

# Miocene Mollusks from the Nagashino Formation of the Shitara Group in Shinshiro City, Aichi Prefecture, central Japan

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愛知県新城市の設楽層群長篠層産中新世貝類化石

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## (Abstract)

The present paper describes and illustrates a molluscan fauna collected from the Nagashino Formation of the Shitara Group at Arumi, Shinshiro City, Aichi Prefecture. The collection locality of mollusks is identical with or very close to the locality from which Hayashi and Koshimizu (1992) reported mollusks identified by them with middle Eocene species. The molluscan fauna consists of nine species; *Modiolus* sp., *Crassostrea gravitesta* (Yokoyama), *Laevicardium* sp., *Phacosoma kawagensis* (Araki), *Meretrix arugai* Otuka, *Hiatula minoensis* (Yokoyama), *Solen* sp., Naticidae gen. et sp. indet. and *Chicoreus* sp. The Nagashino Formation is referred to early Miocene age on the basis of their geologic ranges.

## Introduction

Miura (1890) was the first to make reference to the age of the Shitara Group in the Shitara area, Aichi Prefecture, assigning it to Miocene age on the basis of the molluscan fauna. Thereafter many workers referred it to early or early to middle Miocene age on the paleontological or stratigraphic basis for about a hundred years. They include Ishikawa (1900; 1901), Notomi (1929), Tsuboya (1936), Hayashi (1973), Yoshida (1953), Kato (1962), Shibata and others (1977), Shibata (1978), Collaborative Research Group for the Shidara Basin (1979) and Shibata and Ina (1983).

Hayashi and Koshimizu (1992), however, gave fission track dates of Paleogene age for the Hokusetsu Subgroup of the Shitara Group, and suggested middle Eocene age

for the Nagashino Formation of the Hokusetsu Subgroup from associated mollusks. After the publishment of Hayashi and Koshimizu (1992), Matsuoka (1996) reported Miocene mollusks from the Hokusetsu Subgroup, and Aoyama (1996) assigned the Shitara Group to Miocene age on the stratigraphical basis. More recently Hoshi and others (2000) suggested the early Miocene as the age for the Hokusetsu Subgroup from correlation of radiolarians from its middle to upper part. Thus it is helpful to examine the molluscan fauna from the Nagashino Formation for carrying forward the age assignment of this formation and the Shitara Group. Concerning the molluscan fauna from the Nagashino Formation several works have been previously published besides Hayashi and Koshimizu (1992). They are occurrence records of Miocene species by Hayashi (1973), Shibata and others (1977) and Yokoyama (1987), description of Miocene species by Shibata and Ina

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**Key words** : Mollusks, early Miocene, Nagashino Formation, Shitara Group, Shinshiro City, Aichi Prefecture.

**キーワード** : 貝類, 前期中新世, 長篠層, 設楽層群, 新城市, 愛知県.

(1983) and a taxonomic revision of the previously reported mollusks (Hayashi, 1973) by Hayashi (1988).

We examined a large molluscan collection by Yoshiaki Yokoyama and an additional one by Keiji Matsuoka both from the Nagashino Formation at Arumi, Shinshiro City for this study. Collecting of them was made separately at the same new exposure made by roadworks in 1987. Their collections consist of nine species including three species previously not reported from the Nagashino Formation. The purpose of this paper is to describe and illustrate them and to discuss the age of that formation. We follow Hayashi and Koshimizu (1992) for the stratigraphic classification of the Shitara Group.

All specimens described herein are deposited in Toyohashi Museum of Natural History.

We are indebted to Mr. Yoshiaki Yokoyama of Horaijisan Natural History Museum and Dr. Keiji Matsuoka of Toyohashi Museum of Natural History for allowing us to examine their molluscan collections from Arumi.

### Locality

The two molluscan collections examined were obtained separately by Yoshiaki Yokoyama and by Keiji Matsuoka from the same exposure of the Nagashino Formation at Arumi (Fig. 1) in 1987. Enclosing sediments of mollusks consist of coarse-grained sandstone and granule conglomerate. That exposure was made by roadworks in 1987, and is now lost. A detailed description of its location and the stratigraphy at it can be found in Yokoyama (1987). Hayashi and Koshimizu (1992) gave no detailed description for the locality at which they collected mollusks regarded by them as middle Eocene ones, only showing it on their geologic map. The present collection locality is considered to be identical with or very close to that locality by reference to its location on their geologic map.

### Age

The molluscan collections from Arumi consist of nine species, which are *Modiolus* sp., *Crassostrea gravitesta* (Yokoyama), *Laevicardium* sp., *Phacosoma kawagensis* (Araki), *Meretrix arugai* Otuka, *Hiatula minoensis* (Yokoyama), *Solen* sp., Naticidae gen. et sp. indet. and *Chicoreus* sp. Five of them, *Crassostrea gravitesta*

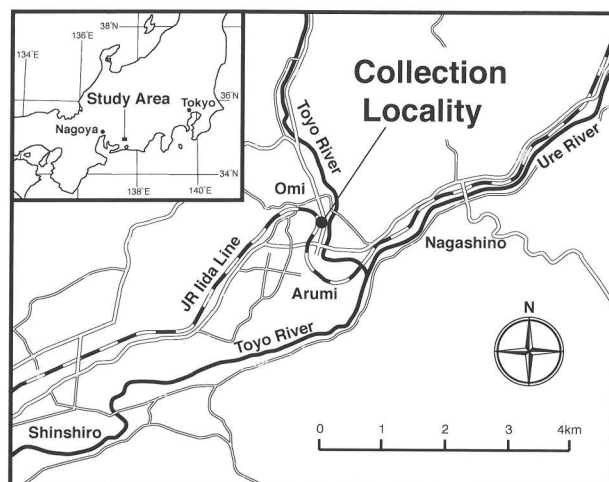


Fig. 1. Map showing the collection locality in Shinshiro City, Aichi Prefecture.

