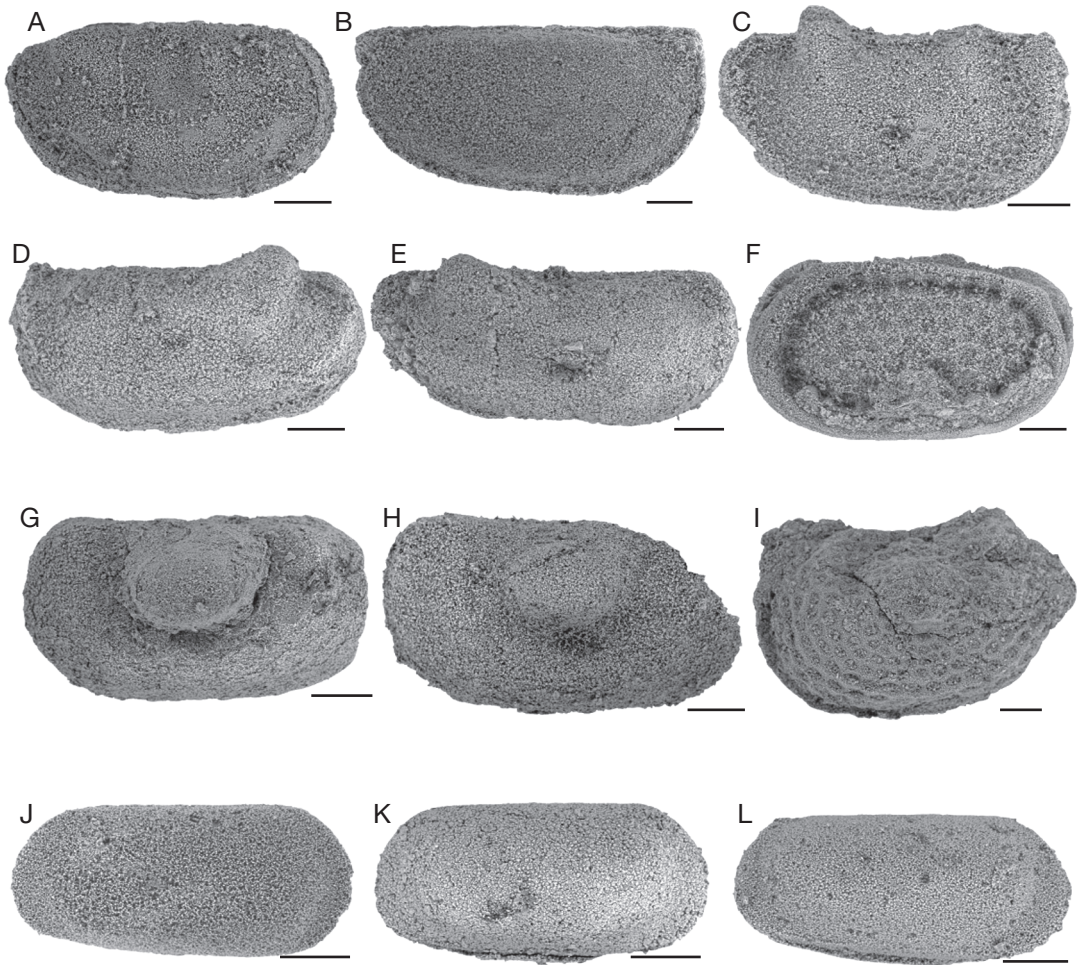


FIG. 18. — Ostracods from Indochina block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A**, *Knightina?* sp., right lateral view of the complete carapace, SUT-09-1423, sample 07LB05-C1; **B**, *Knightina* sp., right lateral view of the complete carapace, SUT-09-1425, sample 08LO02-2; **C-E**, *Knightina* cf. *ultima* Kozur, 1985; **C**, right lateral view of the complete carapace, SUT-09-1431, sample 07PB08-2; **D**, left lateral view of the incomplete carapace, SUT-09-1433, sample 07PB04-5; **E**, right lateral view of the incomplete carapace, SUT-09-1434, sample 08PB01; **F**, *Reviya subsompongensis* Chitnarin, 2008, left lateral view of the complete carapace, SUT-09-1426, sample 08PB02-6; **G, H**, *Polytylites* sp.; **G**, left lateral view of the complete carapace, SUT-09-1428, sample 08LO07-1; **H**, left lateral view of the broken carapace, SUT-09-1429, sample 08LO07-8; **I**, *Shleesha* sp., lateral view of the incomplete carapace, SUT-09-1435, sample 08LO07-1; **J-L**, *Permoyoungiella* sp. 1; **J**, right lateral view of the complete carapace, SUT-09-1473, sample 08LO02-2; **K**, right lateral view of the complete carapace, SUT-09-1474, sample 07PB04-2; **L**, right lateral view of the complete carapace, SUT-09-1475, sample 07PB04-5. Scale bars: 100 μ m.

