

# Middle Triassic cephalopods from the Rifu Formation, Miyagi Prefecture, Northeast Japan

Shuji Niko\* and Masayuki Ehiro\*\*

\* Research Institute of Paleontology and Geology, 5-7 Nagaike-cho, Moriguchi 570-0064, Japan,

\*\*The Tohoku University Museum, Sendai 980-8578, Japan

**Abstract:** Three cephalopod species are described on the new material collected from the Middle Triassic Rifu Formation near Hamada in Miyagi Prefecture, Northeast Japan. They are a pseudorthocerid nautiloid, *Trematoceras* aff. *insperatum* Schastlivtseva, 1988, genus and species indeterminate of the Nautiloidea incertae sedis, and an aulacocerid coleoid, *Choanoteuthis hatai* (Bando, 1963). The first species is indicative of an Anisian age. The new discovery of a rostrum of the last species reveals the apical characters that closely correspond to those of *Crassiatractites* and may suggest a phylogenetic relationship between *Choanoteuthis* and the genera.

## Introduction

The Rifu Formation was named by Ichikawa (1951) for a thick (more than 500 m) series of dark gray to black shales with minor amounts of sandy layers and mainly crops out along the Nagamachi-Rifu Fault in the central part of Miyagi Prefecture, Northeast Japan (Onuki and Bando, 1959a; Ishii et al., 1982, 1983; Kamada, 1989). Diverse marine fossils of Middle Triassic age have been found from the formation, such as bivalves (Jimbo, 1898; Yabe and Shimizu, 1927), gastropods (Hayasaka, 1966), ammonoids (Yabe and Shimizu, 1927; Shimizu, 1930; Bando, 1958, 1964a, 1964b; Onuki and Bando, 1959b; Ehiro, 1992), coleoids (Bando, 1963; Niko and Ehiro, 2018), brachiopods (Yabe and Shimizu, 1927), fish (Shikama and Murata, 1976), plants (Bando, 1963) and trace fossils (Ishii et al., 1982; Kitamura et al., 1986). Among these, ammonoids represent the typical Middle Triassic assemblage in Japan and constrain its age to Anisian to Ladinian (Onuki and Bando, 1959b; Bando, 1964a). The present study deals with the newly collected cephalopod material from sandy shales that crop out at a quarry near Hamada in Miyagi-gun (latitude, 38° 21' 24" N; longitude, 141° 02' 18" E) and situates the middle part of the formation.

In conclusion, three species, *Trematoceras* aff. *insperatum* Schastlivtseva, 1988, genus and species indeterminate of the Nautiloidea incertae sedis and *Choanoteuthis hatai* (Bando, 1963), are identified in the material.

*Repository.*—All specimens examined herein are repositied in the paleontological collections of the Tohoku University Museum, Sendai (prefixed IGPS).

## Systematic paleontology

Class Cephalopoda Cuvier, 1797  
Subclass Nautiloidea Agassiz, 1847  
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* aff. *insperatum* Schastlivtseva, 1988  
Figures 1.A–1.F, 1.H

*Compare with.*

*Trematoceras insperatum* Schastlivtseva, 1988, p. 67, pl. 2, fig. 12a, 12b, 12v.

*Description.*—Four more or less deformed and imperfect specimens of longiconic orthocones were examined; the largest specimens attain 141 mm in length and approximately 14 mm in reconstructed diameter assuming that it has a circular transverse section (IGPS coll. cat. no. 112999, phragmocone and apical body chamber) and 47 mm in length and approximately 18 mm in reconstructed diameter (IGPS coll. cat. no. 113004, apical body chamber with the last septum); conch expansion gradual indicating approximately 5° in reconstructed angle. Surface ornamentation consists of transverse lirae with rounded crests. Camerae relatively long; ratios of length per reconstructed diameter (cameral form ratios) are approximately 0.3–0.5; septal curvatures moderate

to shallow; suture directly transverse. Siphuncle central in position and composed by short orthochoanitic septal necks and cylindrical(?) connecting rings. No cameral and endosiphuncular deposits observable.