(Yokoyama), *Phacosoma kawagensis* (Araki), *Meretrix arugai* Otuka, *Solen* sp. and *Hiatula minoensis* (Yokoyama) have been known to occur outside the Shitara area. *Phacosoma kawagensis* (Araki) and *Solen* sp. have been known from the early Miocene, and *Meretrix arugai* Otuka and *Hiatula minoensis* (Yokoyama) have been recorded from the early to middle Miocene. *Crassostrea gravitesta* (Yokoyama) has a geologic range of the early Miocene to the Pliocene. The geologic ranges of these species indicate the early Miocene is most probable as the age for the Nagashino Formation.

Shibata and others (1977) reported a total of nine species of mollusks from the Nagashino Formation at their localities 1 and 2, which are near to the present collecting locality. Among them are *Trapezium modiolaeforme* Oyama and Saka and *Cyclina japonica* Kamada. These species have a geologic range of the early Miocene and that of the early to middle Miocene, respectively. There is, however, no species of which geologic range extends to the Paleogene in the nine species. These facts support the age assignment mentioned above. All those seven species are found in the molluscan fauna (Itoigawa and others, 1974, Itoigawa and others, 1981) from the Mizunami Group in Gifu Prefecture, and their occurrence in the group is restricted to the lower part of the early Miocene Akeyo Formation. Thus the Nagashino Formation is correlated with it.

### Descriptions

#### Phylum Mollusca

Class Bivalvia  
 Subclass Pteriomorpha  
 Order Mytiloida  
 Superfamily Mytilacea  
 Family Mytilidae  
 Subfamily Modiolinae  
 Genus *Modiolus* Lamarck, 1799

***Modiolus* sp.**  
 (Fig. 2-1)

*Modiolus* sp. Hayashi, 1973, pl. 2, fig. 3.

*Mytilus* sp. Hayashi, 1988, pl. 2, fig. 3.

Material -. One specimen.

Description -. Shell small, ovate, expanded posteriorly, bulged along an oblique medial line running from beak to posterior end. Beak low, situated close to anterior end. Anterior and posterior ends rounded. Postero-dorsal margin slightly arched, passing into posterior margin with a blunt angle. Postero-ventral corner produced postero-ventrally. Surface smooth. Dimensions; length 19.5 mm, height 17.0 mm.

Discussion -. The specimen at hand is a deformed inner cast. It bears a similarity in shape and size to *Modiolus nakamurai* Itoigawa and Shibata from the early Miocene Akeyo Formation of the Mizunami Group in Gifu Prefecture, but it is impossible to make a detailed comparison of the specimen with that species owing to the ill state of its preservation. The specimen resembles *Modiolus yasuiroi* Kamada described from the middle Miocene Taga Group in the Joban Coal-Field and *Modiolus arakawensis* (Kanno) from the middle Miocene Nagura Formation of the Chichibu-machi Group in Saitama Prefecture, but the shell is smaller.

Order Pterioidea  
 Suborder Ostreina  
 Superfamily Ostreacea  
 Family Ostreidae  
 Subfamily Ostreinae  
 Genus *Crassostrea* Sacco, 1897

***Crassostrea gravitesta* (Yokoyama, 1926)**  
 (Fig. 2-4)

1926 *Ostrea gravitesta* Yokoyama, Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, vol. 1, pt. 9, p. 388, pl. 45, figs. 1, 2.

*Ostrea gravitesta* Yokoyama. Nomura, 1938, p. 248, pl. 33, fig. 15; Makiyama, 1958, pl. 57, figs. 1a-c, 2a-c; Ogasawara, 1973, pl. 13, fig. 28; Hayashi, 1973, pl. 2, fig. 5.

*Ostrea (Crassostrea) gravitesta* Yokoyama. Kaseno, 1956, p. 7, pl. 1, figs. 5a-c.

*Crassostrea gravitesta* (Yokoyama). Itoigawa and others, 1974, p. 72, pl. 17, fig. 1; Yoon, 1976, p. 9, pl. 1, figs. 24, 25, pl. 3, figs. 17, 18; Itoigawa and Nishikawa, 1976, pl. 33, fig. 11; Ogasawara and Noda, 1978, p. 32, pl. 3, fig. 23; Taguchi and others, 1979, pl. 1, fig. 15; Yoon, 1979, p. 10, pl. 3, fig. 1; Amano, 1980, p. 106, pl. 13, figs. 29a, b; Takayasu, 1981, p. 99, pl. 2, fig. 15; Itoigawa and others, 1981, 1982, p. 53, pl. 10, fig. 3; Shibata and Ina, 1983, p. 43, pl. 4, fig. 9; Nakagawa and Takeyama, 1985, pl. 21, figs. 1a, b; Okumura and others, 1985, pl. 49, figs. 2a, b; Itoigawa and Shibata, 1986, pl. 16, fig. 11; Hayashi, 1988, pl. 2, fig. 5; Kanno and others, 1988, pl. 2, fig. 12; Okamoto and others, 1989, pl. 5, figs. 14a, b; Muramatsu, 1992, pl. 49, fig. 14.

