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Discovery of Middle Miocene Molluscs at Kumi, Dōgo, Oki Islands

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Introduction

Oki islands have been familiar to the Japanese geologists as the working area of petrological studies of alkaline rocks, while the biostratigraphic works have not so developed as to establish the whole successions. It is the upper Miocene to be confirmed as the oldest horizon by marine fauna. TOMITA (1936) first reported the occurrence of *Cardium shinjiense*, *Crenella paeramaena*, *Mya arenaria*, *Pecten swiftii*, *P. yessoensis*, *Natica janthostoma*, *Chrysodomus despectus* and *Thyasira bisecta* from his Dōgo group. Later, foraminifers such as *Cibicides lobatulus*, *Globigerina bulloides*, *Uvigerina subperegrina*, *Epistominella japonica* and so on, were found out by TAI (1954) from the same horizon. Since then, these fossils have been regarded as the indicators of the upper Miocene, and the whole successions of volcanic activities have been made on this paleontologic basis.

Accordingly, a new middle Miocene fauna described below as Kumi fauna is quite noteworthy, because it means the first evidence of the middle Miocene transgression in Oki islands. It is, moreover, interesting in the paleo-ecological considerations that this new fauna is composed mainly of rocky bottom inhabitants in the warm current.

Before entering into the description, the authors wish to express their hearty thanks to Mr. S. KASAMATSU of Education Office of Saigō-chō for the information of fossil locality, and Dr. M. OMORI of Azabu Veterinary College and Dr. J. ITOIGAWA of Nagoya University for their kind suggestions on paleontology.

Occurrence of Fossils

At the vicinity of Kumi, northwest of Dōgo, are widely developed the alkaliliparite of Pliocene age, and then, the Tertiary sediments are exposing in few places just beneath it. The sandstone beds of middle Miocene age crop out along the narrow valley at about 1.5 km to the southeast of Kumi, extending nearly east-westward and gently dipping to the north. These beds are cut by fault at the south and are overlain by liparite and talus on the other sides. Therefore, the base of these sandstone beds

can not be ascertained. As their outcrops are very restricted, both stratigraphic and tectonic relations to the adjacent areas in Oki islands are almost uncertain.

Fossils dealt in this paper are crowded in the very coarse, calcareous parts within the sandstone beds. There are about five fossil-bearing layers, having 0.1 to 0.5 m in thickness. Fossil shells scarcely suffered deformation, but it is very difficult to isolate the individuals from the hard mother rocks. Nevertheless, the authors have obtained about fifty species of molluscs, of which 14 species will be mentioned in the following pages for the time being. Beside these molluscs, there are many fossils, such as foraminifers, calcareous algae, echinoid spines and sponge spicules. Detailed studies on this fauna will be carried out by the junior author in future. All specimens are preserved in the Department of Geology, Shimane University.

Age of Kumi Fauna

The authors have hitherto recognized the following species at Kumi;

Haliotis notoensis MASUDA
Diodora sp.
Tugali cfr. *decussatoides* (NOMURA and HATAI)
Euchellus cfr. *notoensis* MASUDA
Nerita cfr. *ishidae* MASUDA
Calyptraea sp.
Conus tokunagai OTUKA
Cavolina sp.
Acila cfr. *yanagawaensis* (NOMURA and ZINBO)
Barbatia sp.
Glycymeris sp.
Nipponolimopsis cfr. *azumana* (YOKOYAMA)
Limatula (*Limatula*) sp.
Cardita cfr. *leana* DUNKER

It is noticed that some characteristic species of Higashi-Innai fauna described by MASUDA in 1966 from the Noto peninsula, are included also in Kumi fauna. They are *Haliotis notoensis*, *Euchellus* cfr. *notoensis*, *Nerita* cfr. *ishidae* and *Conus tokunagai*. Beside these molluscs, abundant occurrences of foraminifers, calcareous algae and echinoid spines are common to the both. Basing upon these facts, as well as the geologic and geographic affinities between two areas, it is concluded that the Kumi fauna clearly indicates the middle Miocene, namely the Nishikurosawa stage.

Remarks on species

Class Gastropoda

Genus *Haliotis* LINNAEUS, 1758

Haliotis notoensis MASUDA

(Pl. I, Fig. 1)

1966. *Haliotis notoensis* MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S.*, no. 64, pp. 329–330, Pl. 36, Fig. 1.

