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An Omma-Manganjian Bivalvia, *Profulvia kurodai* (Sawada), from the Plio-Pleistocene strata of Japan

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ABSTRACT

Well-preserved specimens of *Profulvia kurodai* have been examined from the Setana and Shigarami formations. Moreover, a individual of this species was newly obtained from the Suginoya Siltstone in Ishikawa Prefecture. These specimens are characterized by three or four posterior strong radial ribs.

From the occurrence of this species, it has become clear that the *kurodai* might live in the bottom of fine- to medium-grained sand in the sublittoral zone, and evolve from the *harrimani* in the northern Fossa Magna region.

KEY WORDS

Omma-Manganji, *Profulvia kurodai*, Pliocene, Pleistocene

Introduction

The extinct genus *Profulvia* was proposed by Kafanov (1976) for the northwestern Pacific "*Papyridea*", ranging from Oligocene to Early Pleistocene. The species *kurodai*, treated in this aricle, is the last one of the genus.

Profulvia kurodai (Sawada) was first described on the specimens from the Sawane Formation, Niigata Prefecture as *Papyridea* (*Fulvia*) *nipponica* by Yokoyama (1926). Kuroda (1931) illustrated the cardiid species from the Shigarami Formation, Nagano Prefecture as *Cardium* (*Papyridea*) *nipponicum*? (Yokoyama). Hatai and Nisiyama (1952) discriminated the Sawane and Shigarami specimens from the Asagai specimens which are the type of *Papyridea* (*Fulvia*) *nipponica*. They proposed a new name, *kurodai* to the Shigarami and Sawane specimens without any descriptions. However, as pointed by Masuda and Noda (1976), their procedures of nomenclature are so unfavorable that Sawada (1962) is recognized as an author of this species.

Hatai and Nisiyama (1952) and Masuda and Noda (1976) considered that the Kuroda's

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Shigarami specimens were included in the same species from the Sawane Formation. However, as far as judging from the Kuroda's figure, it is uncertain that the Shigarami specimen should be identified with *Profulvia kurodai*. Added to the above taxonomical problems, there is no discussion on the ecology and evolution of this species.

Fortunately, the authors could collect many specimens of *Profulvia kurodai* from the Setana Formation in Hokkaido and examine a well-preserved specimen from the Shigarami Formation stored at the Togakushi Fossil Museum. Moreover, this species was newly obtained from the Suginoya Siltstone in Ishikawa Prefecture. The purposes of this paper are not only to describe these specimens, but also to summarize the ecology and extinction of this species hitherto undiscussed.

Systematic description

Family Cardiidae

Subfamily Laevicardiinae

Genus *Profulvia* Kafanov, 1976

Profulvia kurodai (Sawada, 1962)

Pl. 1, figs. 1-9

Papyridea (*Fulvia*) *nipponica* Yokoyama, Yokoyama, 1926, p. 294, pl. 34, fig. 16.
Papyridea (*Fulvia*) *kurodai* Hatai et Nisiyama, Sawada, 1962, p. 82-83, pl. 1, figs. 15-16.
Papyridea kurodai Hatai et Nishiyama, Kamada, 1962, p. 109, pl. 11, fig. 9 ; Kobayashi et al., 1986, pl. 16, fig. 4.
Profulvia kurodai (Sawada), Uozumi et al., 1986, p. 20, fig. 1.
Papyridea kurodai Sawada, Mizuno and Amano, 1988, p. 82, pl. 16, fig. 15.
Profulvia kurodai (Hatai et Nishiyama), Akamatsu and Suzuki, 1990, pl. 1, fig. 2.

Type locality : Sawane, Sado Island, Niigata Prefecture.
Description :

Shell large in size, attaining about 120mm in length, elongate-ovate, moderately inflated, inequilateral and equivalve. Antero-dorsal margin broadly arcuated ; postero-dorsal margin nearly straight ; ventral margin broadly rounded. Anterior end rounded ; posterior end obliquely truncated and slightly gaping. Beak slightly opisthogyrate, situated at anterior three-seventh or three-eighth of shell length. Surface ornamented with 49-57 radial ribs (Setana specimens). Ribs in anterior part rounded and beaded in cross section, separated by narrower interspaces ; central ribs triangular in section, separated by nearly equal interspaces ; posterior three or four ribs strong and quadrate in section ; ribs on posterior slope irregularly arranged and imbricated. Hinge plate with two small, obliquely cardinal teeth, indistinct lateral teeth, and distinct nymph.
Measurements (in mm) :