*Material examined.*—IGPS coll. cat. nos. 112999, 113000, 113004, 113005.

*Discussion.*—*Trematoceras insperatum* was described by Schastlivtseva (1988) on the basis of a single specimen collected from the Anisian of the Caucasus. Although the Rifu specimens exhibit several synapomorphies with this species including conch expansion angles, surface ornamentation and septal curvatures, their poor preservations preclude a confident specific identification.

The present discovery indicates an Anisian age for the middle part of the Rifu Formation. This result is quite in agreement with that using ammonoids by Bando (1964a).

Order, superfamily and family incertae sedis  
Genus and Species Indeterminate  
Figure 1.G

*Material examined.*—IGPS coll. cat. nos. 113001–113003.

*Discussion.*—Morphologic characters of fragmentary and deformed three specimens are as follows: conchs probably orthoconic attaining approximately 42 mm in reconstructed diameter (IGPS coll. cat. no. 113002); shell surface smooth; camerae very short with directly transverse sutures; siphuncular position and structure unknown. The poorly preserved material is inadequate to determinate even at the order level.

Subclass Coleoidea Bather, 1888  
Order Aulacocerida Stolley, 1919  
Family Xiphoteuthididae Naef, 1922  
Genus ***Choanoteuthis*** Fisher, 1951  
*Type species.*—*Choanoteuthis milleri* Fisher, 1951.

***Choanoteuthis hatai*** (Bando, 1963)  
Figures 1.I–1.L

*Atractites hatai* Bando, 1963, p. 48, 49, pl. 8, figs. 1–6.

*Choanoteuthis hatai* (Bando, 1963); Niko and Ehiro, 2018, p. 4, 7, figs. 4.1–4.9.

*Description.*—An apical part of rostrum was examined; it is conical and 31 mm in preserved length; transverse section of rostrum is laterally compressed oval having 8.8 mm in dorsoventral and 8.2 mm in lateral diameters at adoral end; outline symmetrical; apex acutely pointed with apical angle of 25° and faintly displaced toward dorsal side to form asymmetrical profile; very low but relatively wide keel-like ridge occurs on dorsum; surface of rostrum is smooth; grooves and lines absent; no alveolar region preserved. Rostrum composed by recrystallized calcite; original microstructure (presumably aragonite) disappeared.

*Material examined.*—IGPS coll. cat. no. 113006.

*Discussion.*—The type series of *Choanoteuthis hatai* was recovered from the Rifu Formation (Bando, 1963) and recently revised by Niko and Ehiro (2018). Except for the stratigraphic match, this new specimen shows sufficient features to allow specific determination with confidence.

