

Chlamys (Chlamys) foeda (Yokoyama) from the Shigarami Formation in Nagano Prefecture, Central Japan

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ABSTRACT

Some thick shells of *Chlamys* were found from the Pliocene Shigarami Formation in Nagano Prefecture. The Shigarami specimens have elongate anterior auricles and 14 to 15 imbricated radial ribs, and are identified with *Chlamys foeda* which is a characteristic element of the Plio-Pleistocene Omma-Manganji fauna.

From the occurrence of this species including the Shigarami specimens, it has become clear that the *foeda* lived on the bottom of coarse-grained sediment in the shallow sea, and evolved from the Miocene allied forms in Northeast Japan.

KEY WORDS

Chlamys foeda, Shigarami Formation, Nagano

Introduction

The Neogene deposits in Kamiminochi-gun, Nagano Prefecture are composed of the Aoki, Ogawa, Shigarami and Sarumaru Formations in ascending order (Kato and Akahane, 1986). The Shigarami abundantly yields the pectinid species studied by Akiyama (1958a, 1958b, 1962) and Masuda (1962).

Recently, two pectinids hitherto undescribed were newly found from the Shigarami Formation (Amano and Karasawa, 1986, 1988). Masuda (1986) also reported the first occurrence of *Chlamys foeda* from the Shigarami, but did not describe on the morphological features and the stratigraphic horizon of the Shigarami specimens. Fortunately, the authors have an opportunity to examine five specimens of *Chlamys foeda* from the Shigarami Formation, stored in the Togakushi Fossil Museum.

Chlamys foeda is an important species as a characteristic element of the Plio-Pleistocene Omma-Manganji fauna distributed along the Japan Sea borderland (Ogasawara, 1986). Nevertheless, its ecology and evolution has not been discussed. The Shigarami

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specimen may be the oldest one of this species because the Shigarami Formation was assigned to Early Pliocene by Amano and Karasawa (1986). Therefore, it is worthy to describe on the Shigarami specimens and to infer the ecology and evolution of *Chlamys foeda*.

Locality and occurrence

Chlamys foeda was collected from two localities in the Shigarami Formation (Fig. 1). The formation is subdivided into the Okubo, Arakurayama, and Ogikubo Members in ascending order (Kato and Akahane, 1986). According to Yano (1981), the Ogikubo overlies on the Arakurayama with a partial unconformity. Above two localities are in the lowest part of Ogikubo Member and correspond to the horizon near above this unconformity.

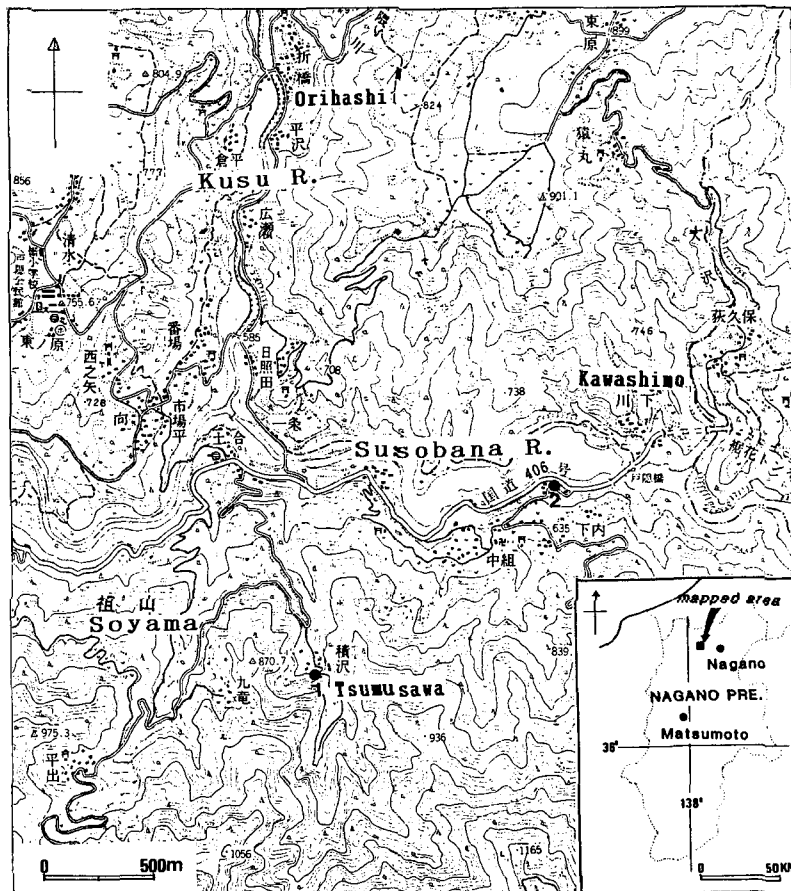


Fig. 1 Map showing the fossil localities (using the topographical map of "Togakushi" and "Shinano Nakajo" scale 1:25000 published by Geographical Survey Institute of Japan).