Remarks: This species was established by MASUDA from the Higashi-Innai formation, and compared with Recent species *H. diversicolor* REEVE. He emphasizes the distinctive features that his new species has strong longitudinal threads, few spiral threads on periphery and fine spiral threads on surface. The specimen at hand represents a quite resemblance with MASUDA's description in its small size and in having curved, coarse longitudinal and fine spiral threads. From *H. kurosakiensis* KOTAKA and OGASAWARA, it is distinguished by the features of longitudinal and spiral threads, as well as by lacking of groove-like portion along the right margin of openings.

Measurements in mm: Height ca. 6.0, Width 28.5+

Genus *Diodora* GRAY, 1821

Diodora sp.

(Pl. I, Figs. 2a–b)

Remarks: With respect to the situation of apical hole and the outline of shell, this specimen resembles *D. minoensis* ITOIGAWA from the Miocene Mizunami group. But the former is different from the latter by the more convex posterior surface and the higher shell. As ITOIGAWA says, the shell of *D. suprapunicea* OTUKA, a related Recent species in Japan, is higher than that of *minoensis*. But *suprapunicea*, on the contrary to the Kumi specimen, shows a rather straight posterior surface. The surface ornaments of the Kumi specimen are characterized by numerous radial ribs and somewhat weak concentric striations, though the details can not be ascertained by its ill preservation.

Measurements in mm: Height 4.5, Length of aperture 14.0+, Breadth of aperture 11.0

Genus *Tugali* GRAY, 1843

Tugali cfr. *decussatoides* (NOMURA and HATAI)

(Pl. I, Figs. 3a–b)

1936. *Tugalia decussatoides* NOMURA and HATAI, *Saito Ho-on Kai Mus. Res. Bull.*, no. 10, p. 148, Pl. 17, Fig. 11.

1965. *Tugali decussatoides*, MASUDA and TAKEGAWA, *Saito Ho-on Kai Mus. Res. Bull.*, no. 34, Pl. 2, Fig. 11.

Remarks: In its small size, high shell and slightly concave posterior surface, this

specimen resembles *Tugali decussatoides*, which was first described by NOMURA and HATAI (1936) from the Tanagura Miocene group, Fukushima Prefecture. But the surface ornaments and other detail characters can not be seen by its ill preservation. *T. notoensis* MASUDA from the Higashi-Innai formation, is distinguished from this specimen by the broadly rounded posterior surface and low shell. *T. vadososinuata* (YOKOYAMA) also differs from the present specimen by the lower and larger shell.

Measurements in mm: Height 5.0, Length of aperture 11.3, Breadth of aperture?

Genus *Euchellus* PHILIPPI, 1847

Euchellus cfr. *notnensis* MASUDA
(Pl. I, Fig. 4)

1966. *Euchellus notoensis* MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S.*, no. 64, p. 330, Pl. 36, Figs. 4–6.

Remarks: This small gastropod is closely related to MASUDA's *notoensis* in having four postnuclear whorls which are rounded and separated by distinctly channeled sutures. That the apical angle is about 90°, and that the surface is covered by several, fine granulated, unequal spiral threads and somewhat oblique fine longitudinal threads, are common to both. But the body whorl of the present specimen is somewhat smaller than that of the type species. It differs from *E. minoensis* ITOIGAWA from the Miocene Mizunami group by its lower shape.

Measurements in mm: Height 5.4, Diameter 6.3

Genus *Nerita* LINNAEUS, 1758

Nerita cfr. *ishidae* MASUDA
(Pl. I, Fig. 5)

1966. *Nerita ishidae* MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S.*, no. 64, pp. 335–336, Pl. 36, Figs. 23–25.

Remarks: This specimen is characterized by the minute apical whorl, very large body whorl and nearly flat surface. These features strongly suggest the identification to *N. ishidae* from the Higashi-Innai formation. But the former is twice as large as the latter, and its details of surface ornaments and feature of aperture are rather indistinct. The Kumi specimen is larger and much flattened than *N. kamigiriensis* ITOIGAWA from the Miocene Mizunami group.

