

# Early Devonian orthocerid cephalopods from the Kamianama Formation, Fukui Prefecture, Central Japan

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**Abstract:** Four species of orthocerid cephalopods, including *Fukujiceras kamiyai*, *Spyroceras fukujiense*, *Mitorthoceras?* sp. and *Buchanoceras* sp., are described from the Kuzuryu Lake-Ise River area, Fukui Prefecture, Central Japan. They occur from the Lochkovian (early Early Devonian) shale of the Oisedani Member, the Kamianama Formation. This assemblage indicates strong affinity to that of the Takaharagawa Member in the Fukuji Formation, Gifu Prefecture. The *Fukujiceras* Fauna is newly defined for the Kamianama and Fukuji cephalopod assemblages

## Introduction

The Kamianama Formation (Fujimoto, 1953; Kurihara, 2003; Niko and Senzai, 2010) of the Kuzuryu Lake-Ise River area, Fukui Prefecture, Central Japan contains the diverse Devonian marine faunas. Here the author discusses orthocerid cephalopods heretofore undescribed in the faunas except for those reported preliminary by Hamada and Itoiwaga (1983), Tokai Kaseki Kenkyukai (1995) and Kamiya and Niko (1997). The material was collected from an outcrop (= locality KU-1 in Niko and Senzai, 2006) of black calcareous shale along the Kamaharadani Valley. Niko and Senzai (2010) divided the Kamianama Formation into the Lochkovian (early Early Devonian) to Emsian (late Early Devonian) Oisedani Member and the Emsian to probably Eifelian (early Middle Devonian) Hakubado Member. Stratigraphic position of the cephalopod bearing shale lies in the Lochkovian part of the Oisedani Member.

Abbreviations used for repositories are as follows. IGPS: Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai, HMNH: Hida Museum of Natural History, Fukuji, Takayama, and UMUT: the University Museum, University of Tokyo, Tokyo.

## Faunal discussion

The present cephalopod assemblage contains *Fukujiceras kamiyai* Niko, 1996, *Spyroceras fukujiense* Niko, 1996, *Mitorthoceras?* sp., and *Buchanoceras* sp. With the exception of *Mitorthoceras?* sp., they are common with those of the assemblage documented by Niko (1990, 1991, 1993, 1996, 1998a, b, 2006) and Niko and Nishida (2003a, b) from the Takaharagawa Member of the Fukuji Formation in Gifu

Prefecture. In the generic level, *Fukujiceras* is an endemic genus in the Hida Gaien Belt including the Kamianama and Fukuji formations. On the basis of their strong faunal affinity and geologic settings, the *Fukujiceras* Fauna is newly defined for these assemblages. This fauna may developed in a non-tropic water condition around northeastern margin of North China (Niko, 1998a).

## Systematic paleontology

Order Orthocerida Kuhn, 1940

Superfamily Pseudorthoceratoidea Flower and Caster, 1935

Family Pseudorthoceratidae Flower and Caster, 1935

Subfamily Pseudorthoceratinae Flower and Caster, 1935

Genus *Fukujiceras* Niko, 1996

*Type species.*—*Fukujiceras kamiyai* Niko, 1996; Lochkovian (lower Lower Devonian) in Gifu Prefecture, Central Japan.

*Fukujiceras kamiyai* Niko, 1996

Figures 1.1–1.3, 1.8, 1.9

*Conularia* sp. (cf. *C. mitchelli* Fletcher, 1938). Murata, 1977, p. 38, 39, figs. 2–4.

*Conularia* sp., Tanaka, Ono and Murata, 1977, figs. 3A–3C.

*Fukujiceras kamiyai* Niko, 1996, p. 348, 350, figs. 2.1–2.13; Niko, 2006, fig. 2.8.2–6.

*Fukujiceras* cf. *kamiyai*; Kamiya and Niko, 1997, p. 83, 85, figs. 1.1–1.3.

*Description.*—Three deformed specimens of incomplete phragmocones are available for study; they are orthoconic longicones with moderate conch expansion; the largest

specimen attains 164 mm in length; surface ornamentation consists of flat topped transverse lirae that frequently form shallow to linguiform salients; adjoining lirae separated by narrow striae. Sutures directly transverse.

*Material examined.*—IGPS coll. No. 111736, 111737. A specimen, T. Kamiya's personal collection, is also examined.

*Type species.*—Holotype, UMUT PM 19111. Paratypes, UMUT PM 19112–19119, 19143.

