

Discovery of the early Spathian (late Olenekian, Early Triassic) ammonoid *Marcouxia chaiburiensis* at Khao Chingcho, Phatthalung Province, southern Thailand

Kittichai Tongtherm^{1*}, Yasunari Shigeta², Apsorn Sardud³,
Katsuo Sashida^{1,4} and Sachiko Agematsu¹

¹ Graduate School of Life and Environmental Sciences, University of Tsukuba,
1–1–1 Ten-nodai, Tsukuba City, Ibaraki 305–8572, Japan

² Department of Geology and Paleontology, National Museum of Nature and Science,
4–1–1 Amakubo, Tsukuba, Ibaraki 305–0005, Japan

³ Mineral Resources Research and Development Center, Department of Mineral Resources,
Ratchatewi, Bangkok 10400, Thailand

⁴ Geoscience Program, School of Interdisciplinary Studies, Mahidol University,
Kanchanaburi Campus, 199 Moo 9, Sai Yok, Kanchanaburi 71150, Thailand

*Author for correspondence: tongtherm@gmail.com

Abstract Marine Triassic carbonate rocks of the Chaiburi Formation are distributed as isolated mountains protruding through the plain formed by Quaternary sediments in the Phatthalung area, southern Thailand. Until now, it had been difficult to understand the detailed stratigraphic relationships within the formation in each isolated mountain because of the lack of key age-dating tuff beds or identifiable age diagnostic fossils. However, the recent discovery of the early Spathian (late Olenekian, Early Triassic) ammonoid *Marcouxia chaiburiensis* at Khao Chingcho permitted us to correlate this section with the Khao Thong section 8 km to the north-northwest. The dip and strike of the beds in each section are nearly the same, but the *M. chaiburiensis*-bearing beds are significantly offset with respect to each other, indicating that these beds are laterally and/or vertically displaced by faulting.

Key words: Chaiburi Formation, *Marcouxia chaiburiensis*, Phatthalung, Thailand, Triassic

Introduction

The marine Triassic carbonate rocks of the Chaiburi Formation, which belong to the Shan-Thai Terrane, are widely distributed in the Phatthalung area, southern Thailand, and are divided into three members, i.e., the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone, in ascending order (Ampornmaha, 1995). Conodonts, radiolarians and foraminifers indicate that the lower, middle and upper members of the formation can be correlated with the uppermost Induan to lowest Anisian, lowest Anisian to upper Carnian and lower to middle Norian, respectively (Sashida and Igo, 1992; Ampornmaha, 1995, 1996; Ueno *et al.*, 2003; Sardud *et al.*, 2017). Rare mega-fossil occurrences, such as ichthyopterygian remains and ammonoids, have been reported in the formation (Mazin *et al.*, 1991; Tongtherm *et al.*, 2016, 2020).

Most outcrops of the Chaiburi Formation occur as isolated mountains protruding through the plain formed by Quaternary sediments (Figs. 1, 2). Because of the absence of age-datable tuff beds or age-diagnostic fossils, it has been difficult, until now, to accurately correlate the different parts of the formation between the isolated mountain outcrops.

Tongtherm *et al.* (2020) described a new ammonoid species, i.e., *Marcouxia chaiburiensis*, from the Khao Thong section, located 14 km north of the center of Phatthalung. And just recently, we discovered specimens referable to *M. chaiburiensis* at Khao Chingcho, located 8 km south-southeast of the Khao Thong. In this paper, we document the occurrence of this ammonoid for the first time outside of the Khao Thong type locality, and discuss its implications for understanding the stratigraphic relationships of the Chaiburi Formation between the isolated mountains.