Measurements in mm: Height ca. 23.5, Diameter ca. 33.0

Genus *Calyptraea* LAMARCK, 1799

Calyptraea sp.
(Pl. I, Figs. 6a–b)

Remarks: In its small size, rather low conical shape, few number of spirals and nearly circular outline, the present specimen resembles *C. tubura* OTUKA from the Miocene Nagura formation in Chichibu Basin (KANNO, 1960) and the Miocene Mizunami group (ITOIGAWA, *et al.*, 1974). But its shell is rather small, and its apex does not situate centrally as in *tubura*, but somewhat eccentrically. Moreover, the surface of this specimen differs from *tubura* by having no radial striations. According to HIRAYAMA (1955), *C. tokunagai* HATAI and NISIYAMA from the Joban Coal-field, has no radial striation, but its apex is in the center. *C. aokii* HIRAYAMA from the same formation associated with *tokunagai*, somewhat resembles to the Kumi specimen in the convex shell and roughly brush-up-like striae in body whorl, but this Oligocene species is distinguished from the latter by the large size and elliptical outline.

Measurements in mm: Height 3.0, Diameter 7.4

Genus *Conus* LINNAEUS, 1758

Conus tokunagai OTUKA
(Pl. I, Fig. 7)

1934. *Conus tokunagai* OTUKA, *Bull. Eathq. Res. Inst.*, vol. 12, pt. 3, p. 632, Pl. 50, Figs. 83–84.
1967. *Conus tokunagai*, MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S.*, no. 65, Pl. 2, Figs. 29–30.

Remarks: This species was first described by OTUKA (1934) from the lower Kadonosawa series, Iwate Prefecture, and later, reported by MASUDA from the Higashi-Innai formation. The present specimen is quite identical with that of MASUDA's illustrations, by its size, rather high spire, number of whorls, rounded smooth shoulder and weak spiral furrows on the last whorl.

Measurements in mm: Height 18.0, Diameter 8.8

Genus *Cavolina* ABILDGAARD, 1791

Cavolina sp.
(Pl. I, Figs. 8a–b)

Remarks: There are about five species of fossil pteropods in Japan, in which *C. raritatis* NOMURA and ZINBO is only the Miocene one. The numerous, fine concentric growth-lines covering the entire surface are characteristics in *raritatis*, but they are not represented in this fractured specimen. The Pliocene and Recent species, *C. longirostris* (BLAINVILLE) and *C. uncinata* (d'ORBIGNY) are obviously different from the present specimen in the convexity of the ventral disc.

Measurements in mm: Height 6.3, Width 6.3

Class Pelecypoda

Genus *Acila* H. and A. ADAMS, 1858

Acila cfr. *yanagawaensis* (NOMURA and ZINBO)
(Pl. I, Fig. 9)

1936. *Nucula* (*Acila*) *yanagawaensis* NOMURA and ZINBO, *Venus* (*Japan Jour. Soc. Mal.*), vol. 6, no. 2, pp. 105–106, Text-figs. 1a–b, 2a–b.
1960. *Acila yanagawaensis*, ARAKI, *Bull. Lib. Arts Dep., Mie Univ., Spec. Vol.*, no. 1, pp. 76–77, Pl. 5, Figs. 2a–b.

Remarks: By the lacking of the posterior divaricating lines and the rostrum, the present specimen is allied at a glance to *Acila* (*Truncacila*) *insignis* (GOULD) of the common Recent species and Pliocene one of Japan. But it differs therefrom by the shorter length and trigonal outline. These characters strongly suggest the identification to those of *A. yanagawaensis* of the Miocene species from Fukushima (NOMURA and ZINBO, 1936) and Mie Prefectures (ARAKI, 1960). According to the original description, the dorsal characters of the species are as follows; "Lunule or anterior area illdefined. Escutcheon or posterior area broad, divided into two parts by an oblique median ridge." However, these areas are indiscernible on the present specimen. In addition, its size is rather smaller than the type.

Measurements in mm: Height 4.9, Length 5.2, Depth 1.4

Genus *Barbatia* GRAY, 1842

Barbatia sp.
(Pl. I, Fig. 10)

Remarks: As the specimen is almost represented by the inner cast, the details of surface ornaments are uncertain, except for the fine radial ribs and weak, close-set lines of growth. But it is safely compared with this genus, through its characteristic teeth and trapezoidal outline.

