Northward expansion of the warm-water chamid bivalve *Chama cerinorhodon* in the northern Japan Sea

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Abstract

A stranding record of the chamid bivalve, *Chama cerinorhodon* Hamada and Matsukuma, along the coast of the Shakotan Peninsula in Hokkaido is described herein. This benthic chamid is sessile and is typically attached to hard substrata by the left valve. *C. cerinorhodon* is also associated with rocky shore mollusks. The increased incidence of *C. cerinorhodon* in the northern Japan Sea appears to be related to an increase in sea surface temperatures since 2010. This stranding record of *C. cerinorhodon* extends the range of this species to approximately 43.3° N on the Japan Sea-side of the Japanese archipelago.

Key words: *Chama*, global warming, Hokkaido, Japan Sea, marine biogeography

Introduction

The family Chamidae Lamarck, 1809, which is composed of approximately 70 extant species, is primarily distributed in the warm water regions of the world (Bernard 1976; Matsukuma 1996). Chamids are sessile, benthic, bivalve mollusks that typically attach themselves to hard substrata by their left valve. Chamid shells are highly inequivalve, with strong prosogyrate beaks; the free valve is relatively flat and smaller than the cemented valve, which is usually convex (Matsukuma 1996).

Although the chamid bivalve, *Chama cerinorhodon,* has frequently been confused with *Chama fragum* and other species (Hamada and Matsukuma 1995), *Chama cerinorhodon* was only described relatively recently (Hamada and Matsukuma 2005). The species is distributed in Japanese waters (Okutani and Soyama 1987; Higo and Goto 1993; Okutani 2000; Hamada and Matsukuma 2005), and has recently become relatively common in the Japan Sea between Jeju Island and Tohoku region in Honshu (e.g., Uozumi, 1998; Noseworthy et al. 2007; Takebayashi and Wada 2010). However, further north in Hokkaido, the distribution and habitat preference of this species have not yet been clarified.

In 2011, new stranding records of *C. cerinorhodon* were reported along the coast of the Shakotan Peninsula in Hokkaido. This study was undertaken to examine stranding of *C. cerinorhodon* and to perform biometric analysis of the shells of this species. In addition, the relationship between the incidence of *C. cerinorhodon* and environmental changes in the marine environment were also examined.

Materials and Methods

The study area was located along the coast of the Shakotan Peninsula in central Hokkaido (Fig. 1). The beaches of the peninsula are mainly composed of medium- to coarse-grained sands with pebbles. *Chama* shells were collected at Hamanaka, Gorota and Horikappu along the peninsula from September to November in 2011 (Fig. 2). We also collected shells that washed up together with the *Chama* shells and identified any stranded marine animals. Undamaged *Chama* shells were subjected to morphometric analysis according to the methods of Hamada and Matsukuma (2005). Measurements were performed using a digital caliper (CD67-S20PS, Mitutoyo, Japan).

Results

Family Chamidae Lamarck, 1809
Genus *Chama* Linnaeus, 1758
Chama cerinorhodon Hamada and Matsukuma, 2005

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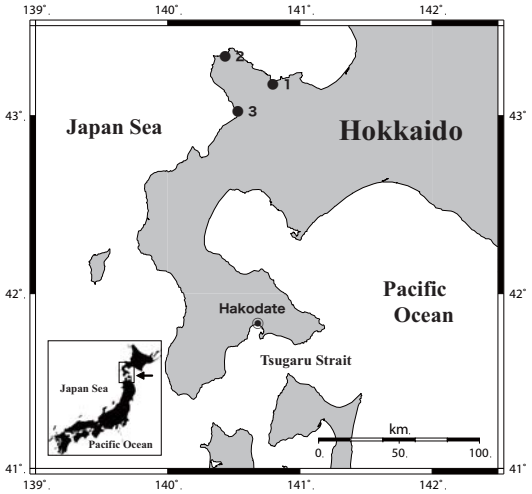

Fig.1 Map of the Shakotan Peninsula, Hokkaido.
1: Hamanaka Beach, Yoichi Town,
2: Gorota Beach, Shakotan Town,
3: Horikappu Beach, Tomari Village.