*Discussion.*—*Fukujiceras kamiyai* is easily recognized by its characteristic surface ornamentation. This species is well described and illustrated by Niko (1996) on the basis of the types from the Lochkovian shale of the Takaharagawa Member, Fukuji Formation.

Murata (1977) and Tanaka et al. (1977) described a single fragmentary shell of *Conularia* from the Kamianama Formation. Although this specimen is inadequate for identification, it exhibits identical lirae and salient with those of *Fukujiceras kamiyai*. There is a high possibility that “the first Devonian conulariid in Japan” in their papers is misidentification.

Dimple-like borings caused by bioerosion are recognized on the shell surface of this species and *Mitorthoceras?* sp. (this report).

Subfamily Spyroceratinae Shimizu and Obata, 1935

Genus **Spyroceras** Hyatt, 1884

*Type species.*—*Orthoceras crotalum* Hall, 1861; Middle Devonian of New York, North America.

***Spyroceras fukujiense*** Niko, 1996

Figures 1.4, 1.5

*Metaspyroceras insignis* Niko, 1991. Field Selection 20, Fossils (Tokai Kaseki Kenkyukai), 1995, p. 49.

*Spyroceras fukujiense* Niko, 1996, p. 350, 352, figs. 3.3–3.11, 4.1–4.5; Niko, 2006, fig. 2.8.2-3.

*Description.*—A weakly deformed specimen of incomplete phragmocone is available for study; it is annulated longicone with gradual conch expansion and 51 mm in length; annulations transverse, low; surface ornamentation consists of longitudinal ribs and coarse lirae. Sutures straight, slightly oblique.

*Material examined.*—IGPS coll. No. 111738.

*Type species.*—Holotype, UMUT PM 18505. Paratypes, UMUT PM 18506, 19507, 18512–18515, 18516, 18517, 19145–19151, HMNH-N098.

*Discussion.*—Previous records of *Spyroceras fukujiense* have been restricted in the Lochkovian shale of the Takaharagawa Member, Fukuji Formation. *Metaspyroceras insignis* is easily distinguished from this species by its lattice-

like surface ornamentation in juvenile shell.

Genus **Mitorthoceras** Gordon, 1960

*Type species.*—*Mitorthoceras perfilosum* Gordon, 1960; Chesterian (Upper Mississippian; upper Lower Carboniferous) in Arkansas, North America.

***Mitorthoceras?*** sp.

Figure 1.7

*Description.*—A strongly deformed specimen is available for study; it is longiconic orthocone with very gradual conch expansion, and 29 mm in length; surface ornamentation consists of fine transverse lirae.

*Material examined.*—IGPS coll. No. 111739.

*Discussion.*—Because this poorly preserved specimen indicates synapomorphies found with the generic type, *Mitorthoceras perfilosum* Gordon (1960, p. 136, 137, pl. 27, figs. 1–4, 8; Niko and Mapes, 2015, p. 54, 56, figs. 2.1–2.11), including general conch shape and ornamentation, it is questionably placed in *Mitorthoceras*.

Subfamily Cayutoceratinae Flower, 1939

Genus **Buchanoceras** Teichert and Glenister, 1952

*Type species.*—*Buchanoceras graviventrum* Teichert and Glenister, 1952; Lower Devonian in Victoria, Australia.

***Buchanoceras*** sp.

Figures 1.6, 1.10

[?] *Michelinoceras hidense* Kobayashi, 1958. Hamada and Itoigawa, 1983, p. 15.

*Buchanoceras* sp., Niko, 1996, p. 358, 359, figs. 8.1–8.4.

