

TWO NEW TRIASSIC EUTOMOCERID AMMONOID CEPHALOPODS (AMMONOIDEA: CERATITIDAE) FROM SOUTHEASTERN PENINSULAR THAILAND

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ABSTRACT: Two ceratitid ammonoids of *Eutomoceras* are described as new species based on characters in the internal mold of the phragmocone. The specimens were collected from Khao Ok-Thalu, Chaiburi Formation, Triassic strata in Changwat Phatthalung, southeastern Peninsular Thailand. The two new species share characters of bifurcate ribs, absence of marginal furrows on the ventral keel and round ventrolateral shoulders. The umbilicus is wide with the absence of knots on the shoulder in *E. paladeji* sp. nov., but it is narrower with the presence of knots in *E. wantanae* sp. nov. The new species bring the number of described *Eutomoceras* species to seven. The identification key to species of *Eutomoceras* is proposed herein.

Keywords: new species, Triassic Strata, ceratitid ammonoids, *Eutomoceras*, Peninsular Thailand

INTRODUCTION

Eutomoceras Hyatt, 1887 is one of thirty-two genera belonging to the family Ceratitidae Mojsisovics, 1879. This genus is common in the Middle Triassic (Late Anisian) strata of North America, but rare in Asia (Meek 1877; Hyatt and Smith 1905; Smith 1914; Silberling and Nichols 1982; Arkadiev and Vavilov 1989; Monnet and Bucher 2005; Tongtherm *et al.* 2016). The generic characters based on Meek (1877) greatly resemble *Hungarites* Mojsisovics, 1879 (family Hungaritidae Waagen, 1895), but differ in appearance of the distinct sickle-shaped ribs, the irregular knots, and the extremely high keel (Hyatt and Smith 1905). *Eutomoceras* probably derived from *Hungarites*, because its young stages are almost identical to the adult forms of the latter genus (Hyatt and Smith 1905). Previously *Eutomoceras* consisted of five species. Phragmocone ribs are present in four species of the genus.

Four species of *Eutomoceras* were recorded from the North America continent, Nevada, western USA in 3 zones (Meek 1877; Hyatt and Smith 1905; Smith 1914; Silberling and Nichols 1982; Monnet and Bucher 2005).

E. laubei Meek, 1877 was first discovered from the New Pass, Desatoya Mountain, Nevada (Meek 1877). The single specimen was selected as the type of the genus *Eutomoceras* (Smith, 1914). This species was also found from *Daonella* beds of *Daonella dubia* Zone (Smith, 1914), *Parafrechites dumni* beds of *Parafrechites meeki* Zone and lower *Frechites occidentalis* Zone (Silberling and Nichols, 1982)

E. dumni Smith, 1904 was the second species found in the West Humboldt Range, in the *Daonella dubia* Zone (Smith, 1914), in *Frechites nevadanus* beds and *Parafrechites meeki* beds of *Parafrechites meeki* Zone (Silberling and Nichols, 1982), as well as in the *Gymnotoceras rotelliformis* Zone (Monnet and Bucher, 2005)

E. dalli Smith, 1914 and *E. lahontanum* Smith, 1914 were found in the West Humboldt Range, *Ceratites trinodosus* Subzone, *Daonella dubia* Zone (Smith, 1914) and in *Gymnotoceras blakei* beds of the *Gymnotoceras rotelliformis* Zone (Silberling and Nichols, 1982), where *E. dalli* was also found in the *Gymnotoceras blakei* Subzone (Monnet and Bucher, 2005). *E. lahontanum* is the only species with single ribs.

E. rarum Arkadiev and Vavilov, 1989 was the first species previously recorded outside North America, from the *Gymnoceras rotelliforme* Zone, Kharaulakh range, Artiste-Agatyn-Yurge Creek, right tributary of the Kengdey River in the northern part of Middle Siberia, Russia (Arkadiev and Vavilov 1989). *E. rarum* is the only species with an absence of ribs.