Measurements in mm: Height 10.5, Length 21.3, Depth 2.7

Genus *Glycymeris* da COSTA, 1778

Glycymeris sp.
(Pl. I, Figs. 11–12)

Remarks: The specimens resemble *G. rhynchonelloides* NOMURA and HATAI from the Miocene Mizunami group (ITOIGAWA, *et al.*, 1974), in having the pointed beak and trigonal outline, but they are distinguishable therefrom by their small size and broad ventral margin. Other Miocene species *G. minoensis* ITOIGAWA from the Mizunami group, one of the allied forms, slightly differs in the situation of beak and shape of the anterior margin.

Measurements in mm:	Height	Length	Depth
	6.5	7.1	1.5
	5.6	6.0	1.2

Genus *Nipponolimopsis* HABE, 1951

Nipponolimopsis cfr. *azumana* (YOKOYAMA)
(Pl. I, Fig. 13)

1974. *Nipponolimopsis azumana,* ITOIGAWA *in* ITOIGAWA, SHIBATA and NISHIMOTO, *Bull. Mizunami Fossil Mus.*, no. 1, pp. 59–60, Pl. 7, Fig. 2.

Remarks: The specimen closely allied to *N. azumana* of the Miocene Mizunami group, except for its small size. The radial striations of the former are less marked than that of the latter, and the shape of the anterior margin is somewhat different in each other.

Measurements in mm: Height 6.3, Length 6.0, Depth 1.8

Genus *Limatula* WOOD, 1839

Limatula (*Limatula*) sp.
(Pl. I, Fig. 14)

Remarks: By the elongated ovate shape and distinct medial groove, these small shells are undoubtedly referred to subgenus *Limatula* (s.s.). According to OYAMA (1943), this subgenus is defined by possessing the strong medial groove and includes two species; namely *Limatula* (*L.*) *sibogai* (PRASHAD) from the recent deep sea and *Limatula* (*L.*) *kurodai* OYAMA from the Pleistocene and recent mesoneritic or bathyneritic zones. And *sibogai* is characterized by the coarse ribs making decussate ornament, while *kurodai* by the very fine ribs without decussate one. On the present specimens, the weak fine striations are slightly observed, but there are no decussate ornaments. Therefore, it may be referred to *kurodai*, but the authors describe them in this paper as *Limatula* (*Limatula*) sp., because their characteristics, especially their ears and distinct surface ornaments are invisible. *Limatula* (s.s.) *minoensis* ITOIGAWA from the Miocene Mizunami group is far from the Kumi specimens by its indistinct medial groove and its coarse radial ribs.

Measurements in mm:	Height	Length	Depth
	7.6	4.0	2.0
	7.7	4.3	2.1

Genus *Cardita* BRUGUIÈRE, 1792

Cardita cfr. *leana* DUNKER
(Pl. I, Fig. 15)

1960. *Cardita leana,* MAKIYAMA, *Spec. Pap., Palaeont. Soc. Japan,* no. 6, Pl. 105, Figs. 8–9.

Remarks: This specimen resembles M. YOKOYAMA's *C. leana* revised by MAKIYAMA, in its coarse radial ribs, concave anterior margin and distinct anterior rostrum. But both are obviously distinguished from their living form (HABE, 1977) by the intensity of rostrum.