Specimens		Length	Height	NR*	Valve	Formation
JUE no.	15383	30.6	22.9+	50	L. V.	Suginoya
〃	15384-1	105.2	75.7	54	R. V.	Setana
〃	15384-2	88.0	61.1	51	L. V.	〃
〃	15384-3	117.6	87.0	53	L. V.	〃
〃	15384-4	94.8	65.0	51	R. V.	〃
〃	15384-5	85.5	60.4	53	L. V.	〃
〃	15384-6	74.7	52.8	52	R. V.	〃
〃	15384-7	75.4	53.9	52	L. V.	〃
〃	15384-8	67.2	49.8+	53	R. V.	〃
〃	15384-9	79.4	60.0	49	L. V.	〃
〃	15384-10	37.2	26.3	50	R. V.	〃
〃	15384-11	29.6	20.8	49	L. V.	〃
〃	15384-29	-	-	57	L. V.	〃
	TFM**	75.7	58.0	41	L. V.	Shigarami

* Number of radial ribs

** Specimen stored at Togakushi Fossil Museum

Remarks :

The present species is characterized by having a few strong posterior radial ribs. Kuroda (1931) doubtfully identified the Shigarami specimens with *Cardium* (*Papyridea*) *nipponicum* Yokoyama. As far as judging from his plate, the specimens illustrated by him do not have any features of the *Profulvia kurodai*.

Tomizawa (1958) also illustrated one ill-preserved specimen as *Papyridea kurodai* Hatai et Nisiyama from the Takafu Formation. However, the outline of this specimen resembles that of the genus *Clinocardium*. Moreover, no strong ribs is recognized in his specimen.

The specimens from the Shigarami Formation (Pl. 1, fig. 3, 6) slightly differ from the typical form of the *Profulvia kurodai* from the Setana Formation in outline and number of radial ribs. Namely, the beak of former is more centrally situated than the latter. Moreover, the former has less numerous radial ribs (41) than the latter (49-57). In spite of these slight differences, the Shigarami specimens can be identified with *Profulvia kurodai* because of having some posterior strong ribs and nearly same proportion of shell with the type specimens (Fig. 1).

Affinities :

The present species is allied to *Profulvia harrimani* (Dall) from the Oligocene to Middle Miocene in Alaska, Kamchatka, Sakhalin, Hokkaido and Northeast Honshu. However, the former differs from the latter by having some strong posterior radial ribs.

Localities :

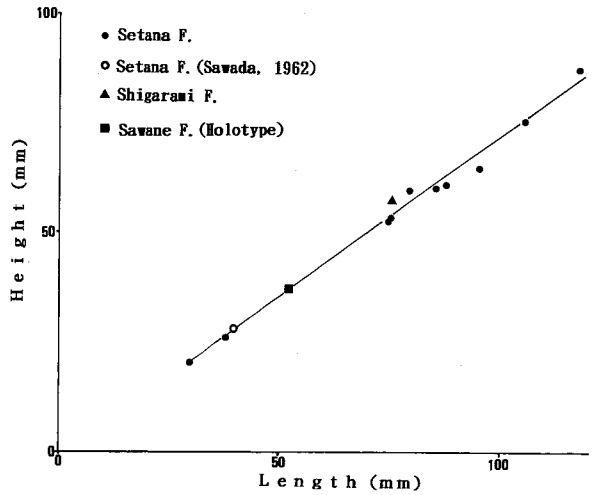

Fig. 1. Bivariate relation between length and height of shell.

