A new Turonian (Late Cretaceous) species of *Inoceramus* (Bivalvia) from the Yezo Supergroup, Hokkaido, northern Japan

Abstract

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A new inoceramid species (*Inoceramus nakagawensis* sp. nov.) from the Upper Cretaceous Yezo Supergroup, Hokkaido, Japan, is reported and systematically described in detail. The shell sculpture of *I. nakagawensis* sp. nov. is characterized by very fine, distinct, and regular to somewhat irregular concentric rings. Its occurrence is probably restricted to the upper Lower to lower Middle Turonian, making it a short-ranging species. The present species would be closely allied to *Inoceramus cuvieri* Sowerby, 1814, from the middle to upper Turonian Stage of Far East Russia.

Keywords: biostratigraphy, Cretaceous, inoceramid, Japan, Hokkaido, Turonian, Yezo Supergroup

Introduction

Inoceramid bivalves (Inoceramidae) are abundant in the Upper Cretaceous Yezo Supergroup (identical to the “Yezo Group” of Takashima et al., 2004), and are useful for intra-basinal stratigraphic correlation (e.g., Kawabe, 2003; Tsuchiya et al., 2003; Uramoto et al., 2007), occasionally interbasinal correlation (e.g., Toshimitsu et al., 1995), owing to their rapid evolution and speciation, and relatively wide biogeographic distribution. Therefore, the discovery of a new short-ranging species allows for progress in biostratigraphy and allied fields.

I collected a few strange inoceramid specimens (*Inoceramus* aff. *concentricus* of Takahashi et al., 2003) along the Chirashinai River of the Teshionakagawa area, northern Hokkaido (Fig. 1), where the Middle Yezo Group of the Yezo Supergroup is widely distributed. Afterward, it became clear for these specimens to belong to a new Turonian species. Here, systematic paleontological and biostratigraphic significances of *Inoceramus nakagawensis* sp. nov. are described in the present study. The specimens described and figured herein are registered and housed at Waseda University, with the prefix WE. B.

Geological setting

The Yezo Supergroup is widely distributed in central Hokkaido Island. It is a thick terrigenous clastic succession consisting of mudstone, sandstone and conglomerate beds, which were deposited in the Aptian to Paleocene forearc basin of the East Asian active margin that is exposed on Hokkaido and Sakhalin (Far East Russia) Islands (e.g., Okada, 1982; Takashima et al., 2004). The

total thickness of the supergroup is about 10,000 m in maximum. The Yezo Supergroup is divided into four groups, namely the Lower Yezo, Middle Yezo, Upper Yezo and Hakobuchi groups (Matsumoto, 1951; Okada, 1983).

The Middle Yezo Group in the Teshionakagawa area, northern Hokkaido, is subdivided into five formations, namely the Moehoro, Shirataki, Sakotandake, Sakugawa and Saku formations, in ascending stratigraphic order (Kawaguchi, 1997; Takahashi et al., 2003, 2007). New inoceramid specimens reported herein were discovered from the Sakugawa Formation exposed along the Chirashinai River in the Teshionakagawa area (loc. N15033 of Fig. 1). The Sakugawa Formation, which is composed mainly of siltstone and sandy siltstone beds, is correlated with the Cenomanian to the Middle Turonian (Takahashi et al., 2003). A Turonian ammonite, *Mesopuzosia pacifica* Matsumoto, occurs in the same horizon as the inoceramid specimens.

Systematic Paleontology

Family Inoceramidae Giebel, 1852

Genus *Inoceramus* Sowerby, 1814

Type species.— *Inoceramus cuvieri* Sowerby, 1814 (Cox, 1969, p. N315 by subsequent designation).

Remarks.—*Inoceramus* (s.l.) has been subdivided into many subgenera, such as *Inoceramus*, *Cremonoceramus*, *Cordiceramus*, *Cladoceramus*, *Platyceramus*, and *Volviceramus* etc. (e.g., Noda, 1986, 1996; Toshimitsu, 1986; Noda and Matsumoto, 1998; Noda, 2002). On the other hand, those subgenera are currently ranked as the independent genera (e.g., Dhondt, 1992; Voigt, 1995; Takahashi, 2005; Kauffman et al., 2007; Kennedy et al.,

Fig. 1. Index and route maps along the Chirashinai River in the Teshionakagawa area of Hokkaido, northern Japan. *Inoceramus nakagawensis* sp. nov. has been found at the loc. N15033 along the Chirashinai River. Prefix “N” is omitted in each locality number.

2008) in the Family Inoceramidae, because those genera are clearly distinguishable each other based on morphological characters of the shell. The present new inoceramid species described here is erect-ovate to elliptic outline, subequivalve, and growth axis does not extremely bend. In addition, that has projecting beak. Since those characters are peculiar to the genus *Inoceramus* (s.s.) (Harries et al., 1996), I assign the following new species to the genus *Inoceramus* (s.s.).