The fossil localities and sedimentary facies are briefly described below :

Loc. no. 1. Road-side cliff near Tsumusawa, Togakushi-mura, Kamiminochi-gun. Facies : tuffaceous medium-grained sandstone.

Loc. no. 2. Road-side cliff about 250 m west of Togakushi Bridge, Togakushi-mura, Kamiminochi-gun. Facies : coarse-grained sandstone.

Systematic description

Family Pectinidae

Subfamily Chlamiinae

Genus *Chlamys* (Röding)

Subgenus *Chlamys* s.s.

Chlamys (Chlamys) foeda (Yokoyama, 1926)

Pl. 1, figs. 1-4

Pecten foedus Yokoyama, 1926, p. 305-306, pl. 37, fig. 1

Chlamys (Mirapecten) robustus Ozaki, 1958, p. 116, pl. 12, figs. 1, 2.

Chlamys (Chlamys) foeda (Yokoyama), Masuda, 1962, p. 165, pl. 18, fig. 17 ; Matsuura, 1985, pl. 35, fig. 12

Chlamys foeda (Yokoyama), Sakagami *et al.*, 1966, pl. 5, figs. 3a, b ; Masuda, 1980, pl. 3, fig. 5 ; Masuda and Ogasawara, 1981, pl. 3, figs. 3 ; Masuda, 1986, pl. 3, figs. 1, 2 ; Kobayashi *et al.*, 1986, pl. 15, fig. 16 ; Kobayashi, 1986, pl. 21, fig. 11.

Type Locality :

Kaidate-no-sawa, Sawada-machi, Sado-gun, Niigata Prefecture.

Material :

Five specimens, two right valves, three left valves. All specimens from the Ogikubo Member.

Description :

Shell thick, large in size, inequilateral and inequivalve ; apical angle about 92°.

Right valve slightly inflated. Surface of right valve ornamented with 14 strong radial ribs ; ribs squarish and imbricated, separated by nearly equal interspaces. Concentric lamellae of right valve distinct in whole surface. Anterior auricle of right valve elongate, narrow, with irregular growth lines ; byssal fasciole rather wide ; ctenolium consisting of 3 strong denticles. Posterior auricle more wide than the other specimens already illustrated and with one or two distinct radial ribs.

Left valve also slightly inflated. Surface of left valve sculptured by 14 to 15 radial ribs ; ribs elevated and imbricated, slightly narrower than interspaces. Concentric lamellae of left valve also distinct in whole surface. Anterior auricle with 5 radial ribs.

Measurements (in mm) :

Specimens*	Length	Height	NR**	Valve
TFM 0010-08	99.5	108.3	14	R.V.
" "	101.4+	113.3	14	L.V.
" 0010-02	—	—	15	L.V.
" 0010-03	—	—	14	R.V.
" 0010-04	—	—	12+	L.V.

* All specimens are stored in the Togakushi Fossil Museum

** Number of radial ribs

Remarks :

Ozaki (1958) described *Chlamys (Mirapecten) robustus* as a new species from the Na-arai Formation in Chiba Prefecture. According to his description, this "new species" differs *Chlamys foeda* by having a flatter shell, narrower apical angle and more numerous ribs (15 in *robustus* and 13 in *foeda*). However, some specimens of the *foeda* from the Shigarami and the Hitachi Formations have 15 radial ribs and show nearly same apical angle to the *robustus*. Therefore, it is hard to distinguish the *robustus* from the *foeda*.

Affinities :

The present species is closely related to *Chlamys (Chlamys) niikappuensis* (Pl. 1, fig. 5) from the early Middle Miocene Noya Formation in Hokkaido described by Masuda (1962). The latter species has 12 strong and imbricated radial ribs. However, the interspaces of the latter are ornamented with 4 radial ribs, 5 weak radial threads and network sculpture which are never observed in the *foeda*.

Chlamys chiyodai, described from the Middle Miocene Otsutsumi Formation in Miyagi Prefecture, is another allied species to the present one. According to Masuda and Sato (1977) who proposed the *chiyodai* as a new species, this species can be distinguished from the *foeda* by its few, fine riblets on the radial ribs in the right valve and less lamellated growth lines.

Surely, the above two Miocene forms are discriminated from the present one. However, both description of these forms were based on only one specimen respectively. Therefore, it is too difficult to conclude whether the Miocene forms can be distinguished from the *foeda* as an independent species or should be included in an infraspecific rank.

Except for the above Miocene forms, there is no related species to the present one in and around Japan. *Chlamys (Leochlamys) tugidakensis* MacNeil (1967) from the Pliocene in Alaska resembles the present species in having an elongate anterior auricle of right valve and imbricated radial ribs. However, the former has more numerous and shows narrower apical angle than the latter. Moreover, as pointed by MacNeil (1967), the Alaska species seems to be a descendant of *Chlamys columbiana* (Clark et Arnold) from the Early Miocene

Sooke Formation of Vancouver Island.

Distribution :

Early Pleistocene Sawane, Haizume and Tomikawa Formations ; Pliocene Shigarami, Zukawa, Na-arai and Hitachi Formations.