Superfamily YOUNGIELLOIDEA Kellert, 1933
 Family YOUNGIELLIDAE Kellert, 1933

Genus *Permoyoungiella* Kozur, 1985

TYPE SPECIES. — *Permoyoungiella bogschi* Kozur, 1985.

Permoyoungiella sp.
 (Fig. 18J-L)

MATERIAL. — 4 complete carapaces.

OCCURRENCES. — **Northeastern Thailand**, Tham Nam Maholan section, Nam Maholan Formation, Loei Province, Early Permian (sample 08LO02-2);

central Thailand, Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (samples 07PB04-2, 07PB04-5).

DIMENSIONS. — H = 0.22-0.24 mm, L = 0.49-0.50 mm, H/L = 0.45-0.47.

DISCUSSION

The genus *Permoyoungiella* can be recognised by small and elongate-oblong carapace, smooth or faintly reticulated surface. *Permoyoungiella* sp. has an AB larger than PB, straight VB, narrow overlap of LV over RV at VB, and carapace flattened laterally.

Superfamily HOLLINOIDEA Swartz, 1936

Family HOLLINELLIDAE Bless & Jordan, 1971

Genus *Hollinella* Coryell, 1928

TYPE SPECIES. — *Hollinella dentata* Coryell, 1928.

Subgenus *Hollinella*

Hollinella (Hollinella) martensiformis
Crasquin, 2010
(Fig. 19A-D)

Hollinella martensiformis Crasquin in Crasquin, Forel, Feng, Yuan, Baudin & Collin, 2010a: 336, fig. 4D-F.

MATERIAL. — 23 complete carapaces and 3 incomplete carapaces.

OCCURRENCES. — Meishan section, South China, Late Permian (Crasquin *et al.* 2010a);

central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (samples 07PB03-1, 07PB03-3, 07PB03-5); Nong Phai section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (07PB04-5); Phu Lam Yai section, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (samples 07LB04-8, 07LB04-10, 07LB04-12, 07LB04-17); Khao Phu Chongkho locality, Tak Fa Formation, Nakhon Sawan Province, Late Early Permian (sample 07LB09-1); Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-C1, 07LB05-D2, 07LB05-D3).

DIMENSIONS. — H = 0.21-0.58 mm, L = 0.37-1.06 mm, H/L = 0.53-0.56.

DISCUSSION

The genus *Hollinella* is characterised by a bilobate carapace and the presence of adventral structures. *Hollinella (H.) martensiformis* can be recognised by the presence of a frill formed by a row of small tubercles along the free margins, and faint lobes. The studied specimens vary from small to large sizes which are comparable to specimens found in the latest Permian of Meishan section in South China (Crasquin *et al.* 2010a). The ACA and PCA vary from 110-130° and 110-125°, respectively that is the smaller carapace has the smaller cardinal angles. *Hollinella (H.) martensiformis* can be differentiated from *H. martensi* Crasquin-Soleau, 1999 from the Middle Permian of Oman Sultanate (Crasquin-Soleau *et al.* 1999) by the sharper ACA and PCA, and the fainter lobes.

Hollinella (Hollinella) herrickiana (Girty, 1909)
(Fig. 19E, F)

Hollina herrickiana Girty, 1909: 115, pl. 8, figs 10, 11.

Hollinella herrickiana [sic] – Kellett 1929: 197; 1934: 626. — Delo 1930: 156, pl. 12, fig. 4. — Bassler & Kellett 1934: 333.

Hollinella tuberculata – Belousova 1965: 254, pl. 46, fig. 2a-c. — Non Gorak, 1958.

Hollinella (Hollinella) herrickiana – Bless & Jordan 1972: 38, 39. — Lethiers *et al.* 1989: 230, pl. 1, figs 2-4. — Crasquin-Soleau *et al.* 1999: pl. 2, fig. 5.

MATERIAL. — Two incomplete valves.

OCCURRENCES. — Yeso Formation, New Mexico (USA), Early Permian; Texas (USA), Late Carboniferous (Girty 1909; Kellett 1929; Delo 1930; Bassler & Kellett 1934); Caucasus (U.S.S.R.), ?Late Permian (Belousova 1965); Merbah el Oussif Unit, Jebel Tebaga, Tunisia, late Middle Permian (Lethiers *et al.* 1989); Khuff Formation, Sultanate of Oman, Middle Permian (Crasquin-Soleau *et al.* 1999);

central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB03-3).