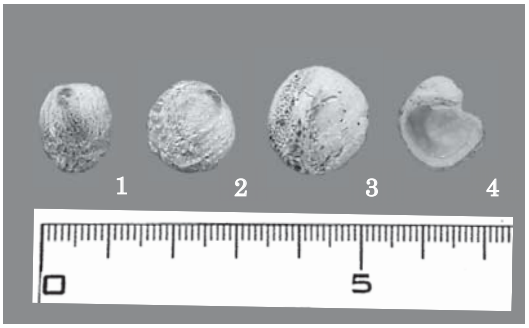

Fig.2 Shells of *Chama cerinorhodon* from the Shakotan Peninsula.
1. Right valve; Hamanaka Beach, Yoichi Town.
2. Right valve; Hamanaka Beach, Yoichi Town.
3. Right valve; Hamanaka Beach, Yoichi Town.
4. Left valve; Hamanaka Beach, Yoichi Town.

Chama cerinorhodon Hamada and Matsukuma, 2005, p.14, Figs.1-4.

Chama fragum Reeve 1846, pl.9, sp.48; Taki and Oyama, 1954, p.99, pl. 11, Fig. 13; Oyama, 1973, p.99, pl. 42, Fig. 1; Okutani and Soyama, 1987, p.83; Uozumi, 1998, p.137; Okutani, 2000, p.945.

Chama sp.: Hamada and Matsukuma, 1995, pp.95-96.

Locality: Hamanaka Beach, Yoichi Town, Gorota Beach, Shakotan Town and Horikappu Beach, Tomari Village.

Description: Shell thick, rather small, ca. 20 mm in length, cemented to hard substratum by wide section of left valve. Outline of both valves circular or ovate, depending upon habitat. Exterior sculpture of both valves consisting of radial lamellate spines with several folds. Exterior waxy, translucent, reddish pink to white. Shell margins minutely crenulated.

Measurements: See Table 1. The shell length in the 33 *Chama cerinorhodon* specimens collected in the study area ranged between 5.77 to 18.91 mm (Table 1). The shell length of 19 of these specimens (ca. 80%) measured less than 10 mm and only one shell exceeded 15 mm in length.

Distribution: Pleistocene-Miyata and Yokosuka Formations, Yokosuka, Kanagawa Prefecture; Semata Formation, Ichihara, Chiba Prefecture.

Recent-Shakotan Peninsula, Hokkaido to Kyushu,

Table 1 Morphometric measurements of selected *Chama cerinorhodon* specimens.

	Valve	Length(mm)	Height(mm)
SK-01	Right	9.5	13.1
SK-02	Right	12.5	15
SK-03	Right	13.5	13.7
SK-04	Right	11.3	11.1
SK-05	Right	11.2	10
SK-06	Right	6.6	8.4
SK-07	Right	14.7	16.4
SK-08	Right	8.1	9.1
SK-09	Right	6	7.4
SK-10	Right	13.1	14.4
SK-11	Right	11.7	13.7
SK-12	Right	10.4	11
SK-13	Right	9.1	10.1
SK-14	Right	7.6	10
SK-15	Right	7	8.9
SK-16	Right	7.1	8.1
SK-17	Right	7.5	7
SK-18	Right	9.7	9.5
SK-19	Right	8.5	11.3
SK-20	Right	6.8	6.9
SK-21	Right	5.8	6.7
SK-22	Right	10.4	11.5
SK-23	Right	9.6	11.3
SK-24	Right	6.3	7.4
SK-25	Right	14.5	17.4
SK-26	Right	6.8	8.3
SK-27	Right	6.2	8.4
SK-28	Right	12.3	13.5
SK-29	Left	11.4	13.8
SK-30	Right	18.9	16.4
SK-31	Right	9	8.6
SK-32	Right	11.2	11.2
SK-33	Right	8.6	10.7

Japan. Jeju Island, Korea.