*Crassostrea gravitesta eoliensis* Kim, Noda and Yoon, 1974, p. 274, pl. 38, fig. 15, pl. 39, figs. 1a-c; Lee, 1992, p. 79, figs. 28-10a, b.

Material -. Two right valves.

Description -. Right valve large, very thick, ovate, flattened. Beak pointed, with a triangular ligamental groove below it. Surface with rudely corrugated growth lines.

Dimensions (in mm) -.

Length	Height
82.3	188.7
88.5	125.3

Discussion -. The large and thick shell is a diagnostic character of *Crassostrea gravitesta* (Yokoyama). *Crassostrea gravitesta* (Yokoyama) closely resembles *Crassostrea gigas* (Thunberg), a living species of Japan, but the shell is thicker.

Geologic range -. Early Miocene to Pliocene.

Subclass Heterodonta

Order Veneroida

Superfamily Cardiacea

Family Cardiidae

Subfamily Laevicardiinae

Genus *Laevicardium* Swainson, 1840

*Laevicardium* sp.

(Figs. 2-2, 3a, b)

*Glycymeris cisshuensis* Makiyama (non Makiyama). Hayashi, 1973, pl. 1, fig. 6.

*Glycymeris* cf. *altoumbonata* Nagao. Hayashi, 1988, pl. 1, fig. 6.

Material -. Two specimens.

Description -. Shell small, thin, ovate in outline, slightly longer than high, moderately inflated. Beaks small, situated at a little anterior of the middle of the shell length. Anterior end rounded, ventral margin arched, postero-ventral corner roundly angulate. Surface with many radiating ribs.

Dimensions (in mm) -.

Length	Height	Thickness
32.6	30.0	13.0
26.1	21.8	-

Discussion -. *Laevicardium* sp. resembles *Laevicardium undatopictum* (Pilsbry) living in the West Pacific in shape, but the shell is larger, and radial ribs in the posterior part of the shell are less prominent. *Laevicardium* sp. is also analogous to *Laevicardium yoshidense* Kanno from the early Miocene Nenokami Sandstone of the Ogano-machi Group in Saitama Prefecture, but it has a larger number of radial ribs. It somewhat resembles *Nemocardium* sp. reported by Shibata (1970) from the early Miocene Ichishi Group in Mie Prefecture, but the shell is more elongate.

Superfamily Veneracea

Family Veneridae

Subfamily Dosiniinae

Genus *Phacosoma* Jukes-Brown, 1912

*Phacosoma kawagensis* (Araki, 1960)

(Figs. 2-5a-c, 6; Fig. 3-1)

1960 *Dosinia japonica kawagensis* Araki, Bull. Lib. Arts Dept., Mie Univ., Spec. Vol., (1), p. 95, pl. 7, fig. 3.

*Dosinia (Phacosoma) kawagensis* Araki. Masuda, 1963, p. 22, pl. 4, figs. 1-8; Yoon, 1979, p. 15, pl. 2, figs. 7, 9, 10; Matsubara, 1995, p. 330, figs. 4-9-11; Honda and others, 1998, p. 20, fig. 5-16.

*Dosinia anguloides* Nomura (non Nomura). Hata, 1967, pl. 4, figs. 2, 3.

*Dosinia kawagensis* Araki. Hayashi and Miura, 1973, pl. 2, fig. 12; Hayashi, 1973, pl. 1, figs. 2, 3; Ishida and others, 1980, pl. 3, fig. 12.

*Dosinia nomurai* Otuka (non Otuka). Hayashi, 1973, pl. 1, fig. 1.

*Dosinorbis kawagensis* (Araki). Itoigawa and others, 1974, p. 87, pl. 23, figs. 1-6.

*Phacosoma kawagensis* (Araki). Itoigawa and others, 1981, 1982, p. 80, pl. 14, figs. 6a, b; Shibata and Ina, 1983, p. 48, pl. 5, fig. 12; Itoigawa and Shibata, 1986, pl. 16, fig. 13; Muramatsu, 1992, pl. 49, fig. 10.

*Dosinia (Phacosoma) chikuzenensis nomurai* Otuka (non Otuka). Hayashi, 1988, p. 5, pl. 1, figs. 2, 3.

*Dosinia (Phacosoma) chikuzenensis* Nagao (non Nagao). Hayashi, 1988, pl. 1, fig. 1.

Material -. More than 160 specimens in the Yokoyama's collection and 22 specimens in the Matsuoka's collection. About 2/5 of them are with their both valves conjoined, and the others are with their both valves disarticulated. All specimens are more or less laterally compressed.