In Asia, Tongtherm *et al.* (2016) also recorded *E. dumni* and *E. laubei* (as *E. aff. laubei*) from the Phukhaothong Dolomite Member, Chaiburi Formation of the Triassic strata at Khao Ok-Thalu, Changwat Phatthalung, peninsular Thailand.

MATERIALS AND METHODS

All materials were collected by Paladej Srisuk in September 1973 as unidentified outcrop fossils from Khao Ok-Thalu (07°37'N, 100°50'E), Amphoe Muang Phatthalung, Changwat Phatthalung, Phukhaothong Dolomite Member, Chaiburi Formation, Early to Middle Triassic (Anisian) strata (Ampornmaha 1995; DMR 2001; Sardud 2001) in the eastern part of the peninsula on the Gulf of Thailand coast (Fig. 1). The geological setting of the locality is described by Tongtherm and Nabhitabhata (2018) and Tongtherm *et al.* (2018). The type specimens have been deposited in the Reference Collections of the Palaeontological Research and Education Center, Mahasarakham University (PRC).

The terminology used in describing morphology, morphometric measurements and indices essentially follows Arkell *et al.* (1957), Wright *et al.* (1996) and Furnish *et al.* (2009). The Thai words used on specimen labels and in the text are Khao (= Mountain), Amphoe (= District), Muang (= City) and Changwat (= Province).

RESULTS

Suborder Ceratitina Hyatt, 1884 Family Ceratitidae Mojsisovics, 1879 Genus *Eutomoceras* Hyatt, 1877

Eutomoceras Hyatt in Meek, 1877: p. 126. - Hyatt and Smith 1905: 129–131. - Arkell *et al.* 1957: L152.

Type species - *Eutomoceras laubei* Meek, 1877

Phragmocone involute, discoidal, laterally compressed, surface ornamented, venter narrow, acute, surmounted by sharp, solid keel, marginal furrows absent. Umbilicus narrow, umbilical shoulders distinct. Ribs radial, dichotomous, curve upward, bend sharply to keel, originated from knots on umbilical shoulders. Knots on ribs small, irregular with intervals. Septa ceratitic. Lobes distinctly serrated. Ventral lobe divided, two lateral lobes principal, auxiliary lobes smaller, numerous. Saddles rounded, entire. (Hyatt 1877; Hyatt and Smith 1905; Arkell *et al.* 1957).

Eutomoceras paladeji sp. nov.

Fig. 2 (A–C)

Diagnosis. Umbilical zone slightly concave, angle rounded. Venter narrow. Keel entire. Ribs bundle, falcoid, thick and thin alternate. Knots absent on umbilicus and lateral whorl.

Material examined

Holotype: PRC-SHM-KO-53, diameter 55.4 mm, Chaiburi formation, Triassic rock, Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand, 07°37'N, 100°50'E, collector P. Srisuk, 2 September 1973.

Paratypes: PRC-SHM-KO-58, diameter 38.0 mm, PRC-SHM-KO-139, diameter 14.1 mm, Chaiburi formation, Triassic rock, Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand, 07°37'N, 100°50'E, collector P. Srisuk, 2 September 1973.

Other Materials: PRC-SHM-KO-57, diameter 32.9 mm, PRC-SHM-KO-625, diameter 29.2 mm, Chaiburi formation, Triassic rock, Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand, 07°37'N, 100°50'E, collector P. Srisuk, 2 September 1973.