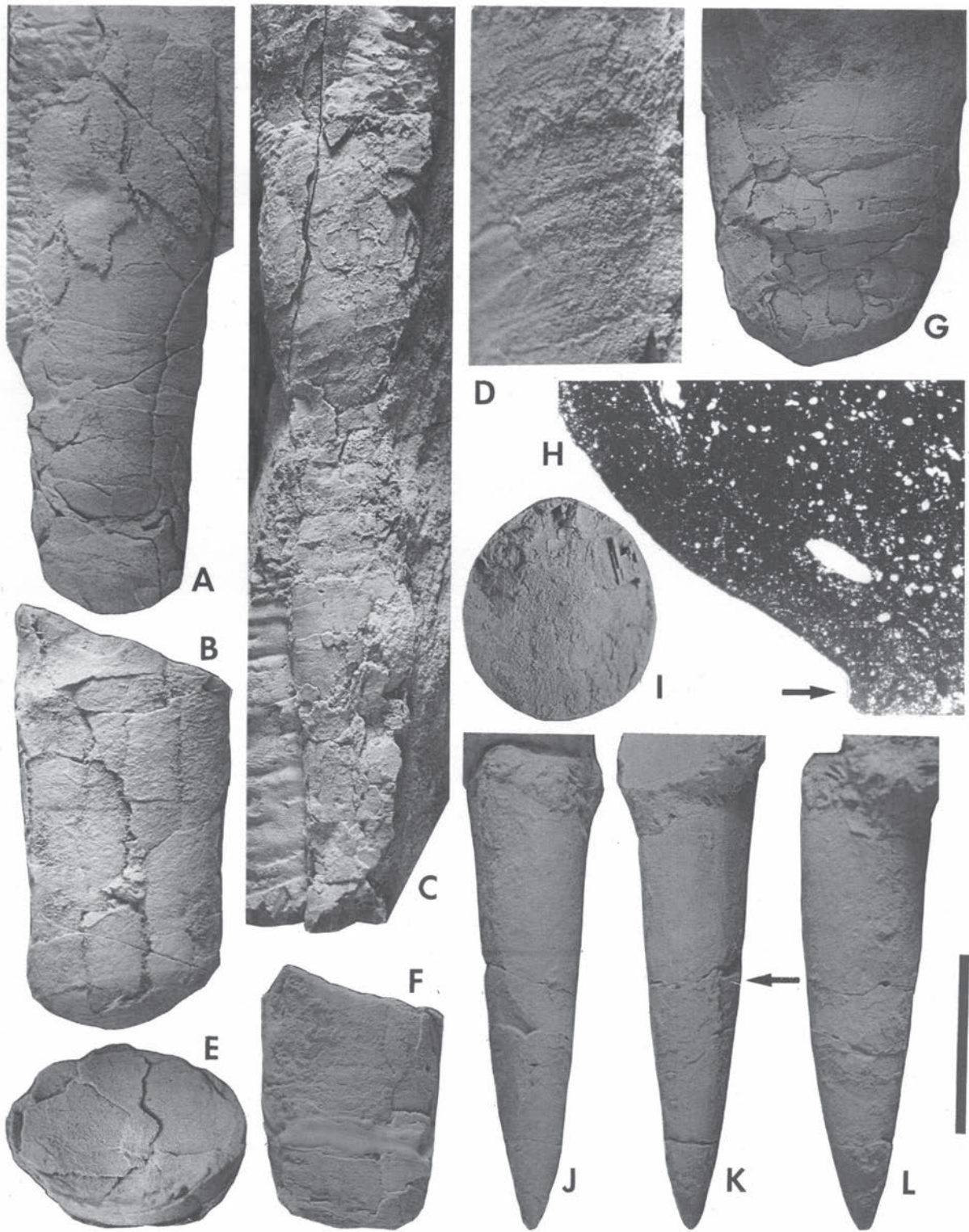
*Choanoteuthis* is a rare and poorly known genus, in which three species are currently placed, namely *C. milleri* Fisher, 1951, *C. antimoniaensis* Miller, 1961, and *C. hatai* (Bando, 1963). Furthermore, their diagnoses are based on fragments of the adoral stem and alveolar regions. The present discovery has revealed that the genus possesses the following morphologies of the apical region: acutely pointed apex; faintly asymmetrical profile; smooth surface; and absence of grooves and lines. The characteristics closely correspond to those of *Crassiatractites* Mariotti and Pignatti (1992; type species, *Atractites crassirostris* Hauer, 1887, from the Anisian to Ladinian of Central to Southeast Europe) and may suggest a phylogenetic relationship between the genera.

## Acknowledgements

We are most indebted to Yukihiko Takaizumi who collected the all cephalopod specimens described herein and donated them to the Tohoku University Museum. We also wish to acknowledge Masayuki Fujikawa for comments and suggestions that improved the manuscript.