Ecology and evolution of *Chlamys foeda*

The occurrences of *Chlamys foeda* are summarized in Table 1. At a glance of this table, it is noticed that this species is frequently obtained from the medium- to very coarse-grained sandstone and conglomerate, and is associated with some shallow sea pectinids such as *Chlamys cosibensis* and *Mizuhopecten yessoensis* group. This association resemble *Patinopecten-Chlamys* assemblage from the coarse-grained sandstone by Chinzei and Iwasaki (1967) and Iwasaki (1970). As already pointed by Oyama (1952), the shallow water pectinids favour the bottom where the water flow rapidly, making rich the oxygen supply. Therefore, it seems that *Chlamys foeda* lived on the bottom of coarse-grained sediment in the shallow sea.

The shell morphology of *Chlamys foeda* shows the adaptation to the habitat above-mentioned. Namely, the species has a thick shell test and an elongate anterior auricle. According to Stanley (1970), the thick shell and the elongate anterior auricle are enough to withstand breakage and overturning in rigorous wave or current-dominated benthic settings.

Another feature of the occurrence is a low frequency at each localities as shown in

Table 1 Occurrences of *Chlamys foeda*

	Ozaki (1958)	Masuda (1962)	Sakagami <i>et al.</i> (1969)	Matsuura (1985)	Kobayashi <i>et al.</i> (1986)	Present study
Formation	Na-arai	Sawane	Hitachi	Tomikawa	Zukawa	Haizume Shigarami
Facies*	cg.	v.c.s.s.	v.c.s.s.	c.s.s.	c.s.s	calc.s.s. m.-c.s.s.
Frequency	1, L.V.	few	rare	?(one loc.)	rare	rare 5
Associated fauna**						
<i>Ch. cosibensis</i>	-	+	?	+	+	+
<i>M. yessoensis</i> gr.	-	+	?	+	+	+

* cg.=conglomerate, v.c.s.s.=very coarse-grained sandstone, c.s.s.=coarse-grained sandstone, m.s.s.=medium-grained sandstone, calc.s.s.=calcareous sandstone.

** *Ch. cosibensis*=*Chlamys cosibensis* (Yokoyama), *M. yessoensis* gr.=*Mizuhopecten yessoensis* (Jay) group.

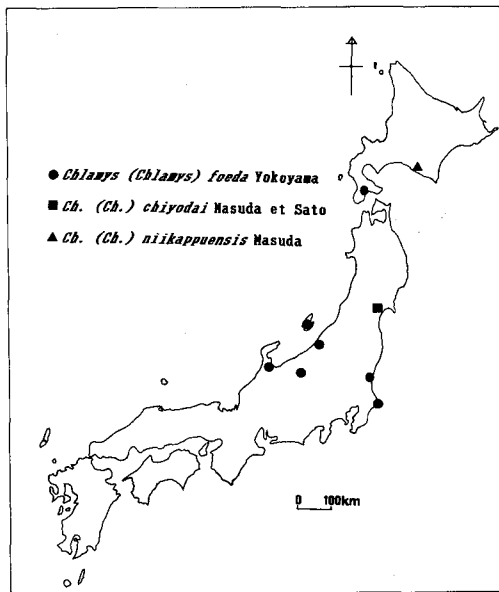


Fig. 2 Distribution of *Chlamys foeda* and its related species in Japan.

part of Japan and advanced southward in Early Pliocene. This evolutionary pattern resembles that of *Yabepecten tokunagai* (Yokoyama) recently described from the Shigarami Formation by Amano and Karasawa (1988).

Table 1. Instead of having the adaptive morphology to the habitat, one or a few specimens have been collected from one or two localities of each formations. Moreover, up to this time, no juvenile specimen has not been found from any above strata. However, the reason of this feature remains unsolved.

As aforementioned, *Chlamys foeda* is one of the representative elements of the Plio-Pleistocene Omma-Manganji fauna, and distributes mainly in Central Japan (Fig. 2). On the other hand, the Miocene forms allied to the *foeda* (*Chlamys niikappuensis* and *Ch. chiyodai*) distribute in northern Japan. Therefore, it is possible that the *foeda* evolved from the above Miocene forms in northeastern

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Explanation of Plate 1

- Fig. 1, 3, 4 *Chlamys (Chlamys) foeda* (Yokoyama)
fig. 1, $\times 0.7$, TFM 0010-08, Loc. 1 ; fig. 3, $\times 0.6$, TFM 0010-02, Loc. 2 ; fig. 4, $\times 0.75$, TFM 0010-08, Loc. 1 ; Shigarami Formation.
- Fig. 2 *Chlamys (Chlamys) foeda* (Yokoyama)
 $\times 0.65$, JUE no. 15276, Loc. Zukawa ; Zukawa Formation in Toyama Prefecture.
- Fig. 5 *Chlamys (Chlamys) niikappuensis* Masuda
 $\times 1$, IGPS no. 90536 (Holotype) ; Noya Formation in Hokkaido.

