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Two Olenekian (Early Triassic) species of longiconic cephalopods from the Osawa Formation, Miyagi Prefecture, Northeast Japan

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Abstract: Two species of longiconic cephalopods, *Pseudotemperoceras*? sp. and *Trematoceras osawaense* sp. nov., are described from laminated mudstones of the Lower Triassic Osawa Formation at Asadanuki, Tome City, Miyagi Prefecture, Northeast Japan. The new species is differentiated from other species assigned to *Trematoceras* by the morphological combination of its very gradually expanding conchs with a 4°–5° apical angle, moderate to relatively long cameral lengths, nearly central siphuncular position, and well-developed cameral deposits. Biostratigraphically, *T. osawaense* provides a regional index suggesting the latest Olenekian in the South Kitakami Belt.

Introduction

Following Bando and Ehiro (1982) and Ehiro (2022b), the present study is the third fascicle of our publication series concerning the latest Olenekian (late Early Triassic) cephalopods from the uppermost part of the Osawa Formation, lower Inai Group, in the South Kitakami Belt, Northeast Japan. We describe two longiconic orthoceratoid species, namely *Pseudotemperoceras*? sp. and *Trematoceras osawaense* sp. nov., based on material collected from black laminated mudstones at the upper reaches of Nameshi-zawa Valley in Asadanuki, Tome City, Miyagi Prefecture. Their detailed geologic, stratigraphic, and geographic settings are given in the proceeding papers (Bando and Ehiro, 1982; Ehiro, 2022b).

Repository.–All specimens examined for this paper are reposited in the Toholu University Museum, Sendai (prefixed IGPS).

Systematic paleontology

Subclass Orthoceratoidea Teichert, 1967
Order Orthocerida Kuhn, 1940
Family Geisonoceratidae Zhuravleva, 1959
Genus ***Pseudotemperoceras*** Schastlivtceva, 1986

Type species.–Pseudotemperoceras pulchrum Schastlivtceva, 1986.

Pseudotemperoceras? sp.
Figures 1.A, 1.B

Description.–Two incomplete and flattened phragmocones were examined; they are longiconic orthocones with moderate expansion; the largest specimen (IGPS coll. cat. no. 112845) attains 45 mm in length and approximately 12 mm in reconstructed diameter assuming it has a circular cross section; conch surface lacks distinct ornamentation. Camerae short exhibiting approximately 3.6 in reconstructed width/length ratio; septal curvature relatively deep. Sutures directly transverse. Siphuncle cannot observable.

Material examined.–IGPS coll. cat. nos. 112843, 112845.

Discussion.–Among the previously known Triassic genera of longiconic nautiloids, the preserved characters of the present species such as its moderately expanding conch and short camerae, correspond to those of *Pseudotemperoceras*, whose type species was described from the Olenekian of Verkhoyansk, northeastern Siberia (Schastlivtceva, 1986). We keep the genus assignment open for the Osawa species as it is questionable because of the poor preservation until better material becomes available.

Order Pseudorthocerida Barskov, 1963
Superfamily Pseudorthoceratoidea Flower and Caster, 1935
Family Trematoceratidae Zakharov, 1996
Genus ***Trematoceras*** Eichwald, 1851

Type species.–Orthocera [sic] *elegans* Münster, 1841.

Trematoceras osawaense sp. nov.
Figures 1.C–1.J

Diagnosis.–Species of *Trematoceras* with very small apical angle between 4° to 5°, circular conch cross sections, and fine transverse lirae as surface ornamentation; camerae long to very long with approximately 1–2 in form ratio (maximum width per length); siphuncular position nearly central; ratio of siphuncular diameter per corresponding conch diameter at septal foramen attains 0.2; septal necks suborthochoanitic and very short; cameral deposits well developed.