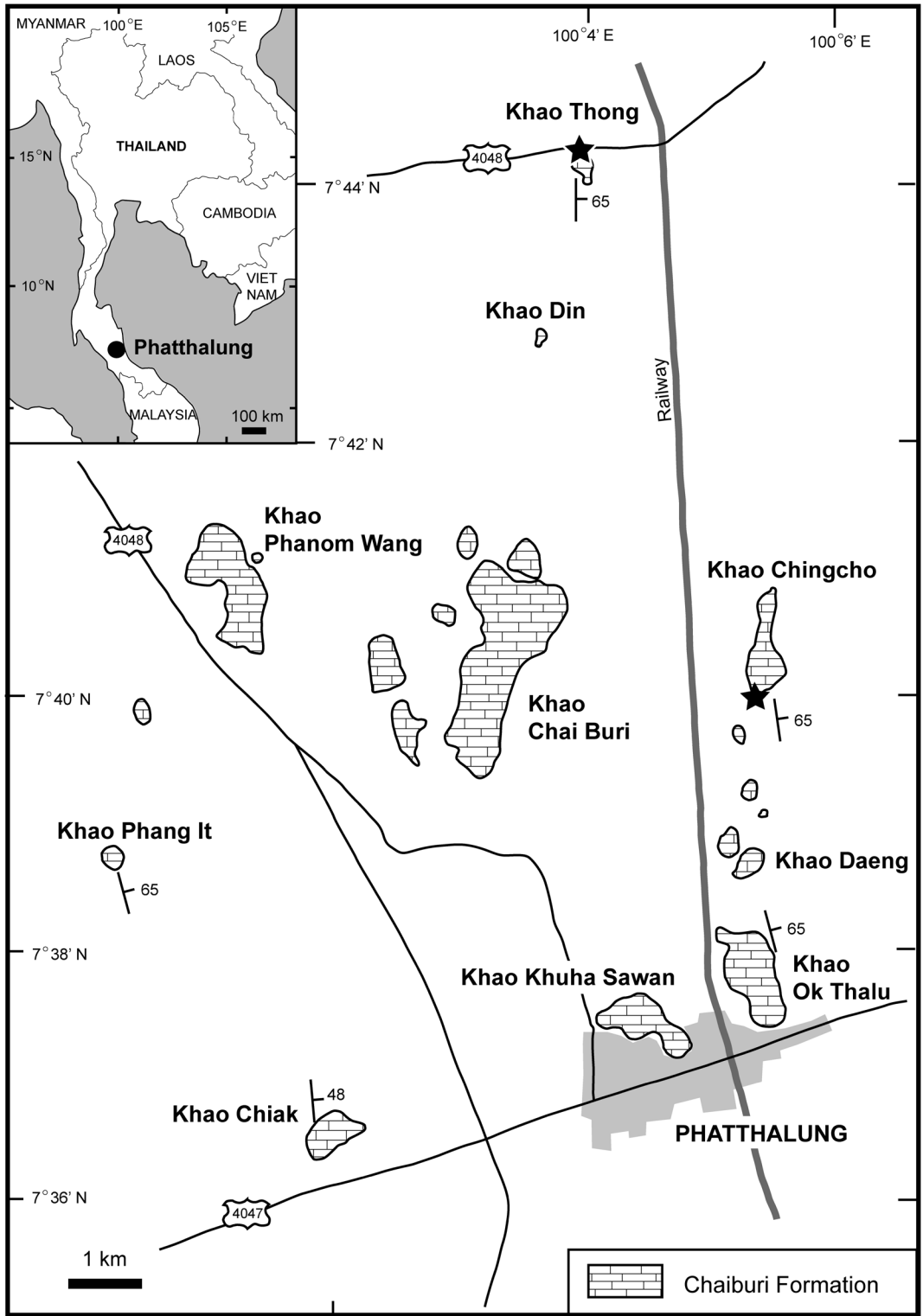


Fig. 1. Geological map of the Phatthalung area, southern Thailand, and localities from which *Marcouxia chaiburiensis* specimens were collected (indicated by stars). The Chaiburi Formation, comprised of marine Triassic carbonate rocks, is distributed as isolated mountain protruding through the plain formed by Quaternary sediments.

Ammonoid occurrences

Located 6 km north-northeast of the center of Phatthalung, the 226 m high carbonate mountain at Khao Chingcho, which contains the newest ammo-

noid occurrences, measures 1.7 km north to south and 0.5 km east to west. The strata in the mountain, consisting of the Chaiburi Formation, strikes N10° westward and dips 65° eastward (Figs. 1, 2).