Description. Phragmocone preserved, beloconic, diameter 14.1–55.4 mm. Whorl height 7.6–22.1 mm, 37.3–54.4% of diameter, oval, compressed, widest on median flank, width 19.1% of diameter, slightly compressed on median to venter. Keel present on venter, sharp, entire, height 0.4–1.2 mm, 1.4–3.3% of diameter, width 0.5–1.3 mm, 1.7–3.6% of diameter. Umbilicus circular, diameter 4.6–13.0 mm, 19.4–32.7% of diameter, expand on inner and outer whorl, shoulder abrupt sloping. Knots absent on umbilicus and lateral whorl. Ribs

Two new Triassic eutomocerid ammonoid cephalopods

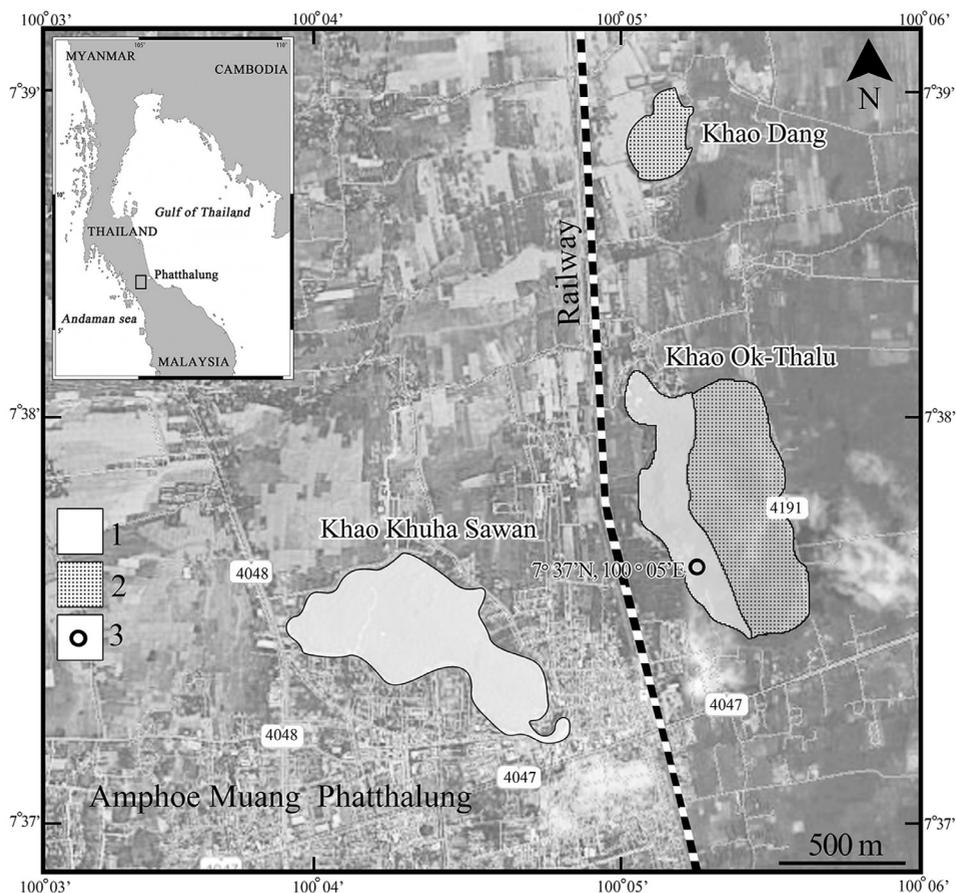


Figure 1. Type locality; Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand; 1. Phukhaothong Dolomite Member, Khao Khuha-Sawan; 2. Chiak Limestone Member, the eastern zone of Khao Ok-Thalu; 3. Specimen collection site (circle, $7^{\circ}37'N$, $100^{\circ}05'E$) (Modified from Google map after Tongtherm and Nabhitabhata (2018), number are highway numbers).

present on inner and outer whorl (1st to 5th whorl), direction prorsiradate, from umbilical shoulder to keel basement, thick and thin alternate, falcid, bundle, blunt. Thick ribs widest, distant, 46–64 ribs on whorl, distance 0.7–1.4 mm, 1.4–10.3% of diameter, width 0.7–1.4 mm, 1.9–9.0% of diameter. Thin ribs fasciculate.

Distribution. Known only from the type locality.

Etymology. The name ‘*paladeji*’ (Latin for “Paladej”) commemorate the collector of type-specimens, Paladej Srisuk, Palaeontological Research and Education Center, Mahasarakham University.