Description.–The type series consists of two incomplete and more or less deformed phragmocones; an apical shell, 33 mm in length, is designated as the holotype (IGPS coll. cat. no. 112844; Figures 1.E–J), that exhibits a slightly cyrtoconic appearance and misalignment of camerae probably by post mortem deformation; conch cross sections of an apical part of the holotype are circular; the paratype is another deformed longiconic orthocone; it is a more adoral part than the holotype with 46 mm in length and approximately 4 mm in reconstructed conch diameter near the adoral end; the angle of conch expansion is very small, approximately 4° in the holotype; reconstructed angle of ditto in the paratype is approximately 5°; conch surface ornamented by fine transverse lirae; apex not preserved. Sutures directly transverse; septal curvature shallow; camerae long to very long for the superfamily; approximate numbers of camerae per corresponding conch diameter are 1–1.5 in the holotype and 1.5–2 in the paratype (i.e. form ratios (maximum width per length) approximately 1–2). Siphuncle nearly central in position; septal necks suborthochoanitic and very short having 0.25 mm in the holotype; widths of septal foramina are large for the genus, 0.31–0.46 mm in the holotype, and ratio of their diameter per corresponding conch diameter attains 0.2; connecting rings are not preserved. Cameral deposits well developed, differentiated into episeptal-mural and hyposeptal types, and partly indicate mamillary growth; no endosiphuncular deposits detected.

Material examined.–Holotype, IGPS coll. cat. no. 112844. Paratype, IGPS coll.cat. no. 112842.

Etymology.–The specific name is derived from the Osawa Formation.

Discussion.–*Trematoceras osawaense* sp. nov. most closely resembles *T. clarum* Schastlivtceva (1986, p. 79, 80, pl. 1, figs. 2, 3; 1988, p. 65, 66, pl. 2, figs. 8a, b, v) from the Olenekian of Verkhoyansk, northeastern Siberia, especially their apical angles, cameral lengths and siphuncular positions are nearly identical. The principal differences between them are as follows: cameral deposits are well developed in *T. osawaense*, whereas they are not observable in *T. clarum*, and slightly larger diameter of the siphuncle in *T. osawaense* than that of *T. clarum*, whose ratio of siphuncular diameter per corresponding conch diameter is 0.15. *Trematoceras mangyshlakense* Schastlivtceva (1981, p. 79, 80, pl. 1, figs. 3, 4a, b, v; *T. mangishlakense* [sic], 1988, p. 66, pl. 2, figs. 6a, b, 7a, b), described from the Olenekian of Mangystau, Kazakhstan, is also similar to *T. osawaense*, but this species indicates slightly larger angles of conch expansion, (6°–7°), than those of the new species and a subcentral position of the siphuncle.

The new species is well different from the previously known two *Trematoceras* species from the South Kitakami Belt (*T. hikichii* Niko, Ehiro and Takaizumi, 2016, p. 1-3, figs. 1.1–1.7 and *T. watanabei* Niko and Ehiro, 2020, p. 2, 3, 5, figs. 2.A–2.M; see the following chapter for their geologic settings) by its much finer transverse lirae than those of *T. hikichii* and slightly larger apical angles (4°–5° versus 3° in *T. watanabei*) at the corresponding ontogenetic stages. In addition, the fused endosiphuncular deposits developed in *T. watanabei* are not recognized in *T. osawaense*.

Biostratigraphic significance

Except for the present *Trematoceras osawaense* sp. nov., two species of the genus have been described from the Inai Group in the South Kitakami Belt as mentioned above. *Trematoceras hikichii* and *T. osawaense* occur in the middle and uppermost parts of the Osawa Formation. The diverse ammonoid fauna comprises the taxa *Hemilecanites discus, Tardicolumbites* aff. *tardicolumbus, Yvesgalleticeras* sp., *Hellenites elegans, Epiceltites* sp. (described originally as *Columbites parisianus*), *Nordophiceratoides bartolinae*, etc. These taxa indicate that the former horizon belongs the upper Olenekian (Ehiro *et al*., 2016). By contrast, ammonoids associated with the present

