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Bandoceras, a new Late Silurian genus of orthocerid cephalopod from the Hitoegane Formation, Gifu Prefecture, Central Japan

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Abstract: A new genus of orthocerid cephalopod, *Bandoceras*, is proposed on the basis of *B. gifuense* sp. nov. from the Ludlow (early Late Silurian) calcareous shale of the upper Hitoegane Formation in the Shinhirayuonsen area, Takayama City, Gifu Prefecture, Central Japan. Its morphologies of septal necks, connecting rings, endosiphuncular deposits suggest the new genus and species belong to the subfamily Spyroceratinae. *Bandoceras gifuense* differs from the possible ancestor, *Gordonoceras* Teichert and Glenister, 1953, from the Lower (or Middle) Silurian of Tasmania, in having transverse surface lirae.

Introduction

The Hitoegane Formation, named by Nakai (1984), crops out in the Hitoegane and Shinhirayuonsen area, Takayama City, Gifu Prefecture, Central Japan. A diverse fauna of middle to late Ludlow (or Pridoli; Late Silurian) age, including tabulate corals (Niko, 2001, 2004, 2007, 2008), trilobites (Kobayashi and Hamada, 1974, 1987) and machaerid (Kobayashi and Hamada, 1976), have been described from calcareous beds (= the Hitoegane Limestone Member in Igo, 1990) of the upper part of the formation. Recently, a single orthocerid specimen was collected from this fossiliferous member as the first occurrence of cephalopod from the formation. The intent of this paper is to propose a new genus and species, *Bandoceras gifuense*, on the basis of the new material.

Systematic Paleontology

Order Orthocerida Kuhn, 1940
Superfamily Pseudorthoceratoidea Flower and Caster, 1935
Family Pseudorthoceratidae Flower and Caster, 1935
Subfamily Spyroceratinae Shimizu and Obata, 1935
Genus ***Bandoceras*** gen. nov.

Type species.—*Bandoceras gifuense* sp. nov. by monotypy.

Diagnosis.—Exogastric cyrtocone with gradual conch expansion and subcircular cross section; shell surface ornamented by transverse lirae; sutures straight and transverse; camerae short; siphuncle relatively narrow, subcentral with suborthochoanitic to cyrtochoanitic septal necks and subcylindrical connecting rings; endosiphuncular deposits form continuous lining; cameral deposits mostly episeptal-mural.

Etymology.—The generic name honors the late Dr. Yuji Bando, in recognition of his contributions to the taxonomic and biostratigraphic studies on fossil cephalopods.

Discussion.—The siphuncular morphologies of this cephalopod, such as the suborthochoanitic to cyrtochoanitic septal necks, subcylindrical connecting rings and continuous lining of the endosiphuncular deposits, suggest that the new genus belongs to the Spyroceratinae of the family Pseudorthoceratidae. In the subfamily, *Gordonoceras* Teichert and Glenister (1953; type species, *G. bondi* Teichert and Glenister, 1953, p. 39, 40, pl. 4, figs. 1–3, text-fig. 2C) from the Lower (or Middle) Silurian of Tasmania, shows close similarity with *Bandoceras* gen. nov. in its exogastric conch with gradual expansion, subcentral siphuncle and short camerae, but is differentiated by the latter in lacking distinct surface ornamentation. The author believes that *Gordonoceras* is the ancestor of *Bandoceras*.

