Sci. Rep., Inst. Geosci., Univ. Tsukuba,
Sec. B, vol. 23, pp. 53-116, March 29, 2002

Molluscan fossils from the Ryukyu Islands, Southwest Japan —Part 4, Gastropoda and Pelecypoda from the Nakoshi Formation in the Motobu Peninsula, Okinawa-jima—

Hiroshi Noda*

Abstract

A total 110 species of 68 bivalves and 42 gastropods are described from the Nakoshi Formation in the Motobu Peninsula, central part of Okinawa-jima Island. The Nakoshi molluscan fauna is of embaymental shallow marine (lowerpart of the Nakoshi Formation) to infaunal and open marine species (upper part of the Formation). The faunal association in total is quite different in composition from the fauna of the Chinen Sand or underlying the Shimajiri Group distributed in the southern part and central part of Okinawa-jima.

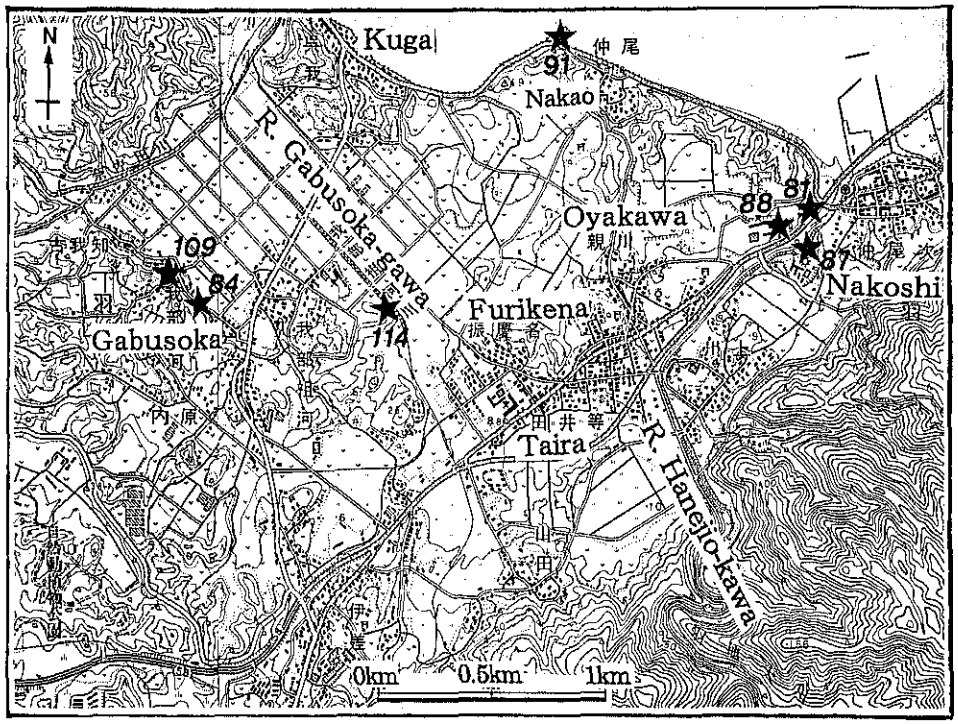
Key words: Okinawa-jima, Neogene, Gastropoda, Pelecypoda, Nakoshi Formation, Ryukyu

Introduction

Molluscan fossils from the Haneji Formation in the central part of Okinawa-jima (Fig. 1), were first studied by Nomura and Zinbo (1936), Yabe and Hatai (1941a, b) and then by MacNeil (1961). After the short note on *Anadara* and its associated molluscan fauna described from the Haneji Formation by Minoura (1978) and Noda (1971) except for some listed molluscan species, Nohara and Miyagi (1984) reported 51 species of 42 genera from the Nakoshi Sand (Table 1), which corresponds to the lower part of the Haneji Formation. During the study of the molluscan fauna from the Nakoshi Formation, the present writer recognized 62 pelecypods and 42 gastropods as described with photographs, herein. From the paleobiogeographical and systematic points of the present molluscan fauna in relation with the faunal province and systematic with those of Taiwan and Philippines and southwest Japan seem to be important. Especially, the Nakoshi Formation was previously of the Pliocene in the geological age by molluscan studies (MacNeil, 1961; Noda, 1971), however, the micro-paleontological data as nannofossils pointed out the Nakoshi Formation is of Pleistocene (Nishida, 1973). Since the detail discussion on the geological data by molluscan fossils only is difficult but data of the molluscan fauna described herein from the Nakoshi Formation is significant for the discussion in future.