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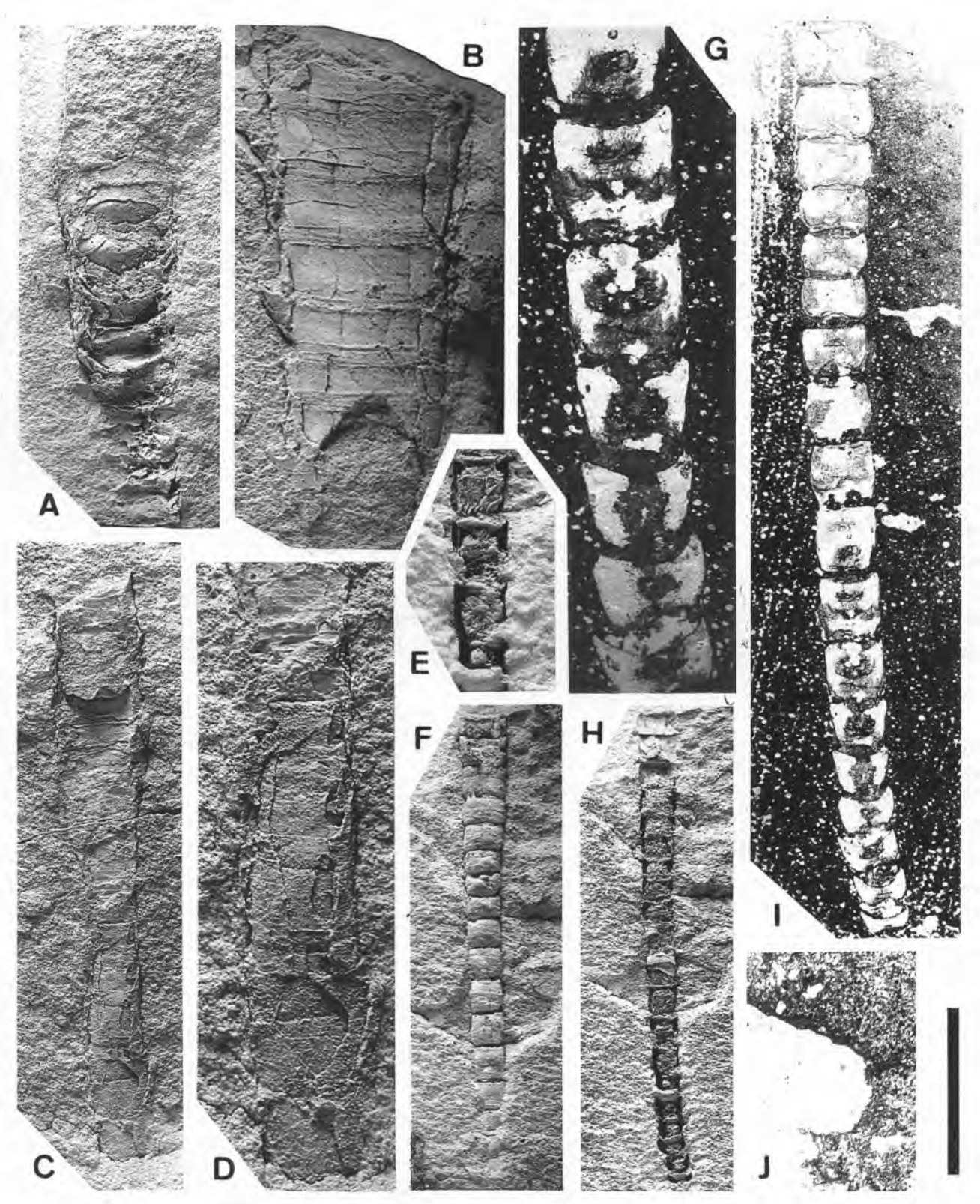
Figure 1. A, B. *Pseudotemperoceras*? sp. A, side view of phragmocone, silicone rubber cast, IGPS coll. cat. no. 112843: B, side view of phragmocone, IGPS coll. cat. no. 112845, internal mold. **C–J.** *Trematoceras osawaense* sp. nov. C, D, paratype, IGPS coll. cat. no. 112842, adoral phragmocone: C, lateral view; D, partial enlargement of C to show details of surface ornamentation and sutures: E–J, holotype, IGPS coll. cat. no. 112844, apical phragmocone: E, magnified detail of H to show septal character; F, lateral view, silicone rubber cast; G, magnified detail of I to show siphuncular position and details of cameral deposits; H, lateral view, internal mold; I, longitudinal thin section; J, magnified detail of I to show septal neck shape. Scale bar is 12 mm in A, C, F, H; 15 mm in B; 6 mm in D, E, I; 3 mm in G; 0.6 mm in J.