DIMENSIONS. — H = 0.471-0.684 mm, L = 0.857-1.06 mm, H/L = 0.55-0.64.

DISCUSSION

These specimens are assigned to *H. (H.) herrickana* from the Late Carboniferous-Middle Permian of USA, Russia, Arabia, Tunisia, by long and connecting L1 and L2, bulbous L3 and velate structure.

?*Hollinella (Hollinella) herrickana* (Girty, 1909)
(Fig. 19G)

MATERIAL. — 2 incomplete valves.

OCCURRENCE. — Central Thailand, Khao Kana section, Pha Nok Khao Formation, Phetchabun Province, Early Permian (sample 07PB03-3).

DISCUSSION

General appearance of both valves suggests the *H. (H.) herrickana*; however, the postero-dorsal spine on LV is an unusual feature which is found only on the studied specimen.

Hollinella? sp. (Fig. 19H)

MATERIAL. — One incomplete carapace.

OCCURRENCE. — Central Thailand, Phu Phra That section, Pha Nok Khao Formation, Phetchabun Province, Middle Permian (sample 08PB03-3).

DIMENSIONS. — H = 0.31 mm, L = 0.79 mm, H/L = 0.63.

DISCUSSION

This specimen is assigned with doubt to *Hollinella* based on the presence of bulbous L3 and possible adventral structure, but preservation is poor.

Superfamily indet.

Family COELONELLIDAE Sohn, 1971

Genus *Microcoelonella* Coryell & Sohn, 1938

TYPE SPECIES. — *Microcoelonella scantia* Coryell & Sohn, 1938.

Microcoelonella takliensis Chitnarin n. sp.

(Figs 13J-L; 16)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 13K), SUT-09-1354.

Paratypes, complete carapace (Fig. 13L), SUT-09-1355, complete carapace (Fig. 13J), SUT-09-1356.

ETYMOLOGY. — From the type locality at Ta Kli District.

MATERIAL. — 107 complete carapaces and five incomplete carapaces.

DIMENSIONS. — H = 0.29-0.38 mm, L = 0.52-0.66 mm, H/L = 0.56-0.58.

TYPE HORIZON. — Sample number 07LB05-B2, Ta Kli section, Tak Fa Formation, Capitanian? late Middle Permian.

TYPE LOCALITY. — Ta Kli section (15°19'05"N, 100°22'46"E), Nakhon Sawan Province, Central Thailand.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-2, 07LB05-A1, 07LB05-B1, 07LB05-B2, 07LB05-B3, 07LB05-D2, 07LB05-D3).

DIAGNOSIS. — Species of *Microcoelonella* with subelliptical carapace in lateral view, slightly convex DB, and H/L = 0.56-0.58.

DESCRIPTION

Carapace long and subelliptical in lateral view; dorsal outline arched; DB slightly convex at booth valves; hinge invaginated, dorsum widely incised; AB round, with maximum convexity located above mid H; VB convex; PB round, with maximum convexity located above mid H, at the same level than AB; greatest H located in front of mid L; RV larger and overlapping LV on free margins; dorsal view subelliptical, greatest thickness located at mid L; surface smooth; H/L = 0.56-0.58.

DISCUSSION

Subelliptical carapace, slightly convex DB, channelled dorsum, narrow overlap along the free margin are the specific characters of *Microcoelonella takliensis* n. sp. *Microcoelonella takliensis* n. sp. can be compared to *M. longula* Chen, 1958 from Early Permian of Chisia Limestone at Nanking, south China (Chen 1958); however, specimens from Thailand have smaller H/L ratio and narrower overlap of RV on LV along free margins than the Chinese species.

Microcoelonella takfaensis Chitnarin n. sp.
(Figs 14B-F; 17)

TYPE MATERIAL. — **Holotype**, complete carapace (Fig. 14B), SUT-09-1357.

Paratypes, complete carapace (Fig. 14E), SUT-09-1361, complete carapace (Fig. 14F), SUT-09-1362.

ETYMOLOGY. — From the type level, the Tak Fa Formation.

MATERIAL. — 33 complete carapaces and three incomplete carapaces.

DIMENSIONS. — H = 0.34-0.48 mm, L = 0.49-0.67 mm, H/L = 0.63-0.74.

TYPE HORIZON. — Sample number 07LB05-A1, Ta Kli section, Tak Fa Formation, Capitanian? late Middle Permian.

TYPE LOCALITY. — Ta Kli section (15°19'05"N, 100°22'46"E), Nakhon Sawan Province, Central Thailand.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (samples 07LB05-A1, 07LB05-B1, 07LB05-B2, 07LB05-B3, 07LB05-D2, 07LB05-D3).