Remarks. The absence of marginal furrows on keel basement is similar in *E. dumni* and *E. paladeji* (Smith 1914; Silberling and Nichols 1982; Monnet and Bucher 2005), but the latter species can be distinguished from the former one by its round ventrolateral shoulder. *E. laubei* and *E. paladeji* sp. nov. are the only two taxa with bundle ribs and a sharp thin keel (Meek 1887; Hyatt & Smith 1905; Smith 1914). Knots are present on the umbilicus and lateral whorl in *E. laubei* (Meek, 1887), but absent in *E. paladeji* sp. nov. *E. laubei* (Meek, 1887) carried an angular ventrolateral shoulder with weak marginal furrows on keel basement, but *E. paladeji* are with the narrow ventrolateral shoulder and the absence of marginal furrows.

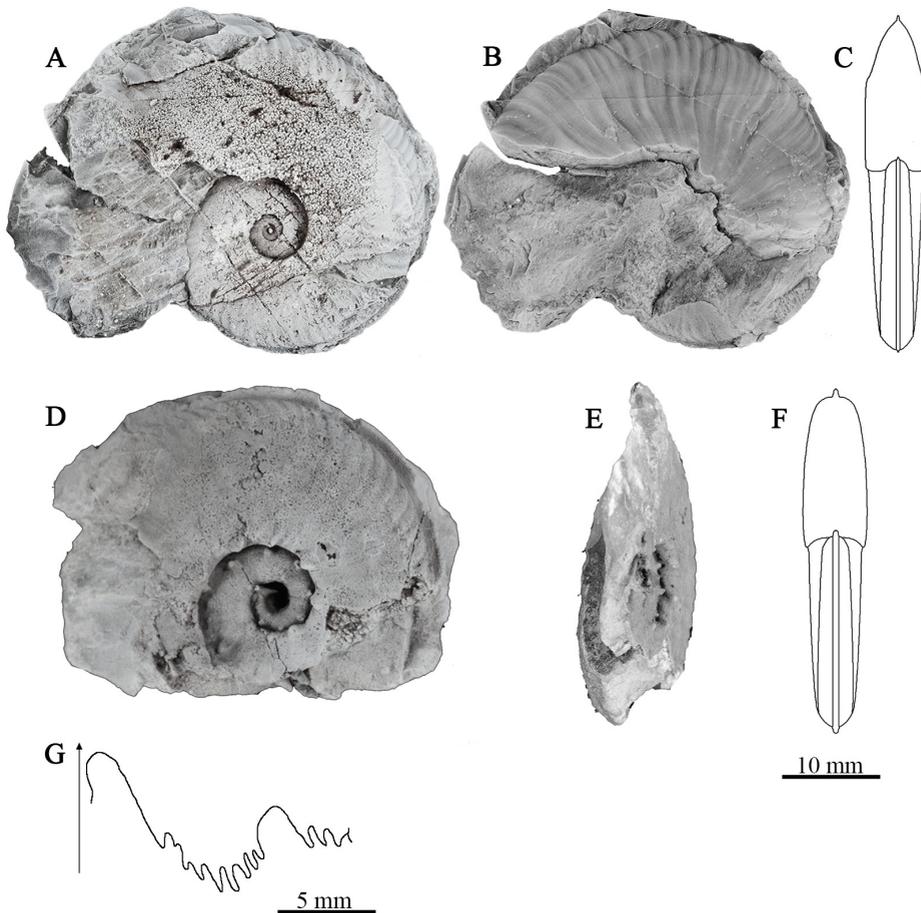


Figure 2. A–C. *Eutomoceras paladeji* sp. nov., Holotype, PRC-SHM-KO-053: A. lateral view with expand umbilicus; B. lateral view with bundle ribs; C. cross section with acute venter and thin keel. D–G. *E. wantanae* sp. nov.: D–F. Holotype, PRC-SHM-KO-108; D. lateral view, knots on umbilicus and median; E. cross section, knots on umbilical shoulder; F. cross section; G. Paratype, PRC-SHM-KO-058, suture characters.