The Early Carboniferous genus *Pseudocyrtoceras* Schindewolf (1943; type species, *Cyrtoceras acus* Koninck, 1880, p. 28, 29, pl. 35, figs. 6, 6a, 7, pl. 36, fig. 3; Schindewolf, 1943, fig. 15) differs from the new genus in having more rapid expansion of the conch with dorsoventrally depressed profiles and the well-inflated subglobular connecting rings. Among them, the

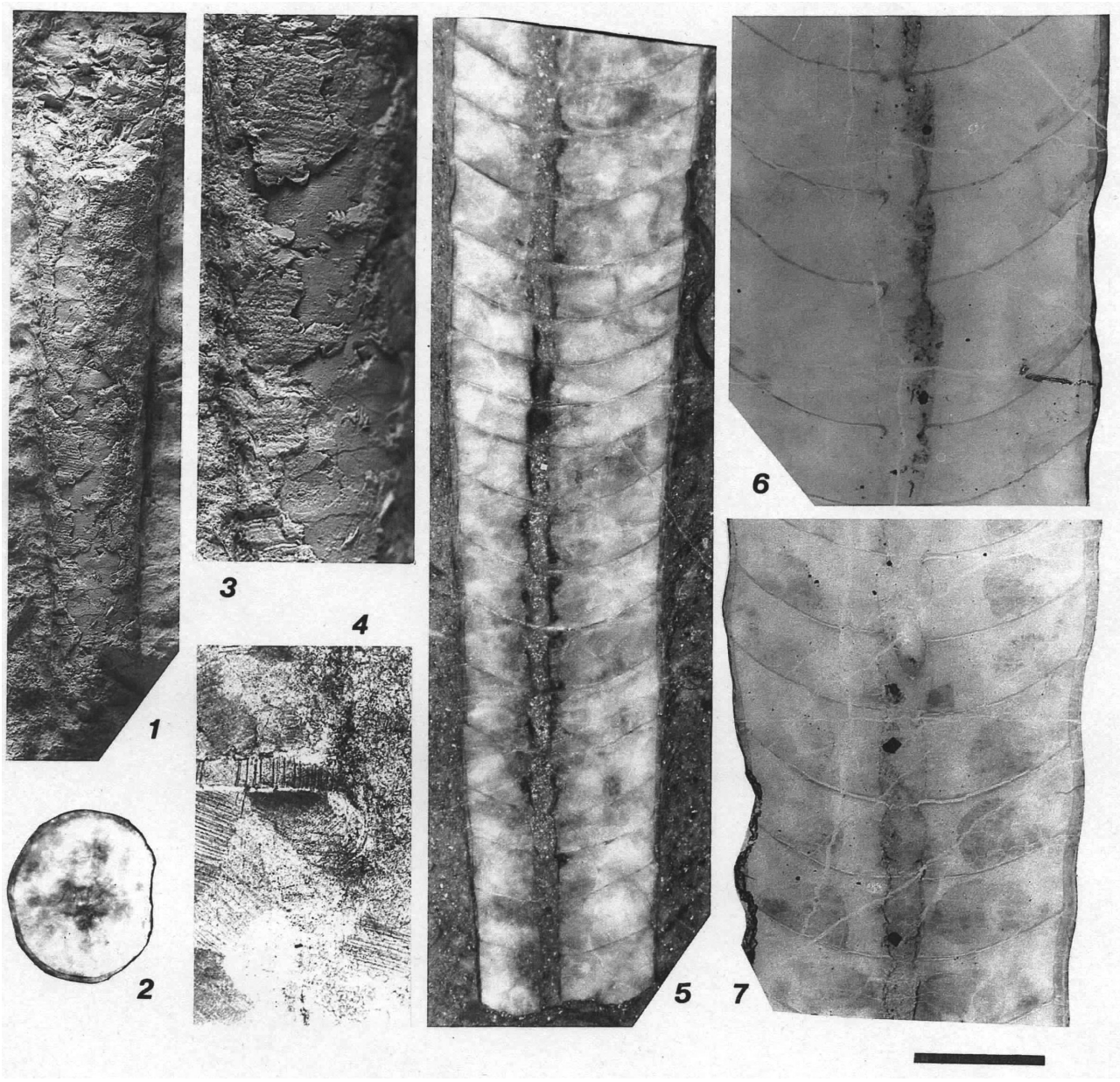

Figure 1. *Bandoceras gifuense* gen. et sp. nov., holotype, IGPS coll. cat. no. 111568, from the Upper Silurian Hitoegane Formation in Takayama City, Gifu Prefecture. **1**. Lateral view, venter on left. **2**. Transverse polished section, venter down. **3**. Partial enlargement of Figure 1.1 to show details of surface ornamentation. **4**. Longitudinal thin section, showing details of septal neck. **5**. Dorsoventral polished section of apical shell, venter on left. **6**, **7**. Longitudinal thin sections of adoral shell, venter on left (but oblique to dorsoventral plane), showing details of siphuncle, endosiphuncular deposits (in Figure 1.6), and cameral deposits. Scale bar is 5 mm in Figure 1.1; 4 mm in Figure 1.2; 2 mm in Figures 1.3, 1.6, 1.7; 0.2 mm in Figure 1.4; 2.5 mm in Figure 1.5.

latter is one of the important characters of the subfamily Pseudorthoceratinae Flower and Caster, 1935.

Similar surface ornamentation with *Bandoceras* is found in a Middle Silurian species *Orthoceras wauwatosense* Whitfield (1882, p. 297, pl. 19, fig. 2; Foerste, 1928, p. 250–252, pl. 53, figs. 2A–D, 3(?), pl. 56, fig. 9(?) as *Geisonoceras wauwatosense*) that is the type species of *Geisonocerina* Foerste, 1935. Internal features of the species are

incompletely known but reportedly it has an orthoconic conch with circular cross section and very deeply concaved septa. Familial placement of *Geisonocerina* is still uncertain.

The Middle Ordovician genus *Centroonoceras* Kobayashi (1934; emended by Niko, 2005; type species, *Ooceras*? *tokunagai* Kobayashi, 1927, p. 202, 203, pl. 18, figs. 10a, b; Niko, 2005, p. 1028–1030, figs. 1.1–1.8) also resembles *Bandoceras*. However, the relatively wide siphuncle of *Centroonoceras* suggests that it belongs to the family Proteoceratidae Flower, 1962. Similarities between the two genera are probably superficial.