Description -. Shell of medium size, suborbicular, longer than high, slightly inflated. Beaks pointed, turned forward, a little anteriorly situated. Antero-dorsal margin short, nearly straight. Postero-dorsal margin gently arcuate, passing into anterior margin with an obtuse angle. Ventral margin rounded. Pallial sinus deep, angulate. Surface with regular concentric lines. Lunule well marked, small, cordate, depressed. Escutcheon long, narrow.

Dimensions (in mm) -.

Length	Height	Thickness
47.2	41.4	18.5
42.6	39.2	12.5

41.8	36.2	16.1
40.5	36.7	11.7
46.2	43.1	-

Discussion -. *Phacosoma kawagensis* (Araki) resembles *Phacosoma japonicum* (Reeve) living in the adjacent seas of Japan, but the shell is smaller, and the proportion of the shell length to the shell height is smaller. It also resembles *Phacosoma nomurai* (Otuka) described from the early Miocene Lower Kadonosawa Formation in Iwate Prefecture, but the shell is slightly depressed in the anterior and posterior parts, and the postero-dorsal margin less slopes ventrally.

This species is the most abundant species at the collection locality. Specimens occur in a cluster, mostly with the convex sides of their valves parallel to the bedding planes of their enclosing sediment.

Geologic range -. Early Miocene.

Subfamily Meretricinae  
Genus *Meretrix* Lamarck, 1799

*Meretrix arugai* Otuka, 1938  
(Figs. 3-2-5a, b)

1938 *Meretrix arugai* Otuka, Jour. Fac. Sci., Imp. Univ. Tokyo,

Sec. 2, p. 30, pl. 2, figs. 11, 12.

*Meretrix arugai* Otuka. Hatai, 1940, p. 129; Araki, 1960, p. 93, pl.

7, fig. 5; Itoigawa and others, 1974, p. 86, pl. 22, figs. 5-8;

Itoigawa and Nishikawa, 1976, pl. 34, fig. 8; Taguchi and

others, 1979, pl. 3, fig. 8; Ishida and others, 1980, pl. 3, fig.

5; Itoigawa and others, 1981, 1982, p. 89, pl. 17, figs. 4a, b,

5a, b; Takahashi, 1984, pl. 1, fig. 2; Itoigawa and Shibata,

1986, pl. 17, fig. 5; Sasaki and Ogasawara, 1986, pl. 5, figs.

7a, b; Nakagawa, 1989, pl. 1, fig. 8; Noda and others, 1989,

pl. 25, figs. 5a, b; Okamoto and others, 1989, pl. 6, fig. 12;

Okamoto and others, 1990, pl. 9, fig. 6; Noda and others,

1994, figs. 6-10, 14a, b, 18; Matsubara, 1995, p. 333, figs.

5-8, 9, 11.

*Meretrix* cf. *arugai* Otuka. Hayashi, 1973, pl. 2, figs. 1, 2.

?*Meretrix arugai* Otuka. Ogasawara and Noda, 1978, p. 35, pl. 3,

figs. 17, 20, 22a, b.

*Pitar* ? sp. Shibata and Ina, 1983, p. 48, pl. 5, fig. 15.

*Callista* cf. *hanzawai* (Nagao). Hayashi, 1988, pl. 2, fig. 1.

*Mactra squalida* (Yokoyama) (non Yokoyama). Hayashi, 1988, pl. 2, fig. 2.

*Eomeretrix* sp. Hayashi and Koshimizu, 1992, figs. 3-4, 5.

Material -. Twenty-seven specimens in the collection by Yokoyama and 2 specimens in the collection by Matsuoka. Most of them are well preserved, and 7 specimens in the former are with their both valves articulated.

Description -. Shell medium in size, thick, subtrigonal, longer than high, inflated. Beaks swollen, high, turned inward, located at a little front of the center of the shell. Antero-dorsal margin straight, postero-dorsal margin slightly arcuate, ventral margin broadly rounded. Anterior end rounded, posterior end more narrowly rounded. Lunule and escutcheon absent. Three cardinal teeth on cardinal plate. Pallial sinus moderately deep, angulate. Surface smooth with fine growth lines.

Dimensions (in mm) -.

Length	Height	Thickness
71.0	59.0	30.2
59.4	51.2	34.4
79.5	65.2	-
79.3	65.1	-
79.1	61.8	-

Discussion -. *Meretrix arugai* Otuka is characterized by the well swollen beak. It resembles *Meretrix lusoria* (Röding) and *Meretrix lamarcki* (Deshayes), both living species of Japan, but the beak is more swollen.

Geologic range -. Early to middle Miocene.

Superfamily Tellinacea  
Family Psammobiidae  
Subfamily Sanguinolariinae  
Genus *Hiatula* Modeer, 1793

*Hiatula minoensis* (Yokoyama, 1926)

(Figs. 4-1a, b, 2a, b)

1926 *Soletellina minoensis* Yokoyama, Jour. Fac. Sci., Imp. Univ.

Tokyo, Sec. 2, vol. 1, pt. 7, p. 221, pl. 28, figs. 13-16.