DIAGNOSIS. — Species of *Microcoelonella* with subelliptical carapace in lateral view, highly convex DB, and H/L = 0.63-0.74.

DESCRIPTION

Carapace subelliptical in lateral view; dorsal outline highly arched; DB highly convex; hinge invaginated, dorsum widely incised; AB round, maximum convexity located above mid H; VB convex; PB round with maximum convexity located above mid H, at the same level to AB; greatest H located in front of mid L; RV larger and overlapping LV on free margins; dorsal view subelliptical in shape, greatest W located at mid L; surface smooth.

DISCUSSION

Microcoelonella takfaensis n. sp. can be differentiated from *M. takliensis* n. sp. (see above) by its greater H/L ratio and more convex DB.

Microcoelonella? sp.
(Fig. 14G-J)

MATERIAL. — 28 complete carapaces and 4 incomplete carapaces.

OCCURRENCE. — Central Thailand, Ta Kli section, Tak Fa Formation, Nakhon Sawan Province, Middle Permian (sample 07LB05-A1).

DIMENSIONS. — H = 0.27 mm, L = 0.43-0.50 mm, H/L = 0.54-0.62.

DISCUSSION

The specimens are assigned to *Microcoelonella* with doubt because of the absence of V-shape trough on DB. *Microcoelonella?* sp. is similar to *Microcoelenella* sp. of Chen (1958) from Early Permian of Kwanshan and Lungtan sections, Chihhsia Limestone, Nanking Province, South China (Chen 1958) in lateral outline. The V-shape trough on DB (channelled dorsum) which is an important feature of the genus is absent in *Microcoelonella?* sp.

PALAEOECOLOGICAL REMARKS OF THE PALAEOCOPIDA OSTRACODS

The palaeoecology of Late Palaeozoic ostracods at families and/or superfamilies is relatively well known according to researches of Peterson & Kaesler (1980), Crasquin (1984), Costanzo & Kaesler (1987) and Melnyk & Maddocks (1988). According to the previous works as mentioned prior, the characteristics of the palaeocopid ostracods can be summarised as follows: Kloedenelloidea are found in very shallow paleoenvironments, on stable, soft substrates with a wide range of salinity; the Kirkbyoidea were inhabitants of shallow water environments, on firm calcareous mud substrates, under normal marine conditions; Hollinoidea lived in shallow to very shallow water environments, on firm and stable substrates, with a wide range of salinity, large species with developed adventral structure may indicate marginal environments; the Youngielloidea lived in shallow water environments with normal salinity; Paraparchitidae lived in shallow to deep water, on firm terrigenous mud substrates with wide range of salinity; Aparchitidae are found in deep water paleoenvironments. The palaeoecology of a particular study section can be examined by the general composition of the ostracod assemblages; that is, not only the Order