***Inoceramus nakagawensis* sp. nov.**

Figure 2

Material.- Holotype (WE. B. 0001) and paratypes are from loc. N15033 of Takahashi et al. (2003, 2007) (Fig. 1). A holotype (WE. B. 0001) and all paratypes (WE. B. 0002–0004) are at Waseda University.

Etymology.- The present species is named after Nakagawa Town, Hokkaido Island, in which the type locality is situated.

Diagnosis.- Adult shell very small in size, inequilateral, rounded to parabolical (somewhat nearly mytiliform) in outline, with growth axis convex toward the dorsal margin. Shell surface characterized by very fine, distinct, and regular to somewhat irregular concentric rings and very weakly concentric ribs.

Description.- Adult shell very small in size, inequilateral, prosocline, slightly higher than long (Table 1), rounded to parabolical in outline, obliquity (δ) weak to moderate (Table 1), with growth axis convex toward posterior margin. Subequivalve or maybe slightly inequivalve. Umbo terminal, prominent and incurved. Anterodorsal margin slightly to moderately concave, and anteroventral margin slightly to moderately rounded, passing into

Table 1. Measurements on the type specimens. h: shell height, l: shell length, H: maximum linear dimension from umbo to ventral extremity, L: maximum linear dimension perpendicular to H, b: shell breadth, s: length of hinge line, (h-s: in mm), α : angle between anterodorsal margin and hinge line, β : beak angle, γ : angle between posterodorsal margin and hinge line, δ : obliquity, (α - δ : in degrees)

Specimens	h	l	l/h	H	L	L/H	b	s	s/l	α	β	γ	δ
WE.B. 0001 (holotype) (R)	15.00	12.25	0.82	15.50	12.70	0.82	6.20	3.95	0.32	108	93	—	62
WE.B. 0002 (paratype) (R)	—	—	—	17.80	8.15	0.46	5.00	—	—	—	67	—	—
WE.B. 0003 (paratype) (R)	—	—	—	20.60	11.75	0.57	8.05	—	—	—	105	—	—
WE.B. 0004 (paratype) (L)	15.50	11.25	0.73	17.85	14.25	0.80	5.80	7.60	0.68	110	72	113	70

rounded ventral margin, with narrow to moderately broad ventral area. Posteroventral margin weakly to fairly rounded, passing into posterodorsal margin that is weakly rounded to nearly straight. Valve slightly to greatly inflated, with convexity relatively uniform along growth lines. Ornamentation consists of very fine, distinct, closely and regularly to somewhat irregularly spaced concentric rings, and very weakly concentric ribs.

Measurements.— See Table 1.

Intrapopulational variation.— The present new species shows some extent of morphological variation. The shell outline is rounded, parabolical to somewhat mytiliform, but the outline of the specimen of WE. B. 0004 (left valve) is exceptionally nearly square. All specimens are ornamented by fine concentric rings, both the outer shell surface (WE. B. 0001, 0002) and internal mold (WE. B. 0003, 0004). Although the concentric rings are rather regular, the specimen of WE. B. 0003 is ornamented by irregular rings. Very weak concentric ribs appear in the holotype (WE. B. 0001).

Comparison.— The present specimens are characterized by very fine and distinct concentric rings. *Inoceramus sorachiensis* Noda and Matsumoto MS (see Noda, 2002; Tanaka and Toshimitsu, 2003 = *I. concentricus* var. *costatus* Nagao and Matsumoto, 1939, and *I. costatus* of Toshimitsu et al., 1995), which has not been formally described and is an invalid biological name, somewhat resembles the present species in its small adult size and the shell outline. *I. sorachiensis* MS is an important index species for the lower Middle Turonian (fig. 1 in Toshimitsu et al., 1995), so may be related to phylogenetically *I. nakagawensis* sp. nov. However, *I. nakagawensis* sp. nov. can be distinguished from *I. sorachiensis* MS by having much fine and distinct concentric rings. Contrary, the shell ornamentation of *I. sorachiensis* MS is characterized by coarser concentric ribs. Therefore, *I. sorachiensis* MS is not a valid name. This allied but different species is needed to be formally described as *I. sorachiensis* in future.