*Soletellina minoensis* Yokoyama. Masuda, 1955, pl. 19, fig. 9;

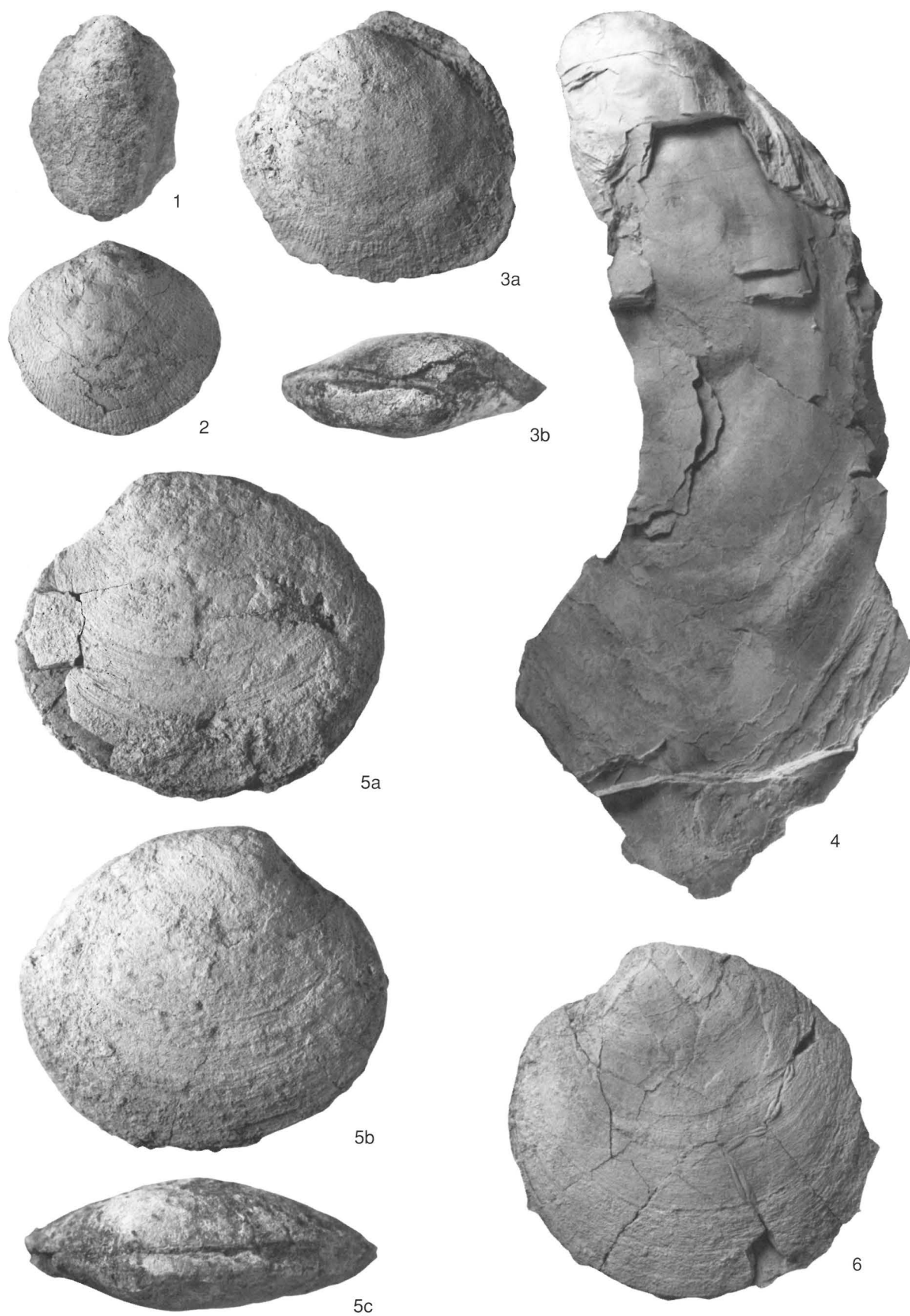
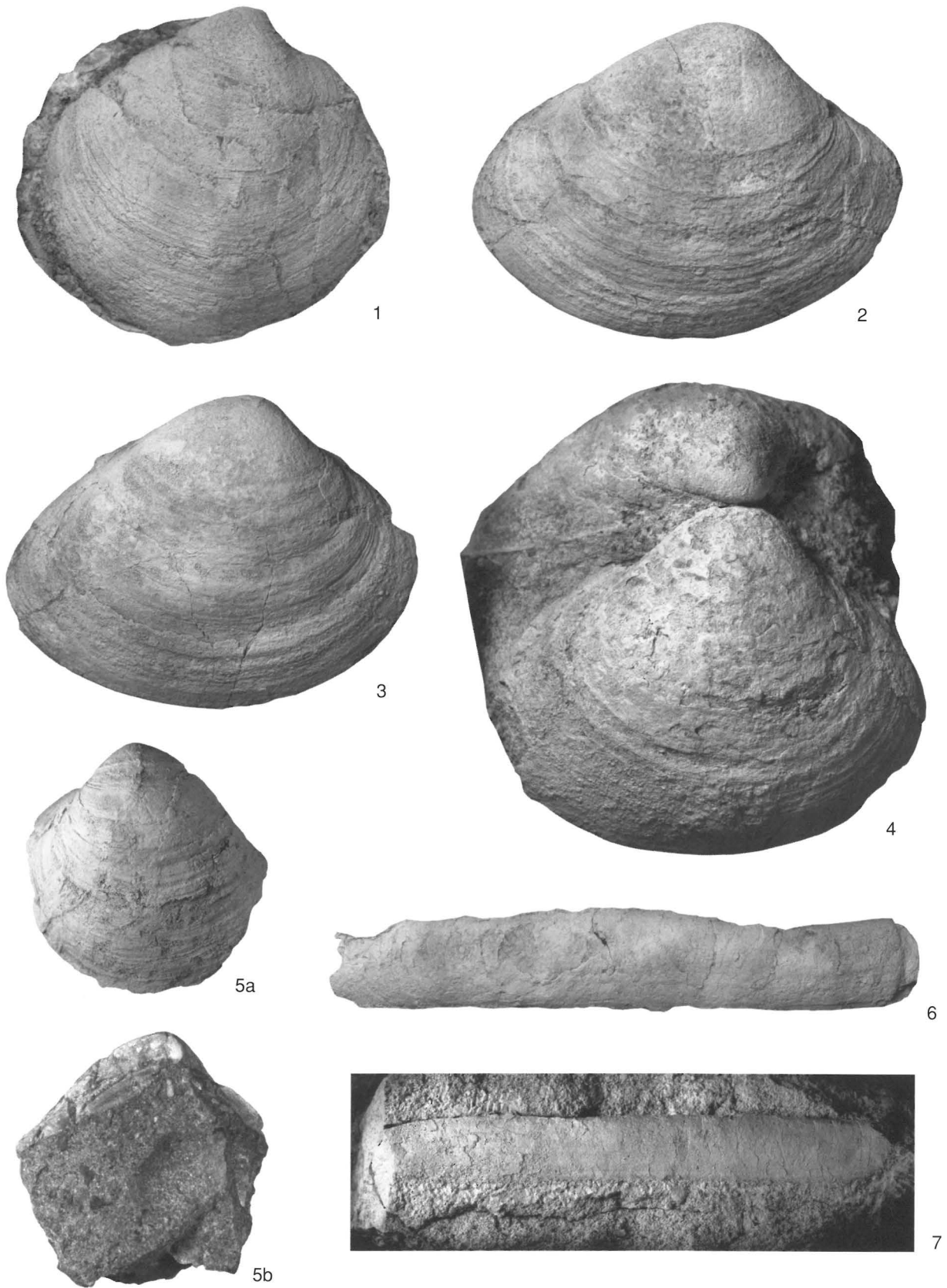