Specimens referable to *Marcouxia chaiburiensis*

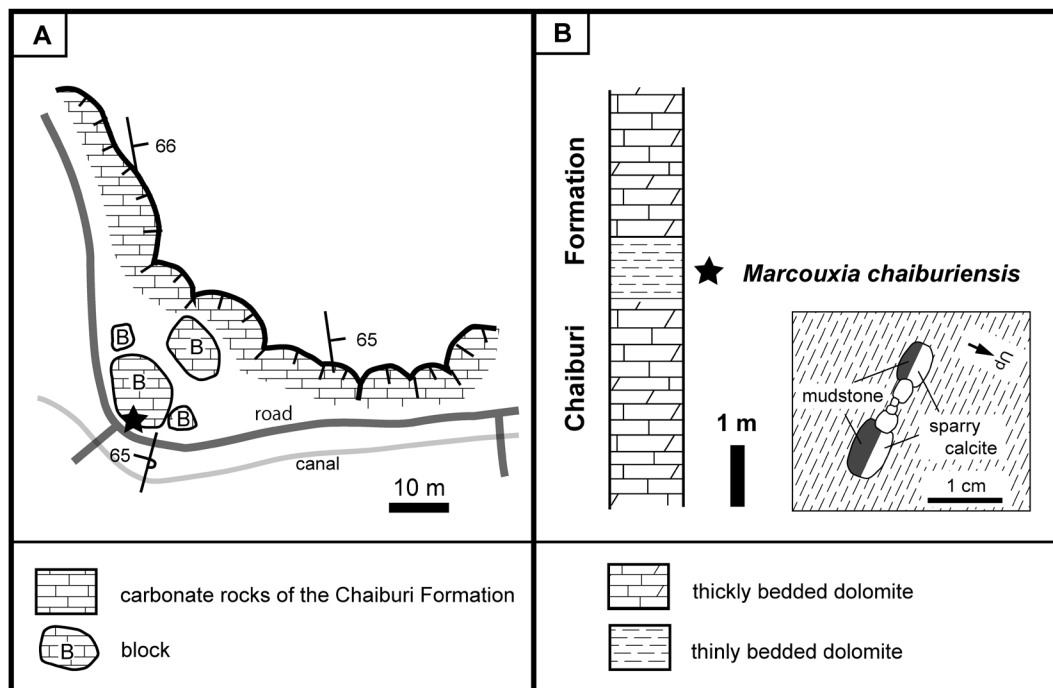


Fig. 2. Locality map (A) and lithology of a huge block of the Chaiburi Formation that fell from the southern end of the mountain at Khao Chingcho ($7^{\circ}40'15''N$, $100^{\circ}5'20.7''E$) and stratigraphic horizon and mode of occurrence of *Marcouxia chaiburiensis* (B). The upper and lower halves of the ammonoid phragmocone are often filled with sparry calcite and calcareous mudstone, respectively, thus exhibiting geopetal structure, which suggests that the block is overturned.

were obtained from a huge block that fell from the southern end of this mountain. Although the strata within the block strike $N15^{\circ}$ westward and dip 65° westward, the geopetal structure within the ammonoid phragmocone suggests that the block is overturned (Fig. 2). The 7 m thick block consists of whitish-pink, thickly bedded dolomite and a 1 m thick, thinly bedded part with *Marcouxia chaiburiensis* (Figs. 2, 3).

Because most ammonoid specimens exist as outer molds due to excessive weathering, it was possible to obtain quality specimens by making silicon rubber casts from the outer molds.

Paleontological description

The systematic description basically follows the classification of Triassic ammonoids established by Shevryev (1986), Tozer (1981) and Guex *et al.* (2010). Morphological terms are those used in Arkell (1957).

Institution abbreviation: NMNS, National Museum of Nature and Science, Tsukuba.

Order Ceratitida Hyatt, 1884
 Superfamily Dinaritoidea Mojsisovics, 1882
 Family Columbidae Spath, 1934
 Genus *Marcouxia* Guex *et al.*, 2005

Type species: *Tirolites astakhovi* Kummel, 1969.

Marcouxia chaiburiensis Tongtherm and Shigeta
 in Tongtherm *et al.*, 2020

Fig. 4

Marcouxia chaiburiensis Tongtherm and Shigeta in Tongtherm *et al.*, 2020, p. 280, figs. 3A–T.

Holotype: NMNS PM35431, figured by Tongtherm *et al.* (2020, p. 280, fig. 3A), from the Phukhaothong Dolomite Member of the Chaiburi Formation at the Khao Thong section, Phatthalung Province, southern Thailand ($7^{\circ}44'16.4''N$, $100^{\circ}03'59.8''E$).

Material examined: Seven specimens, NMNS PM35832–35838, from Khao Chingcho, Phatthalung Province ($7^{\circ}40'15''N$, $100^{\circ}5'20.7''E$; Figs. 1–3). All specimens are silicon rubber casts of outer molds.

Description: Very evolute, fairly compressed shell with quadrate whorl section, arched venter,



Fig. 3. Photographs of the Chaiburi Formation at Khao Chingcho. A, thickly bedded dolomite and thinly bedded dolomite containing *Marcouxia chaiburiensis* (arrow). B, bedding plane of thin bedded dolomite. Most ammonoid specimens exist as outer molds due to excessive weathering, but it is possible to obtain quality specimens by making silicon rubber casts from the outer molds (see Fig. 4).