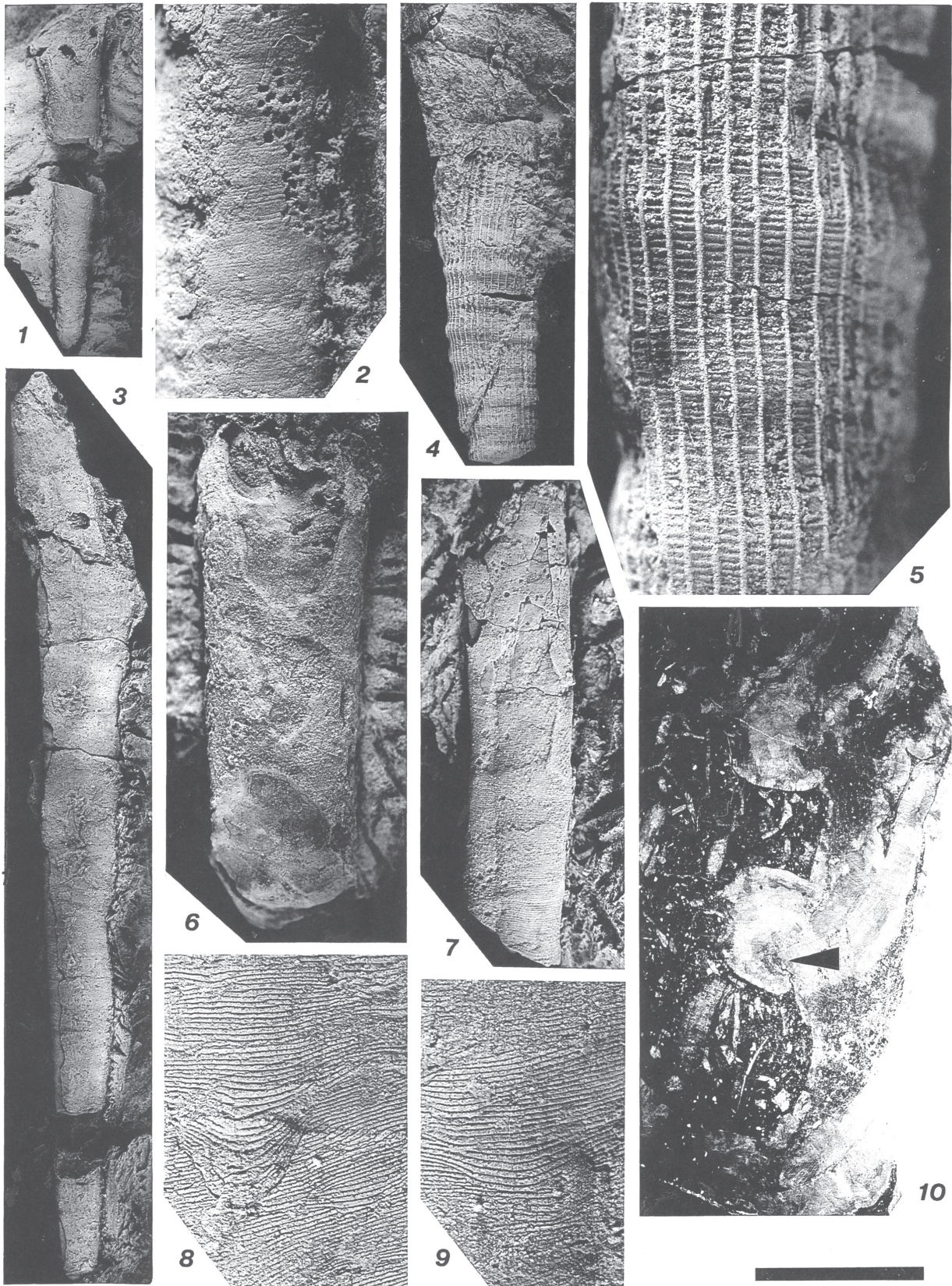
*Description.*—A weakly deformed specimen of incomplete phragmocone is available for study; it is longiconic orthocone measuring 48 mm in length; conch expansion very gradual; conch surface lacks distinct ornamentation. Sutures directly transverse; camerae relatively short; siphuncle consists of cyrtochoanitic septal necks and expanded connecting rings. Cameral deposits occur at episeptal-mural and hyposeptal positions; annulosiphonate endosiphuncular deposits are well developed, but not fusing.

*Material examined.*—IGPS coll. No. 111740.

*Discussion.*—The specimen is conspecific with those from the Lochkovian shale of the Takaharagawa Member, Fukuji Formation and probably represent a new species. However, their preservations are not adequate for detailed systematic treatment.

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**Figure 1.** 1–3, 8, 9. *Fukujiceras kamiyai* Niko, 1996: 1, 2, IGPS coll. No. 111736, side view and partial enlargements to show details of surface ornamentation, note borings caused by bioerosion; 3, side view of Kamiya's specimen, note borings on the shell surface; 8, 9, IGPS coll. No. 111737, partial enlargements to show details of surface ornamentation. 4, 5. *Spyroceras fukujiense* Niko, 1996, IGPS coll. No. 111738, side view and partial enlargements to show details of surface ornamentation. 6, 10. *Buchanoceras* sp., IGPS coll. No. 111740, ventral view and dorsoventral thin section, arrow indicates septal neck. 7. *Mitorthoceras?* sp., IGPS coll. No. 111739, side view, note borings on the shell surface. Scale bar is 15 mm in Figures 1.1, 1.4, 1.6; 3 mm in Figures 1.2, 1.5, 1.8–1.10; 30 mm in Figure 1.3; 10 mm in Figure 1.7.



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