Before going into the discussion, the present writer would like to express his hearty thanks to Dr. Tamio Kotaka, Professor Emeritus of Tohoku University, Dr. Koichiro Masuda, Professor Emeritus of Miyagi University of Education, Prof. Tomohide Nohara of Ryukyu University, and Prof. Kenshiro Ogasawara of the University of Tsukuba, for their many helps and very kind suggestions during the present study. The photographic works are due to Mr. Yoshibumi Kikuchi of Institute of Geoscience, the University of Tsukuba. The present study was partly supported by a Grant in Aids for

* The University of Tsukuba (Professor Emeritus) and Department of Geology, National Science Museum (Visiting Researcher)



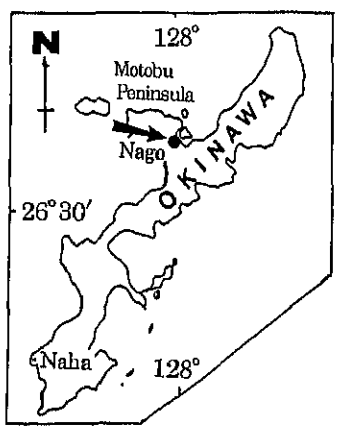


Fig. 1. Molluscan fossil localities in Haneji, Nago City.

Scientific Research from the Ministry of Education and Culture of Japan, and also by a Grant in Aids for Research Project from the University of Tsukuba.

Occurrence of Molluscan Fauna in the Nago district

The stratigraphy in the area of Nakoshi, Motobu Peninsula, central part of Okinawa-jima Island was summarized by Nohara and Miyagi (1984). The stratigraphic horizon of the present molluscan fauna described herein is of the Nakoshi Sand of MacNeil (1961) same with the Haneji Formation of Noda (1971) and the Nakoshi Sand of Nohara and Miyagi (1984). The marine molluscan fossils in the Nakoshi are restricted in the Nakoshi Sand. As the distribution of the Nakoshi Sand is restricted in the northern part of the Nago district as mentioned by Nohara and Miyagi (1984), the molluscan fossils are collected from the middle to northern part of Nago City (Fig. 1). The dominant fossil localities are pointed on Fig. 1. Among the localities, Loc. no. 84 (Figs. 5-7) is probably near to the locality of Nomura and Zinbo (1936). In the lower part of Nakoshi Formation is also distributed in the western part of the River Nasada-gawa on the Kuga Conglomerate (Figs. 2, 3, 4). The lower part of the formation is silty and becomes sandy toward above. The localities of nos. 81, 87, 88 at near Haneji Branch of Nago City Office are of *Operculina* dominant calcareous sandstone with pebbles or conglomerates.

Table 1. Number of molluscan fossils reported from the Nakoshi Formation.

Authors	Pelecypods	Gastropods	Scaphopods	Total	New. sp.
Yabe and Hanzawa (1925)	17 (17)	25 (25)	0	42 (42)	0
Nomura and Zinbo (1936)*	56 (44)	54 (37)	2 (2)	112 (83)	12
Yabe and Hatai (1941a)	6 (2)	8 (6)	0	14 (8)	1
MacNeil (1961)	0	28 (3)	0	28 (3)	2
Noda (1971)	13 (11)	7 (5)	0	20 (16)	2
Nohara and Miyagi (1984)	11 (3)	25 (15)	2 (2)	38 (20)	0
Present paper	68 (5)	42 (0)	0	110 (5)	1

Number in bracket shows the number of non-photographed species. *= Based on the data from Nomura and Zinbo (1934).