***Eutomoceras wantanae* sp. nov.**

Fig. 2 (D–G)

Diagnosis. Phragmocone umbilical angle round, umbilical zone slightly concave, rib single, falcoid, knots present on inner whorl (1st to 3rd whorl), second radial knots present on 4th to 5th whorl on umbilical shoulder and median flank.

Material examined

Holotype: PRC-SHM-KO-108, diameter 21.2 mm, Chaiburi formation, Triassic rock, Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand, 07°37'N, 100°50'E, collector P. Srisuk, 2 September 1973.

Paratypes: PRC-SHM-KO-128, diameter 41.9 mm, PRC-SHM-KO-129, diameter 26.7 mm, Chaiburi formation, Triassic rock, Khao Ok-Thalu, Changwat Phatthalung, Peninsular Thailand, 07°37'N, 100°50'E, collector P. Srisuk, 2 September 1973.

Two new Triassic eutomocerid ammonoid cephalopods

Description. Phragmocone preserved, diameter 21.2–41.9 mm, discocone, whorl height 9.9–17.3 mm, 41.3–47.3% of diameter, width 6.4 mm, 30.2% of diameter, whorl compressed, flatten, slightly compressed on venter. Keel strong, entire, flattened, height 1.0–1.2 mm, 2.8–3.9% of diameter, width 0.8–0.9 mm, 2.0–3.4% of diameter. Outer whorl (5th whorl) deeply indents on umbilical shoulder to umbilicus. Umbilical wall concave, umbilicus fairly narrow to moderate, diameter 6.6–13.3 mm, 24.7–31.7% of whorl diameter, deep, 2nd to 5th whorl hexagonal, 1st whorl unknown. Ribs represent, prorsiradiate, simple, falcid, from umbilical shoulder to keel basement on venter, slightly thin on ventrolateral shoulder to keel basement, smooth on umbilical shoulder to umbilicus, rib on lateral flank thick and blunt, width 0.8–1.2 mm, 2.7–4.6% of diameter, dense spacing, 56 ribs on whorl, distance 0.4–0.8 mm, 1.3–2.8% of diameter. Knots present on 2nd–4th whorl median flank, 4 on 2nd whorl, 9 on 3rd, knots on inner flank thin, diameter 1.0–1.4 mm, 3.3–3.6% of diameter, knots on median flank (2nd knot) 0.8–1.5 mm, 3.5–4.1% of diameter, knots on 4th whorl present on umbilical angle. Suture ceratitic. Lateral saddle elongated, second saddle widest, slightly towards venter. First lateral lobe deep, wide, numerous denticulations at base, second lateral lobe depth about two-thirds of first.

Distribution. Known only from the type locality.

Etymology. The name ‘*wantanae*’ (Latin for “Wantana”) commemorates Wantana Yoosukh, the associate professor and researcher on marine molluscs in the Faculty of Fisheries, Kasetsart University and the Tropical Marine Mollusc Programme (TMMP) (directed by Professor Jørgen Hylleberg).

Remarks. Although *E. lahontanum* and *E. wantanae* (present study) share characteristics of a single rib, strong knots are present only in *E. lahontanum* (Smith, 1914) and *E. wantanae*. The two species can be distinguished from each other by positions of those knots. Knots are on the lower flank and ventrolateral shoulder in *E. lahontanum*, but are

on the umbilical shoulder and median flank in *E. wantanae*, associated with the subsequent hexagonal appearance of the umbilicus in the latter species. Knots of *E. lahontanum* also vary in size (with enlarged ones), but not in *E. wantanae*. *E. wantanae* can be distinguished from *E. paladeji* from the wider and hexagonal appearance of the umbilicus and the presence of knots on the umbilical shoulder. The umbilicus is narrower and knots on the umbilical shoulder are absent in the latter species.