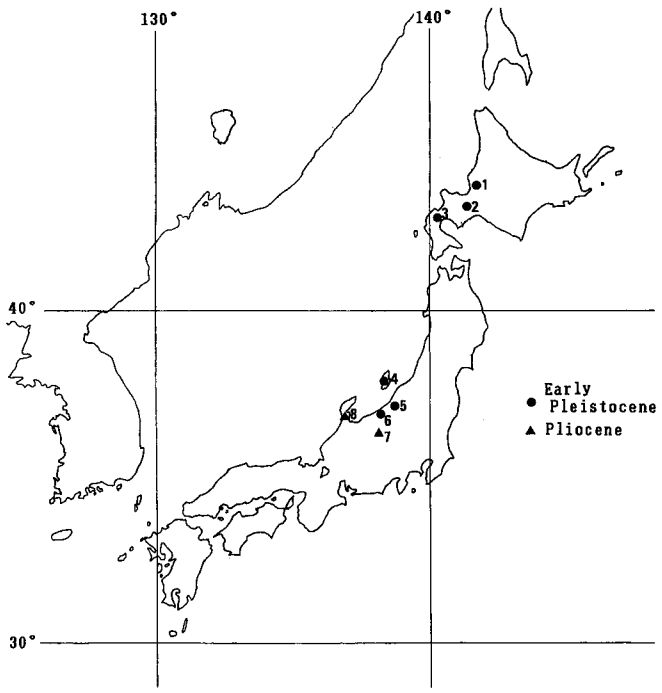

Fig. 2. Distribution of *Profulvia kurodai* (Sawada).
1. Zaimokuzawa F., 2. Shimonopporo F., 3. Setana F., 4. Sawane F., 5. Haizume F., 6. Kota F., 7. Shigarami F., 8. Suginoya Siltstone

1) River floor at about 2km upstream of Soibetsu River, Suttsu-gun, Hokkaido ; Setana Formation ···Pl. 1, figs. 2, 4, 5, 7, 8
2) Road-side cliff at Kawashimo, Togakushi-mura, Kami-minochi-gun, Nagano Pref. ; Shigarami Formation (Ogikubo Member) ···Pl. 1, fig. 6
3) Road-side cliff at Shimo-kusukawa, Togakushi-mura, Kami-minochi-gun, Nagano Pref. ; Shigarami Formation (Ogikubo Member) ···Pl. 1, fig. 3
4) Stream-side cliff at Nakagawa-cho, Hakui City, Ishikawa Pref. ; Suginoya Siltstone ···Pl. 1, fig. 1

Distribution :

Early Pleistocene Zaimokuzawa, Shimonopporo, Setana, Haizume, Sawane, Kota formations ; Pliocene Suginoya Siltstone and Shigarami Formation (Fig. 2).

Ecology and evolution of *Profulvia kurodai*

Profulvia kurodai is occurred mainly from the fine- to medium-grained sandstone, and is frequently associated with the following upper sublittoral species ; namely, *Glycymeris yessoensis* (Sowerby), *Mizuhopecten yessoensis* (Jay) group, *Chlamys cosibensis* (Yokoyama), *Swiftopecten swiftii* (Bernardi) and *Ezocallista brevisiphonata* (Carpenter) (Table 1). From these data, it can be inferred that the species lived in the sandy bottom of the upper sublittoral zone.

Up to this time, the present species has not been emphasized as a characteristic

Table 1. Occurrences of *Profulvia kurodai*. *Data on the Haizume, Kota and Zaimokuzawa formations are based on Kobayashi et al. (1986), Mizuno and Amano (1988), and Akamatsu (1984). **$G.$ = *Glycymeris*, $M.$ = *Mizuhopecten*, $C.$ = *Chlamys*, $S.$ = *Swiftopecten*, $E.$ = *Ezocallista*.

Formation*	Shigarami	Sawane	Haizume	Kota	Suginoya	Setana	Zaimokuzawa
Lithology	f.-m.s.s.	m.s.s.	m.s.s.	f.s.s.	silt.s.	f.-m.s.s.	m.s.s.
Frequency	rare	rare	rare	rare	rare	abundant	?
Associatad fauna**							
G. yessoensis		+	+	+		+	+
M. yessoensis gr.		+	+		+	+	+
M. yamasakii	+						
C. cosibensis				+	+		
S. swiftii	+		+	+		+	+
E. brevisiphonata		+				+	+

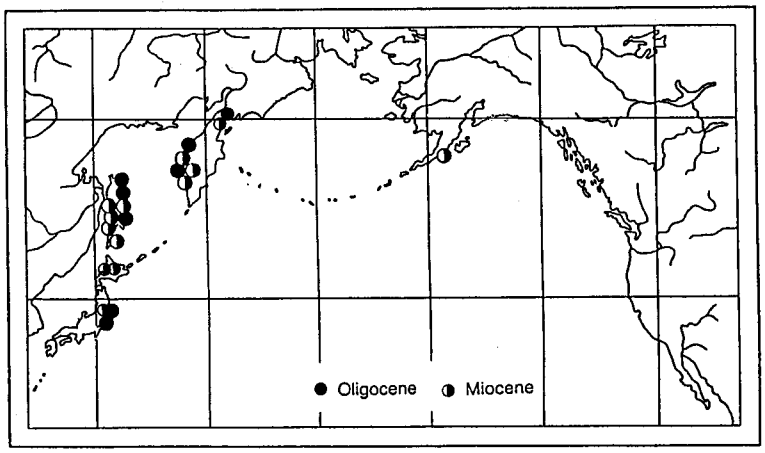

Fig. 3. Distribution of *Profulvia* during Oligocene and Miocene. (Revised from Kafanov, 1980).