Measurements in mm: Height 6.3, Length 10.8, Depth 3.5

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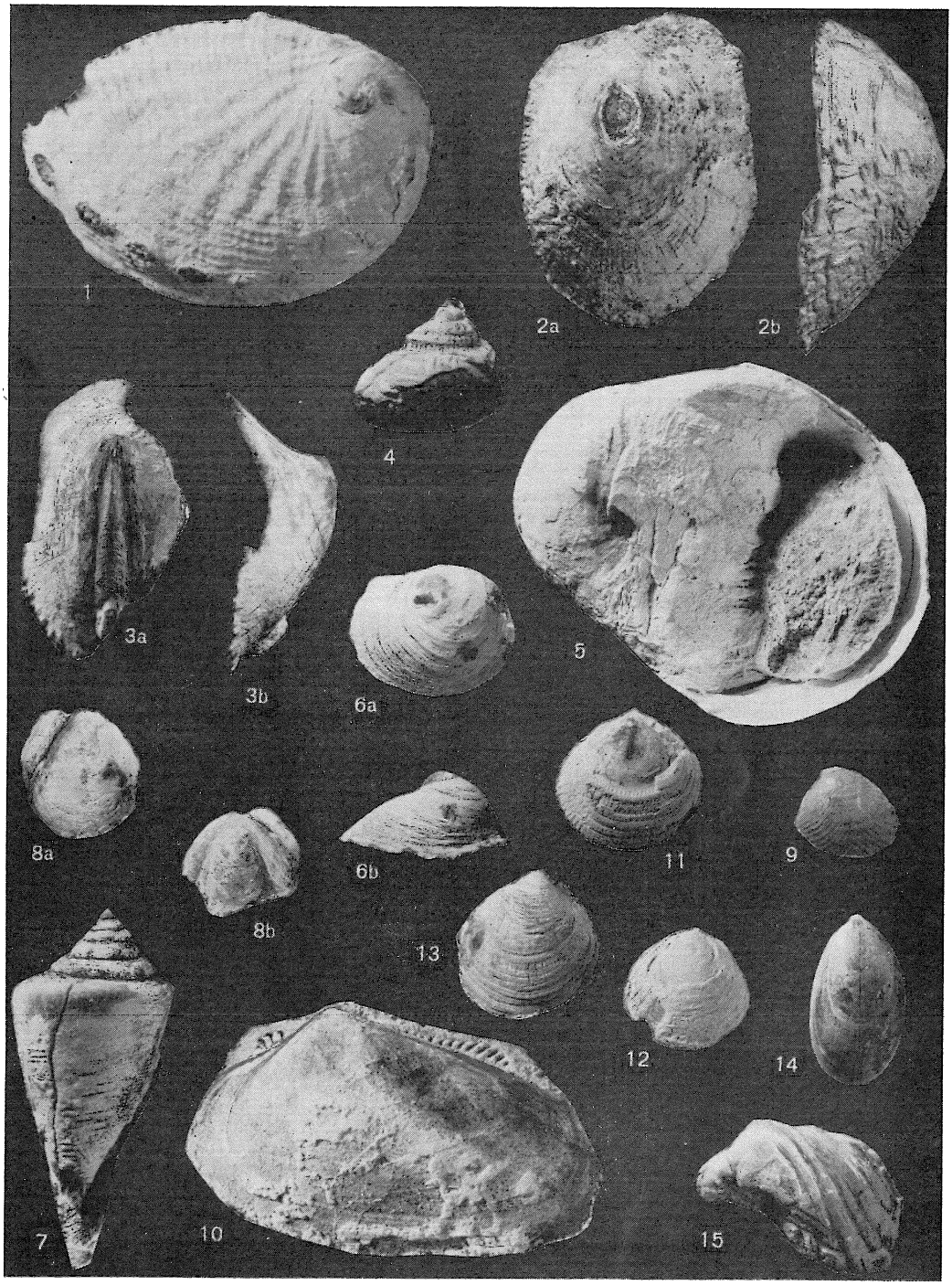
Explanation of Plate I

Fig. 1. *Haliotis notoensis* MASUDA. ×2.5.
Figs. 2a–b. *Diodora* sp. ×3. 2a, Plan. 2b, Lateral view.
Figs. 3a–b. *Tugali* cfr. *decussatoides* (NOMURA and HATAI). ×3. 3a, Plan. 3b, Lateral view.
Fig. 4. *Euchellus* cfr. *notoensis* MASUDA. ×3.
Fig. 5. *Nerita* cfr. *ishidae* MASUDA. ×2.5.
Figs. 6a–b. *Calyptraea* sp. ×3. 3a, Plan. 3b, Lateral view.
Fig. 7. *Conus tokunagai* OTUKA. ×3.
Figs. 8a–b. *Cavolina* sp. ×3. 8a, Ventral view. 8b, Dorsal view.
Fig. 9. *Acila* cfr. *yanagawaensis* (NOMURA and ZINBO) ×3.
Fig. 10. *Barbatia* sp. ×3.
Figs. 11–12. *Glycymeris* sp. ×3.
Fig. 13. *Nipponolimopsis* cfr. *azumana* (YOKOYAMA). ×3.
Fig. 14. *Limatula* (*Limatula*) sp. ×3.
Fig. 15. *Cardita* cfr. *leana* DUNKER. ×3.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