A
B
C
D
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J

new species in the latter horizon are *Pseudosageceras multilobatum, Procarnites kokeni, Japonites* cf. *meridianus* and *Eodanubites* aff. *xinyuanensis*, indicating the latest Olenekian *Eodanubites* Zone (Ehiro, 2022b). *Trematoceras watanabei* occurs in the early Anisian (early middle Triassic) mudstone at the middle part of the Fukkoshi Formation together with abundant and diverse ammonoids, such as *Japonites* cf. *meridianus, Danubites floriani, Paradanubites kansa, Procladiscites brancoi, Leiophyllites pitamaha, L. suessi*, and *Ussuriphyllites amurensis* (Ehiro, 2022a). Their stratigraphic and chronologic distributions are given in Figure 2. These three endemic orthoceratoid species can be considered as regional index fossils around the Olenekian/Anisian boundary in the South Kitakami Belt.

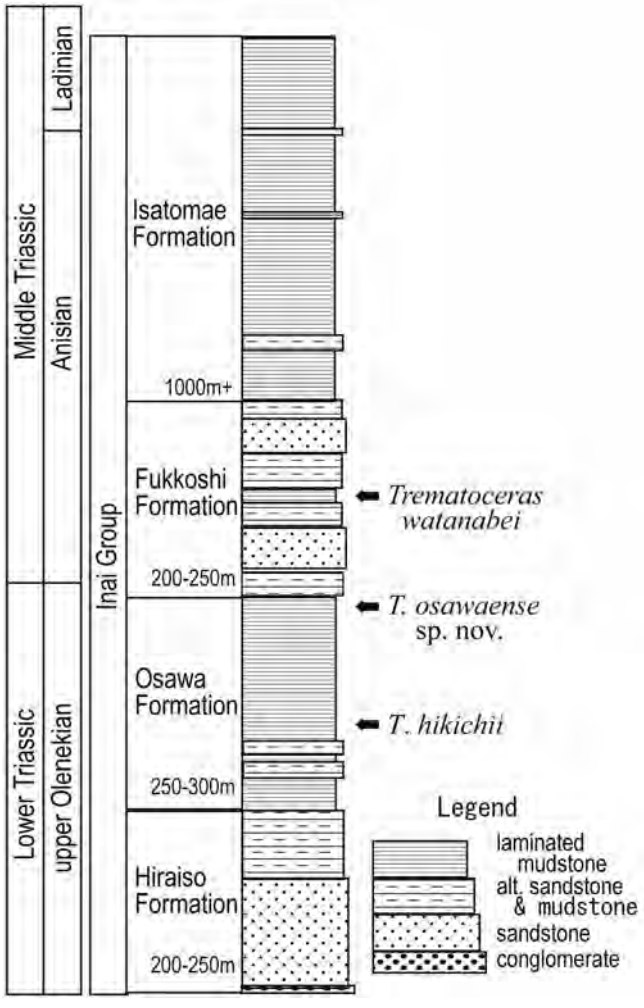

Figure 2. Simplified columnar section of the Lower-Middle Triassic Inai Group in the South Kitakami Belt, Northeast Japan, showing the stratigraphic horizons of three *Trematoceras* species.

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