DISCUSSION

The generic characters of *Eutomoceras* based on rib characters, shell shape and ornamentation. *Eutomoceras* can be distinguished, by rib characters, into two major groups, due to their absence or presence. The first group with the weak to slightly smooth ornamentation consists of only one species, *E. rarum* with radial biconvex folds. The second group, from characteristics of the venter can be separated into two minor groups. The furrows on keel basement are absent in the first group and present in the second group. The first group includes *E. lahontanum*, and *E. dunni*, carrying the angular ventrolateral shoulder, and *E. paladeji* and *E. wantanae* carrying the round ventral shoulder. The second group includes *E. laubei* carrying the angular ventrolateral shoulder and *E. dalli* carrying the round ventral shoulder.

Presence of two knots in *E. lahontanum* and *E. wantanae* are not mentioned in other species of *Eutomoceras*. The size and position of such knots are specific characters of these species. Knots of *E. lahontanum* are enlarged on the lower flank, but not enlarged on ventrolateral shoulders. Knots of *E. wantanae* are present on the umbilical shoulders and median flank, but none are enlarged. However, *E. lahontanum* is the only species with the robust whorl section, congeners were with compressed phragmocone.

The new species increase the number of described *Eutomoceras* species from five to seven, and from two to four in Asia. The dichotomous key to species of the genus is proposed herein.

Provisional Key to Species of *Eutomoceras* Hyatt, 1877

1. Rib course bifurcate.....2
Rib thin to slightly smooth, with radial biconvex folds.....
.....***E. rarum* Arkadiev and Vavilov, 1989**
2. Venter marginal furrows on keel basement absent.....3
Venter marginal furrows on keel basement present.....6
3. Ventrolateral shoulder angular.....4
Ventrolateral shoulder round.....5
4. Whorl section robust, knots on umbilical shoulder strong...***E. lahontanum* Smith, 1914**
Whorl section compressed, knots on umbilical shoulder slightly weak.....
.....***E. dumni* Smith, 1904**
5. Umbilicus narrow, knots on umbilical shoulder absent.....***E. paladeji* sp. nov.**
Umbilicus wide, knots on umbilical shoulder present.....***E. wantanae* sp. nov.**
6. Ventrolateral shoulder angular.....***E. laubei* Meek, 1887**
Ventrolateral shoulder round***E. dalli* Smith, 1914**

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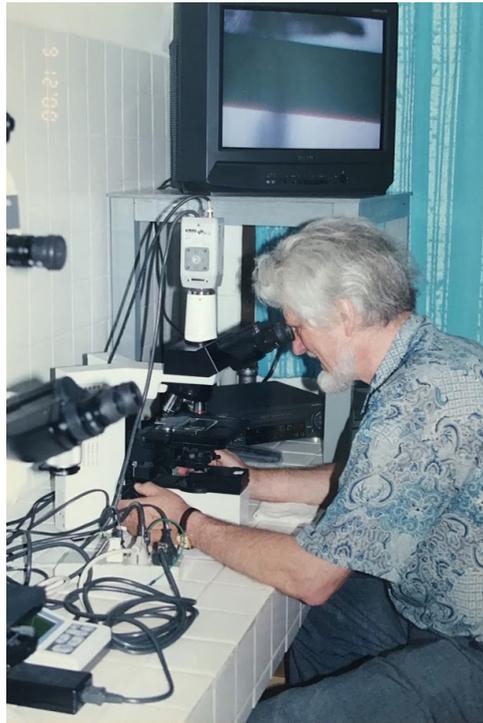
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Two new Triassic eutomocerid ammonoid cephalopods

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Observing the hatchery reared trumpet triton, *Charonia tritonis*, veligers, Prachup Khiri Khan Coastal Aquaculture Fisheries Research and Development Center, Thailand, 2000



On the R/V Chakratong Thongyai, releasing the hatchery-produced *Charonia tritonis* veligers into the sea, Phuket, Thailand, 2000