Bandoceras gifuense sp. nov.
Figure 1

Diagnosis.—Same as for the genus.

Description.—A single longiconic phragmocone, 53 mm in approximate length and 3.5 mm in diameter at apical end, is available for study. It is faintly exogastric cyrtocone with gradual conch expansion, whose angle is approximately 6°; apical shell and body chamber are not preserved; cross sections of conch are subcircular indicating weak lateral compression; ratios of lateral conch diameter per dorsoventral one are approximately 0.88; surface ornamentation consists of transverse lirae that are slightly oblique and incline toward dorsum; there are approximately 8 ridges in 1 mm of conch length. Sutures are essentially straight and transverse; septal curvature is shallow and closely spaced to form short camerae; form ratios of camerae (maximum width per length in dorsoventral plane) range from 2.5 to 5.6; siphuncle is subcentral (ventral from center) in position and relatively narrow; ratios of siphuncular position (distance of central axis of septal foramen from ventral shell surface per corresponding conch diameter in dorsoventral plane) are 0.39–0.41; siphuncular wall consists of suborthochoanitic to cyrtochoanitic septal necks and thin connecting rings; septal neck length is short, 0.19–0.27 mm; connecting rings weakly expanded in camerae and indicate subcylindrical shape. Endosiphuncular deposits partly preserved in adoral shell, and form continuous lining on ventral siphuncular wall; cameral deposits well-developed, episeptal-mural (or mural in rare cases).

Material examined.—Holotype, IGPS coll. cat. no. 111568. The specimen is kept in the Tohoku University Museum, Sendai.

Etymology.—The specific mane is derived from Gifu Prefecture.

Occurrence.—The new species described herein is from the middle to late Ludlow (early Late Silurian) calcareous shale at west bank of the Takahara-gawa River in the Shinhirayuonsen area. The site is at 36°14’10”N latitude and 137°31’28”E longitude, whose position on geographic map was given in figure 1 in Niko (2008).

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