Comparisons:

Chama cerinorhodon is frequently confused with *Chama fragum* and other related species based on morphological characters. However, this species is distinct from *C. fragum* and related species due to differences in shell morphology, mineralogy and structure. For example, *Chama cerinorhodon* has calcitic and aragonitic shell layers (Hamada and Matsukuma, 2005) while *Chama fragum* Reeve, which is considered to be very similar to *Chama cerinorhodon*, lacks a calcitic layer (Kennedy et al. 1970). *Chama japonica* Lamarck is another Japanese chamid that is similar in appearance to *Chama cerinorhodon*, can be distinguished from *Chama cerinorhodon* by its large size, reddish brown color, and more delicate spines.

Discussion

Figure 3 shows the geographic distribution of *Chama cerinorhodon* in Japanese waters. The sea surface temperature (SST) of the Tsushima Warm Current north of 42°N ranged within normal limits (15-16℃: Japan Metrological Agency 2011) until mid-October when it increased abruptly by 1 to 2℃ above the mean for the period 1950-2000 until early November. It seems likely that the observed increase in SSTs was responsible for the mass stranding of warm-water species such as *Chama cerinorhodon*.

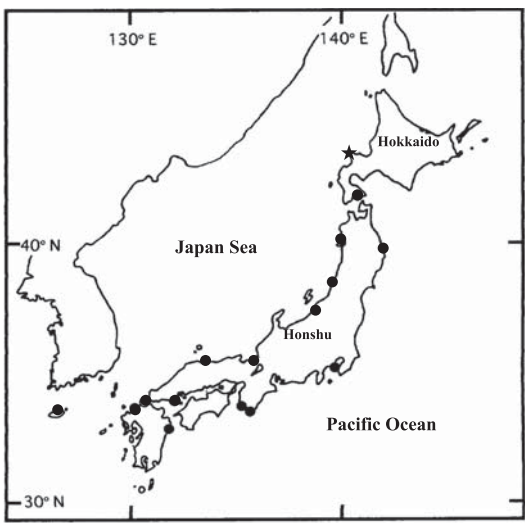

Fig.3 Geographical distribution of *Chama cerinorhodon* in Japanese waters.
Star: Study site. Closed circles: records extracted from literature.

From a faunistic point of view, the marine mollusks along the coast of the Shakotan Peninsula are typical of the cool-template realm and are represented by both cold- and warm-water species. Recently, however, records of subtropical and tropical species are becoming increasingly frequent along the Shakotan Peninsula (Suzuki 2011; Suzuki and Enya 2012). It is thus possible that strandings of *Chama cerinorhodon* and other species along the Shakotan coast could be explained by an increase in the temperature of the Tsushima Warm Current that flows northwards.

Range expansion and an increase in the incidence of *Chama cerinorhodon* along the Japan Sea-side of the Japanese archipelago is considered to have occurred in the following order. Firstly, in the twentieth century, this species was limited to the waters around Honshu and further south (Okutani and Soyama 1987; Hamada and Matsukuma 1995; Okutani 2000). Then, in 2001 to 2010, this species was found to have invaded Hakodate in southwestern Hokkaido (Hamada and Matsukuma 2005). Finally, in 2011, the range of this species had extended all the way to the Shakotan Peninsula (Suzuki and Enya 2012).

It is proposed that the strandings of the chamid bivalve, *C. cerinorhodon*, along the Shakotan coast in 2011 were attributed to the combination of an anomalous increase in SSTs and the northwestern monsoon in autumn. Such increases in SSTs in the northern Japan Sea are considered to be accelerating the northward migration of several warm-water mollusk species into cold regions (Suzuki 2010, 2011).

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日本海北部における暖流系二枚貝イチゴキクザルの北方拡大

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要　約

積丹半島沿岸におけるキクザル科二枚貝イチゴキクザルの漂着記録を記載した．この底生種のキクザルは表在性で，典型的に左殻で硬質物に固着している．また，本種は主に岩礁性貝類と共産した．日本海北部での本種の著しい出現は，2010年以降の海面水温の上昇と関連していると思われる．今回のイチゴキクザルの漂着記録により，日本列島の日本海側における本種の生息範囲はおよそ北緯43.3°に延長された．