In total, the molluscan species from the Nakoshi Sand or Haneji Formation described herein are counted up to 68 species of bivalves, 42 of gastropods, and 110 species in total. As the illustration for the faunal discussion is important, 62 bivalves (91.1%) and 42 gastropods (100%) are illustrated herein and the comparison of the faunal association is mentioned below (Table 1). The total number of the species given by Nomura and Zinbo is almost same with the present data. However, Nomura and Zinbo (1936) illustrated only 12 pelecypod species (21.4%) and 17 gastropods (31.4%). The geological age of the Nakoshi Formation was previously considered to be Pliocene and correlated with the Takanabe, Tonohama and Kakegawa Formations distributed along the Pacific Ocean side of Japanese Island based on the extinct shallow marine molluscan species as like *Anadara suzukii, Amussiopecten praesignis, Venericardia panda* and others (Noda, 1971, Masuda, 1986, Ogasawara, 1981, 1986a, 1988, Ogasawara and Masuda, 1983 and others). However, as Fukuda *et al.* (1970) already mentioned that the Nakoshi Sandstone is almost same with the Ryukyu Limestone and also the Aka Formation in Kumejima Island in geological age.

The Nakoshi Sand yielded the extinct species *Amussiopecten praesignis* which was yielded from the overlying Naha Limestone as already been mentioned by Yabe and Hatai (1941b). The molluscan association of the Nakoshi Formation is different from the molluscan fauna of the Chinen Sandstone or the Chinen Formation in the southern part of Okinawa-jima Island. The Chinen Sand was previously accepted to be Pleistocene by foraminifers by Ibaraki and Tsuchi (1975), and Ujiie (1985). However, the molluscan fauna of the Nakoshi is quite different from the Chinen in the composition of the fauna. Most of the species from the Nakoshi is of shallow or embaymental marine condition and composed of infaunal species, but those of the Chinen is of off shore marine condition and composed of epifaunal species. The Nakoshi molluscan fauna as listed (Table 1) is quite unique because there are no comparable fauna in the Ryukyus. Recently, the molluscan fauna which has similar composition with the Nakoshi as the extinct species of *Amussiopecten praesignis, Anadara suzukii*, and others from the Majya Formation was discussed as to be Late Miocene or Late Miocene to Pliocene in Kumejima Island (Ozawa, *et al.*, 1988; Kawagata *et al.*, MS).

According to the recent studies by Masuda and Huang (1990a, b, 1991, 1993A, b, 1994) on the molluscan fauna in Taiwan (Formosa), the molluscan fauna of those shallow or infaunal species as like the fauna called the Kakegawa Fauna in the Southwest Japan (worm water fauna) is originated or characterized from the late Miocene to Pliocene in the area of Formosa to Okinawa. Up to date, the most of molluscan species recorded from the Ryukyus are quite common with those of the fossil or Recent species of the Southwest Japan. Most of the molluscan species from the Shimajiri and

Table 2. Molluscan fossils from the Nakoshi Formation.