The specimens of *I. nakagawensis* sp. nov. described above would be closely allied to *Inoceramus cuvieri*

Sowerby, 1814, from the middle to upper Turonian Stage of Central Asia, India, Western Interior Seaway, Europe and Far East Russia (see Crampton, 1996). Pergament (1971) reported the occurrence of *I. cuvieri* and described the species from southern Sakhalin and Kamchatka (Far East Russia). *I. cuvieri* is similar to *I. nakagawensis* sp. nov. in the whole outline and the shape of the beak. However, *I. nakagawensis* sp. nov. has much finer concentric rings and does not have a broad posterior wing, while *I. cuvieri* shown in Pergament (1971) does not have such fine, distinct and regular concentric rings and has a broad posterior wing. *I. nakagawensis* sp. nov. also resembles *I. aff. cuvieri* in Zonova (1992; pl. 85, figs. 1-3) from the *I. hobetsensis* Zone in Kamchatka in the overall outline and the curvature of the concentric ribs. However, *I. nakagawensis* sp. nov. has much finer concentric rings and does not have a broad posterior wing compared with Zonova's specimens. In addition, illustrated specimens by Zonova (1992) have a little broader beak angle. A specimen of pl. 36, fig. 1 of *I. aff. cuvieri* seen in Zonova (1993) from Sakhalin, Far East Russia is similar to *I. nakagawensis* sp. nov. in having the relatively regular concentric rings. However, the figured specimen (*I. aff. cuvieri*) by Zonova (1993) is a more quadrilateral outline and the curvature of concentric rings is gentler, so the overall outline is rather different from that of *I. nakagawensis* sp. nov. Moreover, the present new species bears a resemblance to a specimen of pl. 36, fig. 3 of *I. aff. cuvieri* in Zonova (1993). However, the anterodorsal margin of the Russian specimen is not concave and the specimen does not have the fine concentric rings; besides, the curvature of concentric ribs of the Russian specimen is gentler, and the overall shell-outline is more quadrilateral. In summary, *I. nakagawensis* sp. nov. can be distinguished from *I. aff. cuvieri* seen in Zonova (1992, 1993) based on investigation of the above-mentioned characters and from other related species.

Furthermore, *I. pseudocuvieri* Pergament, 1971 seen in Zonova (1987) is very similar to *I. nakagawensis* sp. nov. in the parabolical to mytiliform outline, and the curvature of concentric rings, but *I. pseudocuvieri* has a

Fig. 2. Photographs of *Inoceramus nakagawensis* sp. nov. A: Holotype (WE. B. 0001), right valve, external shell surface. B: Paratype (WE. B. 0002), right valve, external shell surface. C: Paratype (WE. B. 0003), right valve, internal mold. D: Paratype (WE. B. 0004), left valve, internal mold.

broad posterior wing and has more widely-spaced irregular concentric rings. These points are conclusive distinction between two species.

Occurrence.— Probably the uppermost Lower to lowest Middle Turonian Substage (discussed below in detail), where it co-occurs with the ammonite *Mesopuzosia pacifica* Matsumoto in the Sakugawa Formation of the Middle Yezo Group in the Teshionakagawa area, northern Hokkaido Island, Northern Japan (Figs. 1, 3).

Stratigraphic occurrence

Inoceramus nakagawensis sp. nov. occurs near the first appearance datum of the ammonite *Mesopuzosia pacifica* in the Teshionakagawa area (loc. N15033; Figs. 1, 3). Although *M. pacifica* is a long-ranging species, and has been reported from the upper Upper Cenomanian to

Upper Turonian of Japan (Toshimitsu and Hirano, 2000), the species is most abundant from the Middle Turonian (e.g., Toshimitsu et al., 1995; Asai and Hirano, 1990; Kawabe, 2000). Therefore, the stratigraphic level occurring *I. nakagawensis* sp. nov. in the Teshionakagawa area presumably belongs to the *Kossmaticeras flexuosum* - *M. pacifica* Biozone (Middle Turonian) of Toshimitsu et al. (1995). *I. nakagawensis* sp. nov. probably occurs in the upper Lower Turonian to lower Middle Turonian. In addition, *Inoceramus kamuy* Matsumoto and Asai, an age-diagnostic Lower Turonian species (e.g., Matsumoto and Asai, 1996), occurs at loc. N15035, whose horizon is 35-40 m below that of loc. N15033 (Fig. 3). These also support the above view. In summary, *I. nakagawensis* sp. nov. seems to be a short-ranging species to the upper Lower -lower Middle Turonian (Fig. 3). Further studies on

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Takahashi, A., 2010, A new Turonian (Late Cretaceous) species of *Inoceramus* (Bivalvia) from the Yezo Supergroup, Hokkaido, northern Japan. *Jour. Geol. Soc. Japan*, **116, 412-417.** (高橋昭紀, 2010, 北海道蝦夷超層群から産出したチューロニアン期 (後期白亜紀) のイノセラムス類 (二枚貝綱) の 1 新種. 地質雑, **116**, 412-417)

本邦北海道に分布する上部白亜系蝦夷超層群中部蝦夷層群産の新種のイノセラムス類 1 種を記載した. 本種の産出層準は, 下部チューロニアン階上部から中部チューロニアン階下部と考えられ, 表面装飾は非常に細かく明瞭な, 規則正しい (一部不規則な) 同心円輪で特徴付けられる. 本種は, 極東ロシア (サハリンやカムチャツカ半島) で産出している *Inoceramus cuvieri* Sowerby, 1814 に近縁であると考えられる.