→

**Figure 1. A–F, H.** *Trematoceras* aff. *insperatum* Schastlivtseva, 1988. A, IGPS coll. cat. no. 113000, side view. B, IGPS coll. cat. no. 113004, side view. C, D, IGPS coll. cat. no. 112999; C, side view; D, partial enlargement of C, to show details of surface ornamentation. E, F, H, IGPS coll. cat. no. 113005; E, septal view; F, side view; H, longitudinal thin section of internal mold of camera, showing adoral surface of septum as cast, arrow indicates septal neck. **G.** Nautiloidea incertae sedis, genus and species indeterminate, IGPS coll. cat. no. 113003, side view. **I–L.** *Choanoteuthis hatai* (Bando, 1963), IGPS coll. cat. no. 113006, rostrum. I, transverse section, venter down. J, ventral view. K, dorsal view, arrow indicates position of I. L, lateral view, venter on left. Scale bar is 20 mm in A–C, F, G; 6 mm in D, I; 2 mm in E; 3 mm in H; 12 mm in J–L.



## References

- Agassiz, L., 1847, *An Introduction to the Study of Natural History, in a Series of Lectures Delivered in the Hall of the College of Physicians and Surgeons*, 58 p. Greeley and McElrath, New York.
- Bando, Y., 1958, On the discovery and its meaning of *Protrachyceras* from the Rifu Formation in the Kitakami Massif, Northeast Japan. *Journal of the Geological Society of Japan*, vol. 64, p. 348–350. (in Japanese)
- Bando, Y., 1963, A dibranchiate cephalopod from the Rifu Formation (Triassic) near Hamada, Shiogama City, Miyagi Prefecture, Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, no. 50, p. 48–50, pl. 8.
- Bando, Y., 1964a, The Triassic stratigraphy and ammonite fauna of Japan. *Science Reports of the Tohoku University, Second Series (Geology)*, vol. 36, p. 1–137, pls. 1–15.
- Bando, Y., 1964b, On some Lower and Middle Triassic ammonoids from Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, no. 56, p. 332–344.
- Barskov, I. S., 1963, System and phylogeny of pseudorthoceratids. *Bulletin Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Geologicheskii*, vol. 38, p. 149–150. (in Russian)
- Bather, F. A., 1888, Professor Blake and shell-growth in Cephalopoda. *The Annals and Magazine of Natural History, Sixth Series*, vol. 1, p. 421–427.
- Cuvier, G., 1797, *Tableau élémentaire de l'histoire naturelle des animaux*, 710 p. Baudouin, Paris.
- Ehro, M., 1992, A new species of *Parakellnerites* (Triassic ammonoid) from the Rifu Formation, Northeast Japan. *Saito Ho-on Kai Museum of Natural History, Research Bulletin*, no. 60, p. 1–7.
- Eichwald, E. von, 1851, Naturhistorische Bemerkungen, als durch die Eifel, Tyrol, Italien, Sizilien und Algier. *Nouveaux Mémoires de la Société de Naturalistes d'Histire de Moscou*, vol. 9, p. 1–464.
- Fisher, A. G., 1951, A new belemnoid from the Triassic of Nevada. *American Journal of Science*, vol. 249, p. 358–393.
- Flower, R. H. and Caster, K. E., 1935, The stratigraphy and paleontology of northwestern Pennsylvania. Part II: Paleontology. Section A: The cephalopod fauna of the Conewango Series of the Upper Devonian in New York and Pennsylvania. *Bulletins of American Paleontology*, vol. 22, p. 199–271.
- Hauer, F. von, 1887, Die Cephalopoden des Bosnischen Muschelkalkes von Han Bulog bei Sarajevo. *Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe*, vol. 54 [1888], p. 1–50, pls. 1–8.
- Hayasaka, S., 1966, Four Triassic gastropods from the Rifu Formation near Hamada, Shiogama City, Miyagi Prefecture, Japan. *Science Reports of Kagoshima University*, no. 15, p. 25–33, pl. 1.