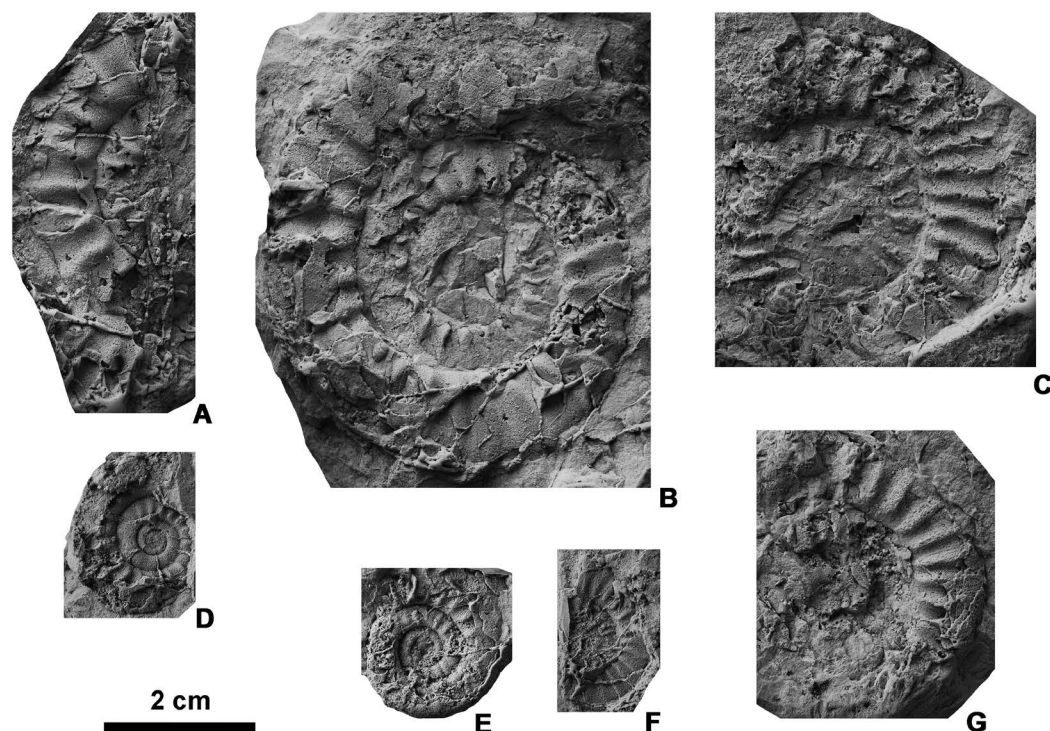


Fig. 4. *Marcouxia chaiburiensis* Tongtherm and Shigeta in Tongtherm *et al.*, 2020, from the Chaiburi Formation at Khao Chingcho in the Phatthalung area. A, NMNS PM35832; B, NMNS PM35833; C, NMNS PM35834; D, NMNS PM35835; E, NMNS PM35836; F, NMNS PM35837; G, NMNS PM35838. All specimens are silicon rubber casts of outer molds.

abruptly rounded ventral shoulders, and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus fairly wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of regularly spaced, numerous, radial or slightly prorsiradiate ribs arising on umbilical shoulder and culminating in spiny tubercles high on ventrolateral shoulder.

Occurrence: *Marcouxia chaiburiensis* occurs in the Phukhaothong Dolomite Member of the Chaiburi Formation, which is correlated with the lower Spathian (Tongtherm *et al.*, 2020).

Discussion

Marcouxia chaiburiensis was described by Tongtherm *et al.* (2020) from the Khao Thong section, located on the north side of an isolated mountain, just south of the Wat Pukhao Thong temple, in which the 85+ m thick Phukhaothong Dolomite Member is well exposed. *Marcouxia chaiburiensis* occurs only within a 4 m thick sequence of thin-bedded dolomite beds in the middle part of the section. We collected 94 ammonoid specimens from these beds (NMNS PM35431–35449, 35512, 35674–

35746, 35790), of which 92 specimens are attributed to *M. chaiburiensis*. As already discussed by Tongtherm *et al.* (2020), the *M. chaiburiensis*-bearing beds belong to the lower Spathian, because the range of the type species of *Marcouxia* is limited to the *Columbites parisianus* Subzone of the lower Spathian in the western USA (Guex *et al.*, 2005, 2010; Jenks *et al.*, 2013).

The occurrence of *Marcouxia chaiburiensis* at Khao Chingcho is the first report of this taxon other than from its type locality Khao Thong. The mode of occurrence is the same at Khao Thong in that it occurs in thin-bedded dolomite beds, suggesting that the *M. chaiburiensis*-bearing beds occur in the same horizon in both sections. The attitude of the beds of the Chaiburi Formation at Khao Thong and Khao Chingcho is nearly the same, but the *M. chaiburiensis*-bearing beds are significantly offset from each other, indicating that the beds are laterally and/or vertically displaced by faulting.

Most of the Chaiburi Formation is distributed as isolated mountains protruding from the Quaternary plan and consequently, it had been difficult to make detailed correlations between these isolated mountain outcrops because of the absence of key age dat-

able horizon such as tuff beds. Because *Marcouxia chaiburiensis* is easily recognizable in the field and its occurrence is limited to a narrow stratigraphic range, this ammonoid may provide an important key for understanding the stratigraphic relationships of the Chaiburi Formation distributed throughout the isolated mountain outcrops as well as the geological structure in the Phatthalung area.

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