Fig. 2. Mollusks from the Nagashino Formation at Arumi, Shinshiro City (1).

1. *Modiolus* sp. ( $\times 2$ ). 2, 3a, b. *Laevicardium* sp. 3b, apical view. ( $\times 1.5$ ). 4. *Crassostrea gravitesta* (Yokoyama). ( $\times 0.8$ ). 5a-c, 6. *Phacosoma kawagensis* (Araki). 5c, apical view. ( $\times 1.5$ ).





**Fig. 3.** Mollusks from the Nagashino Formation at Arumi, Shinshiro City (2).  
 1. *Phacosoma kawagensis* (Araki). ( $\times 1.5$ ). 2-5a, b. *Meretrix arugai* Otuka. 5b, showing the cardinal teeth. ( $\times 1$ ). 6, 7. *Solen* sp. ( $\times 1$ ).

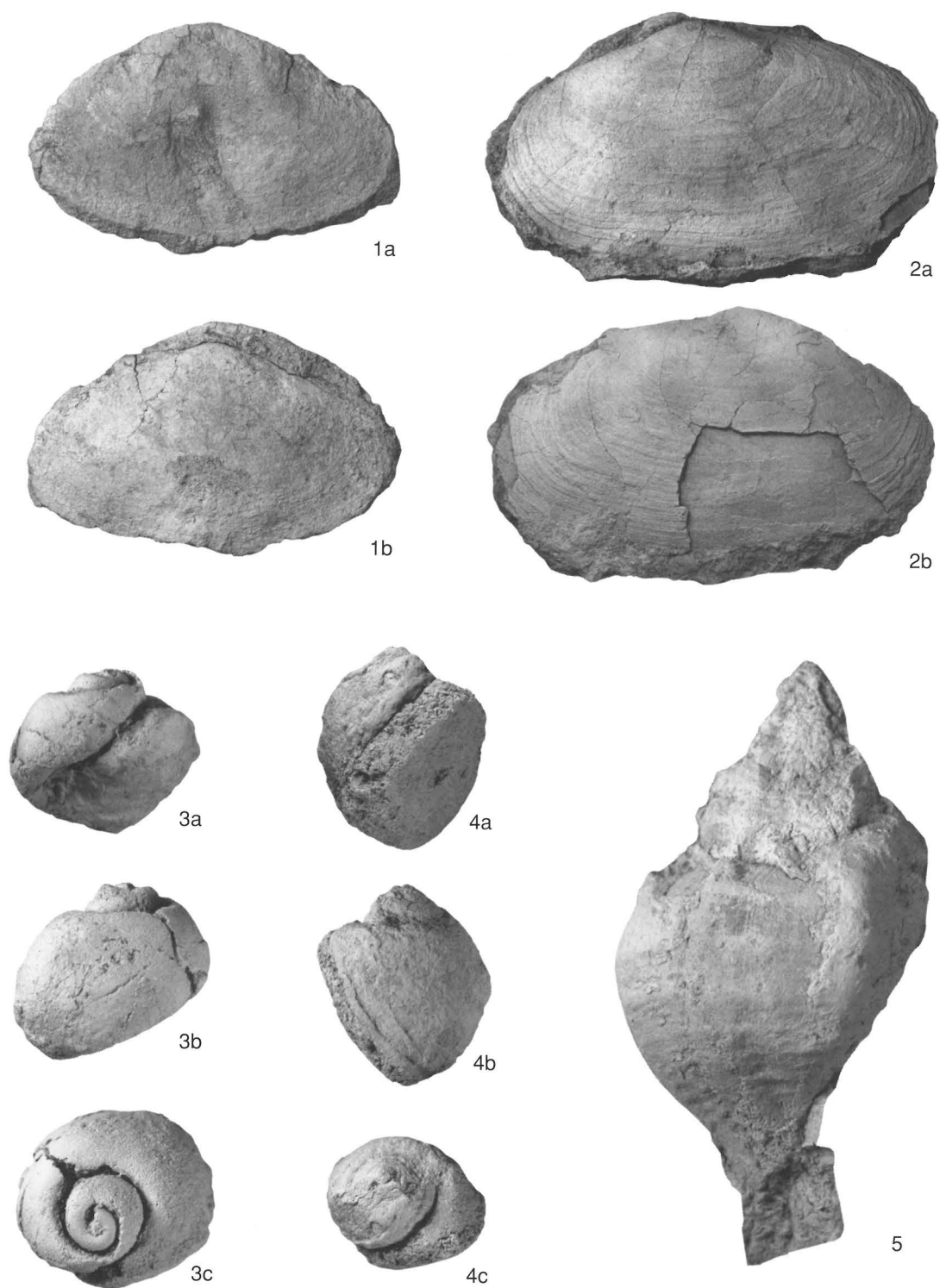


Fig. 4. Mollusks from the Nagashino Formation at Arumi, Shinshiro City (3).  
 1a, b, 2a, b. *Hiatula minoensis* (Yokoyama) ( $\times 1$ ). 3a-c, 4a-c. Naticidae gen. et sp. indet. ( $\times 2$ ). 5. *Chicoreus* sp. Dorsal view. ( $\times 2$ ).



Araki, 1960, p. 100, pl. 8, fig. 1; Kamada, 1962, p. 126, pl. 14, fig. 7; Mizuno, 1964, pl. 4, figs. 3, 4; Mizuno, 1965, p. 34, pl. 1, fig. 3; Uozumi and Fujie, 1966, pl. 12, fig. 12; Hayashi, 1973, pl. 1, figs. 9, 10; Hayashi and Miura, 1973, pl. 1, figs. 19, 20; Kim and others, 1974, p. 278, pl. 38, fig. 4; Okamoto and Terachi, 1974, pl. 47, fig. 9; Yoon, 1979, p. 14, pl. 2, fig. 12; O'Hara and Nemoto, 1984, pl. 1, fig. 17; Kanno and others, 1988, pl. 1, fig. 10.