element of the Omma-Manganji fauna (Otuka, 1939). However, as described in above lines, the distribution of present species is confined to the Pliocene and Lower Pleistocene deposits in the Japan Sea borderland. Therefore, the present one can be considered as a typical Omma-Manganjian bivalve.

The genus *Profulvia* flourished in Northeast Honshu, Hokkaido, Sakhalin, Kamchatka and Alaska. According to Kafanov (1980), Kafanov and Savitsky (1982), Gladenkov et al. (1987), thirteen species and one subspecies of the genus *Profulvia* have been recorded from the Oligocene and Miocene strata in these areas (Fig. 3). However, the species diversity of *Profulvia* suddenly began to decline in Late Miocene. Only one species, *Profulvia kurodai* (Sawada), has been known from the Plio-Pleistocene strata in the Japan Sea borderland.

The Shigarmi Formation consists of the Takafu, Arakurayama, and Ogikubo members in ascending order (Yano and Murayama, 1976). The ages of the latter two members were assigned to 4.1-3.0Ma (Tsuchi and Ibaraki, 1988; Kato, 1989 MS). Amano and Karasawa (1988) only listed up *Papyridea* cf. *kurodai* from the Arakurayama Member. In this paper, the well-preserved Ogikubo specimen was examined and illustrated. Up to this time, the exact age of Suginoya Siltstone has been unknown. Therefore, the occurrences of Shigarami specimens are the oldest record of this species. It is reasonable to conclude that the present species might have evolved from *Profulvia harrimani* (Dall) in and around the Japan Sea side of Central Honshu. This pattern of evolution and migration resembles that of *Yabepecten tokunagai* pointed by Amano and Karasawa (1988).

The fossil horizon of Zaimokuzawa Formation in Hokkaido was chronologically assigned to the earliest Middle Pleistocene by Akamatsu (1984). According to his chronological assignment, the Zaimokuzawa specimen is the youngest record of this species. At least, during Middle Pleistocene, the present species had suffered extinction in Hokkaido.

Among many extinct bivalves of the Omma-Manganji fauna, the following three species are belonged to the extinct genera ; namely, *Yabepecten tokunagai, Pseudamiantis tauyensis* and the herein treated species, *Profulvia kurodai*. These genera shared two notable characteristics ; (1) consisting of only one species, and (2) living in and on the sublittoral sandy bottom. The species-poor clades generally have a greater probablilty of extinction than the species-rich clades (*e. g.* Stanley, 1979). However, some monospecific genera of Omma-Manganjian bivalves continue to survive in Japan Sea such as *Robaia, Porterius* and *Swiftopecten*. The causes arising this contrast may be partly owing to the differences of living depth and bottom characters as suggested by Amano and Narita (1992).

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Explanation of Plate 1

Fig. 1. *Profulvia kurodai* (Sawada), x1.05, JUE no. 15383, Suginoya Siltstone.

Fig. 2, 4, 5, 7a-b, 8. *Profulvia kurodai* (Sawada) ; 2, JUE no. 15384-10, x1 ; 4, JUE no. 15384-4, x0. 8 ; 5, JUE no. 15384-5, x1 ; 7a-b, JUE no. 15384-1, x0.65 ; 8, JUE no. 15384-3, x0.65 ; Setana Formation.

Figs. 3, 6. *Profulvia kurodai* (Sawada) ; 3, JUE no. 15385, x0.8, Loc. Shimo-kusukawa ; 6, TFM, x0.8, Loc. Kawashimo ; Shigarami Formation.

Fig. 9. *Profulvia kurodai* (Sawada), x0.8, JUE no. 15109, Kota Formation.

Amano · Tanaka : *Profulvia kurodai* (Sawada) Plate 1