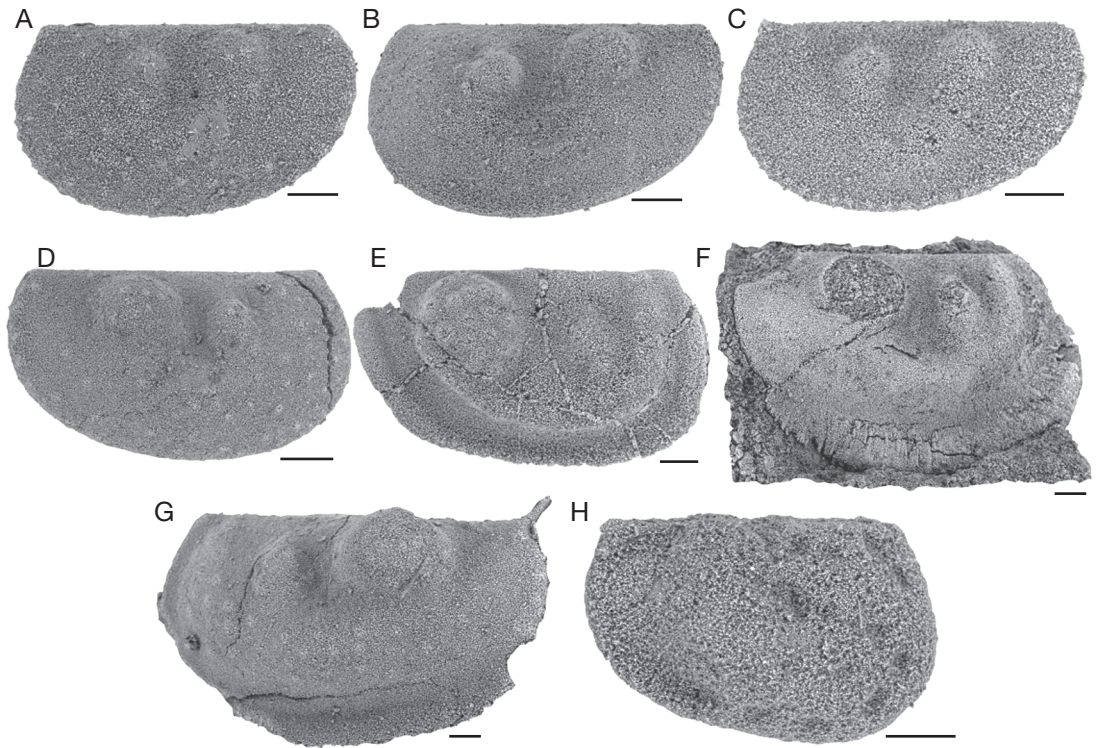


Fig. 19. — Ostracods from Indochina Block limestones, Central Thailand. All specimens are stored at the Suranaree University of Technology Collections (Nakhon Ratchasima, Thailand): **A-D**, *Hollinella (Hollinella) martensiformis* Crasquin, 2010; **A**, left lateral view of the complete carapace, SUT-09-1479, sample 07PB03-3; **B**, left lateral view of the complete carapace, SUT-09-1480, sample 07PB03-5; **C**, right lateral view of the complete carapace, SUT-09-1481, sample 07PB03-3; **D**, left lateral view of the complete carapace, SUT-09-1482, sample 07PB04-5; **E, F**, *Hollinella (Hollinella) herrickana* (Girty, 1909); **E**, right lateral view of the incomplete carapace, SUT-09-1483, sample 08PB03-2; **F**, right lateral view of the incomplete carapace, SUT-09-1484, sample 08PB03-3; **G**, *?Hollinella (Hollinella) herrickana* (Girty, 1909), left lateral view of the incomplete carapace, SUT-09-1485, sample 07PB03-3; **H**, *Hollinella?* sp., right lateral view of the complete carapace, SUT-09-1487, sample 08PB03-3. Scale bars: 100 µm.

Palaeocopida but also the Order Podocopina have to be counted (Crasquin-Soleau & Baud 1998; Crasquin-Soleau *et al.* 1999, 2005; Chitnarin *et al.* 2008). The palaeoecological interpretation is beyond the scope of this paper. However, the palaeocopids discovered in this study provide information on the palaeoenvironment of the limestones of the Indochina block. Members of Kloedenelloidea such as *Sargentina chantarameei* n. sp. and *Geffenina posterodorsospina* n. sp. (the Khao Kana section, 07PB03); *Langdaia meesooki* n. sp. and *G. mariebeatriceae* n. sp. (the Phu Lam Yai section, 07LB04) suggest very shallow water

palaeoenvironments. Especially for the Khao Kana section where kloedenellids occupy most of the assemblages, the palaeoenvironment should be the shallowest, possibly the intertidal zone. Members of Hollinoidea and Kirkbyoidea are usually found associated with kloedenellids that confirm the shallow environments; for instance, at Khao Kana (07PB03) and Phu Pra That (08PB02-03) sections. It should be noted that these ostracods, shallow water indicators, are usually related with brachiopods and small forams. In contrast, members of the Aparchitidae such as the genus *Cyathus* which are known to live in deep water palaeoenvi-

ronments (Yuan 2008; Yuan *et al.* 2009) suggest the offshore paleoenvironment for the Sak Chai Quarry (08LO07), the Nong Phai (07PB04), and the Ta Kli (07LB05) sections (*C. caperata* and *C. elliptica*). This is also evidenced by the presence of fusulinaceans which indicates the normal salinity away from freshwater influence (at 08LO07 and 07PB04) and the presence of intercalations of thin bedded limestones with black shales and the presence of high diversity of the ostracod species (at 07LB05). Members of the Paraparchitidae such as *Samarella sonei* n. sp. and *S. viscusforma* n. sp., associated with genus *Cyathus* are interpreted here to represent the offshore zone of open marine paleoenvironments. The genus *Microcoelonella* of family Coelonellidae has never been analysed for palaeoecology due to rare discovery (Chen 1958 and this study). In this research, *M. takliensis* n. sp. and *M. takfaensis* n. sp. are associated with the *Cyathus*; thus, it is concluded here that they lived in offshore, open marine environments.

The detail characterisation of the environment by the ostracod fauna will be done with the total fauna (including all the orders) in a future paper.

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