*Sanguinolaria (Soletellina) minoensis* (Yokoyama). Otuka, 1934, p. 619, pl. 49, figs. 65a, b; Otuka, 1938, p. 34, pl. 2, figs. 14, 18; Oyama and Saka, 1944, p. 141, pl. 15, figs. 17, 18 (misspelled as *Sanguinoraria*).

*Soletellina* cf. *minoensis* Yokoyama. Kaseno, 1956, p. 8, pl. 3, figs. 14a-c.

*Sanguinolaria minoensis* (Yokoyama). Makiyama, 1958, pl. 39, figs. 13-16.

*Mya cuneiformis* (Böhm) (non Böhm). Hayashi, 1973, pl. 1, fig. 4.

*Laternula* sp. Hayashi, 1973, pl. 1, fig. 8.

*Hiatula minoensis* (Yokoyama). Itoigawa and others, 1974, p. 96, pl. 28, figs. 10, 11a, b; Itoigawa and Nishikawa, 1976, pl. 34, fig. 10; Ogasawara and Noda, 1978, p. 36, pl. 4, figs. 10-12, 15, 17-19, 21, 22; Taguchi and others, 1979, pl. 3, fig. 4; Ishida and others, 1980, pl. 4, fig. 7; Taguchi, 1981, pl. 2, fig. 12; Itoigawa and others, 1981, 1982, p. 102, pl. 20, figs. 1a, b; Shibata and Ina, 1983, p. 51, pl. 7, fig. 4; Okamoto and others, 1983, pl. 23, figs. 31, 32; Nakagawa and Takeyama, 1985, pl. 17, fig. 11; Ozawa and others, 1986, pl. 14, fig. 4; Shibata and Kato, 1988, pl. 3, fig. 14; Nakagawa, 1989, pl. 2, figs. 3a, b; Okamoto and others, 1989, pl. 6, figs. 17, 18, pl. 7, fig. 30; Iwamura Research Group, 1989, pl. 21, fig. 4; Okamoto and others, 1990, pl. 9, fig. 29; Amano, 1992, pl. 57, fig. 14; Lee, 1992, p. 86, figs. 31-4, 5, 14; Noda and others, 1994, figs. 6-8, 11, 16; Ogasawara and Nagasawa, 1992, p. 1241, figs. 8-1a, b, 2a, b, 5, 6a, b, 9-27; Matsubara, 1995, p. 327, figs. 1-20, 21; Taguchi, 2002, pl. 5, fig. 2.