- Ichikawa, K., 1951, Triassic System on the southern Kitakami Mountainland. *Geological Survey of Japan, Special Report*, p. 7–23. (in Japanese)
- Ishii, T., Yanagisawa, Y., Yamaguchi, S., Sangawa, A. and Matsuno, K., 1982, *Geology of the Matsushima District. Quadrangle Series, Scale 1:50,000*, 121 p. Geological Survey of Japan, Tokyo. (in Japanese with English abstract)
- Ishii, T., Yanagisawa, Y. and Yamaguchi, S., 1983, *Geology of the Shiogama District. Quadrangle Series, Scale 1:50,000*, 112 p. Geological Survey of Japan, Tsukuba. (in Japanese with English abstract)
- Jimbo, K., 1898, *Pseudomonotis* from the vicinity of Sendai. *Journal of the Geological Society of Japan*, vol. 5, p. 267. (in Japanese)
- Kamada, K., 1989, The Triassic System. In, Oide, K., Nakagawa, H. and Kanisawa, S. eds., *Regional Geology of Japan. Part 2. Tohoku*, p. 31–35. Kyoritsu Shuppan, Tokyo. (in Japanese)
- Kitamura, N., Ishii, T., Sangawa, A. and Nakagawa, H., 1986, *Geology of the Sendai District. Quadrangle Series, Scale 1:50,000*, 134 p. Geological Survey of Japan, Tsukuba. (in Japanese with English abstract)
- Mariotti, N. and Pignatti, J. S., 1992, Systematic remarks on *Atractites*-like coleoid cephalopods: *Crassiatractites* gen. nov., *Breviatractites* gen. nov. *Paleopelagos*, vol. 2, p. 109–141.
- Miller, H. W., 1961, Belemnoides del Tráásico superior del Estado de Sonora. *Paleontologia Mexicana*, no. 11, p. 1–15, pl. 1.
- Münster, G. zu, 1841, II, Beschreibung und Abbildung der Abbildung der in den Kalkmergelschichten von St. Cassian gefunden Versteinerungen. In, Wissmann, H. L. and Münster, G. zu, *Beiträge zur Geognosie und Petrefacten-Kunde des Südöstlichen Tirol's Vorzüglich der Schichten von St. Cassian*, p. 25–152, pls. 1–16, Bayreuth.
- Naef, A., 1922, *Die Fossilien Tintenfische*, 322 p. Gustav Fisher, Jena.
- Niko, S. and Ehro, M., 2018, Aulacocerid coleoids from the Triassic of the South Kitakami Belt, Northeast Japan. *Bulletin of the Tohoku University Museum*, no. 17, p. 1–8.
- Onuki, Y. and Bando, Y., 1959a, On the Inai Group of the Lower and Middle Triassic System. *Contributions from the Institute of Geology and Paleontology, Tohoku University*, no. 50, p. 1–69. (in Japanese with English abstract)
- Onuki, Y. and Bando, Y., 1959b, On some Triassic ammonites from the Rifu Formation. *Contributions from the Institute of Geology and Paleontology, Tohoku University*, no. 50, p. 70–80, pls. 1–3.
- Shikama, T. and Murata, M., 1976, A fish fossil from Middle Triassic formation in Rifu, Miyagi Prefecture. *Journal of the Geological Society of Japan*, vol. 82, p. 67–71. (in Japanese)
- Schastlivtseva, N. P., 1988, Triassic orthoceratids and nautilids from USSR. *Akademii Nauk SSSR, Trudy Paleontologicheskogo Instituta*, vol. 229, p. 1–104, pls. 1–8. (in Russian)
- Shimizu, S., 1930, Two new species of Ladinic ammonites from the *Daonella* Beds of Rifu, province of Rikuzen. *Science Reports of the Tohoku Imperial University, Second Series (Geology)*, vol. 14, p. 75–77, pls. 24–26.
- Stolley, E., 1919, Die Systematik der Belemniten. *Jahresberichte des Niedersächsischen Geologischen Vereins*, vol. 11, p. 1–59.
- Yabe, H. and Shimizu, S., 1927, The Triassic fauna of Rifu, near Sendai. *Science Reports of the Tohoku Imperial University, Second Series (Geology)*, vol. 11, p. 101–136, pls. 10–13.
- Zakharov, Y. D., 1996, Orthocerid and ammonoid shell structure: Its bearing on cephalopod classification. *Bulletin of the National Science Museum, Series C*, vol. 22, p. 11–35.