*Mya* ? sp. Hayashi, 1988, pl. 1, fig. 4.

*Hiatula* sp. Hayashi, 1988, pl. 1, fig. 9.

*Gobreaeus* ? sp. Hayashi, 1988, pl. 1, fig. 10.

**Material** -. Eighteen specimens. About 1/3 of them are with their both valves conjoined, and the rest are with their both valves disarticulated.

**Description** -. Shell medium, thin, ovate, compressed. Beaks low, turned inward, situated at a little anterior of

the middle of the shell length. Antero- and postero-dorsal margins gently sloping; anterior margin round; posterior margin subtruncate; ventral margin arcuate. A blunt ridge running from beak to the postero-ventral corner. Surface smooth.

**Dimensions (in mm)** -.

Length	Height	Thickness
71.5	40.0	21.5
69.6	40.4	16.4
49.7	32.5	10.8
55.1	32.3	-

**Discussion** -. *Hiatula minoensis* (Yokoyama) resembles *Hiatula diphos* (Linnaeus) living in the West Pacific, but the beak is more posteriorly located. It has some similarity to *Hiatula kobyamae* (Kanno) described from the Oligocene Asagai Formation in Fukushima Prefecture, but the shell is more elongate.

**Geologic range** -. Early to middle Miocene.

Superfamily Solenacea

Family Solenidae

Genus *Solen* Linnaeus, 1758

*Solen* sp.

(Figs. 3-6, 7)

*Solen (Solenarius)* sp. Itoigawa and others, 1974, p. 100, pl. 31, figs. 2, 3a, b.

*Solen* (s. s.) sp. Itoigawa and others, 1981, 1982, p. 103, pl. 20, figs. 2a, b.

*Solen* sp. Shibata and Ina, 1983, p. 52, pl. 7, fig. 1.

**Material** -. Three cast specimens.

**Description** -. Shell large, transversely elongate, compressed, gaping at posterior end. Beaks very low, situated at anterior end. Anterior margin truncated, posterior margin round. Dorsal and ventral margins straight, parallel.

Dimensions (in mm) -.

Length	Height	Thickness
90.0	11.4	7.0
9.9	16.2	-

Discussion -. *Solen* sp. resembles *Solen strictus* Gould living in Japan, China and Korea and *Solen saitamensis* Kanno from the Oligocene Ushikubitoge Formation in Saitama Prefecture, but it differs from these species in having a round posterior end. It has close affinity in shape and size with *Solen* (*Solenarius*) sp. described by Itoigawa and others (1974) from the early Miocene Akeyo Formation of the Mizunami Group in Gifu Prefecture, and it seems to be conspecific with the latter.

Geologic range -. Early Miocene.

Class Gastropoda  
Subclass Prosobranchia  
Order Mesogastropoda  
Family Naticidae

**Naticidae** gen. et sp. indet.  
(Figs. 4-3a-c, 4a-c)

Material -. Three deformed cast specimens.

Description -. Shell small, globular. Whorls more than 3, separated by distinct suture. Spire small, conical. The last whorl large, swollen.

Dimensions (in mm) -.

Height	Width
82.4	13.8
14.8	12.7

Discussion -. All specimens at hand are too poor in the state of preservation to determine their generic and specific names.

Order Neogastropoda  
Family Muricidae  
Genus *Chicoreus* Montfort, 1810

***Chicoreus*** sp.

(Fig. 4-5)

Material -. One cast of which dorsal part is covered with sandstone. The apical part of the shell is crushed in the specimen.

Description -. Shell of medium size, fusiform, with conical spire. Whorls more than three, separated by deep suture, shouldered at a little above their middle. The last whorl large, with contracted base. The penultimate whorl and the last whorl ornamented with two and three spiral cords, respectively. Both whorls bearing prominent varices besides spiral cords. Dimensions; height 46.2 mm, width 28.6 mm.

Discussion -. The specimen is similar in shape and surface sculpture to *Chicoreus* (*Rhizophorimurex*) *tiganouranus* (Nomura) described from the early Miocene Chiganoura Formation in Miyagi Prefecture, but the state of preservation of it is not good enough for a positive identification of it with that species.

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## (要 旨)

柴田 博・市原 俊：愛知県新城市の設楽層群長篠層産中新世貝類化石.

愛知県新城市有海の設楽層群長篠層より産出した貝類化石を記載し、それらの写真を示した。これらの貝類化石の採集地は、林・輿水（1992）が中期始新世の種に同定した有海の長篠層貝類化石の産地と同じかそれに極めて近い地点である。貝類化石は、*Modiolus* sp., *Crassostrea gravitesta* (Yokoyama), *Laevicardium* sp., *Phacosoma kawagensis* (Araki), *Meretrix arugai* Otuka, *Hiatula minoensis* (Yokoyama), *Solen* sp., Naticidae gen. et sp. indet. そして *Chicoreus* sp. の9種よりなる。貝類化石の地質時代から長篠層の時代は前期中新世と考えられる。