Bivalves	
Acila (*Acila*) *divaricata* (Hinds, 1843)	Loc. 87 (rare)
Barbatia (*Acar*) cf. *reticulata* (Gmelin)	Loc. 81 (rare)
Spineara fausta (Habe)	Loc. 81 (rare)
Barbatia (*Abarbatia*) *decussata* (Sowerby)	Loc. 81 (rare), 84 (rare)
Verilarca interplicata (Grabau and King)	Loc. 81 (rare), 84 (rare), 109 (rare)
Spinarca fausta (Habe)	Loc. 81 (rare)
Trisidos sp.	Loc. 87 (rare)
Anadara (*Scapharca*) *suzukii* (Yokoyama)	Loc. 81 (rare), 84 (rare), 87 (rare), 88 (rare)
Striarca (*Galactella*) *symmetrica* (Reeve)	Loc. 81 (rare), 88 (rare)
Anadara (*Scapharca*) *taiwanica* Noda	Loc. 81 (rare)
Anadara (*Scapharca*) *kotakai* Noda	Loc. 81 (rare)
Anadara (*Hataiarca*) *takaoensis* (Nomura)	Loc. 81 (rare), 84 (common), 88 (common)
Anadara (*Hataiarca*) *kogachiensis* Noda	Loc. 81 (common), 83 (common), 84 (rare), 109 (few), 114 (few)
Anadara (*Tosarca*) *sedanensis* (Martin)	Loc. 81 (rare), 84 (few), 88 (rare)
Cucullaea (s.s.) *granulosa* Jonas	Loc. 81 (rare), 84 (few), 87 (rare)
Glycymeris (*Glycymeris*) *formosana* (Yokoyama)	Loc. 81 (rare), 87 (few), 88 (dominant)
Tucetilla pilsbryi (Yokoyama)	Loc. 87 (rare)
Musculites cf. *japonica* (Dunker)	Loc. 88 (rare)
Modiolus sp.	Loc. 109 (rare)
Pteria cf. *coturnix* (Dunker)	Loc. 84 (rare)
Atulina sp.	Loc. 87 (rare)
Chlamys (*Azumapecten*) *subsquamatus* (Nomura)	Loc. 84 (rare), 87 (rare)
Chlamys (*Mimachlamys*) *satoi* (Yokoyama)	Loc. 84 (rare), 87 (few), 88 (rare)
Chlamys (*Mimachlamys*) *granulisquamatos* (Fischer)	Loc. 84 (rare), 87 (rare) ,88 (rare)
Cryptopecten cf. *nux nux* (Reeve)	Loc. 81 (rare)
Cryptopecten vesiculosus (Dunker)	Loc. 87 (rare)
Decatopecten striatus (Schumacher)	Loc. 81 (rare), 84 (few), 87 (rare), 88 (rare)
Decatopecten amiculum (Philippi)	Loc. 81 (rare), 84 (common), 87 (rare), 88 (rare)
Amussiopecten praesignis (Yokoyama)	Loc. 81 (abundant), 84 (few), 87 (rare), 88 (abundant)
Chlamys sp.	Loc. 88 (rare)
Plicatula simplex Gould	Loc. 87 (rare)
Anomia chinensis Philippi	Loc. 81 (rare), 84 (rare), 87 (rare), 88 (rare)
Pododesmus (*Monia*) *noharai* Noda	Loc. 84 (rare), 109 (common), 114 (common)
Ostrea denselamellosa Lischke	Loc. 81 (rare), 84 (rare)
Pretostrrea imbricata (Lamarck)	Loc. 81 (rare), 84 (rare), 87 (rare), 109 (rare)
Lucina kuninagaensis Nomura and Zinbo	Loc. 81 (rare), 87 (rarre)
Epicodalia delicatula Pilsbry	Loc. 87 (rare)
Anodontia stearensiana (Oyama, 1954)	Loc. 109 (rare)
Wallucina sp.	Loc. 81 (rare)
Chama sp.	Loc. 81 (rare)
Cardita leana Dunker	Loc. 88 (rare)
Glans granulosus, n. sp.	Loc. 81 (rare)
Nipponocrassatella nana (A.Adams and Reeve)	Loc. 81 (dominant), 84 (dominant)
Vasticardium (*Vasticardium*) *burchardi* (Dunker)	Loc. 81 (rare), 84 (rare), 87 (few), 88 (few), 109 (rare)

Lunulicardia subretusa (Sowerby).....Loc. 81 (rare), 88 (rare)
Fragum alfiricum (Fischer).....Loc. 81 (rare), 88 (rare)
Laevicardium biradiatum (Bruguiere).....Loc. 81 (rare), 84 (rare)
Fulvia sp. .....Loc. 81 (rare), 87 (rare), 114 (few)
Lutraria (*Psamophila*) *sieboldii* Deshayes .....Loc. 81 (rare), 84 (rare), 87 (rare), 88 (rare)
Tellinella verrucosa (Hanley).....Loc. 81 (rare), 87 (rare)
Macoma (*Macoma*) *praetexta* (Martens).....Loc. 109 (rare)
Grammatomya squamosa (Lamarck) .....Loc. 81 (rare), 88 (rare)
Solecurtus divaricata (Lischke).....Loc. 81 (rare), 87 (rare), 88 (rare)
Azorinus abbreviatus (Gould).....Loc. 88 (few)
Solen cf. strictus Gould .....Loc. 88 (rare)
Ventricolaria (*Ventricoloidea*) *foveolata* (Gmelin) .....Loc. 81 (rare), 87 (rare), 88 (rare)
Periglypta (*Tigammona*) *chemnitzi* (Hanley) .....Loc. 84 (rare), 87 (rare)
Glycydonta marica (Linnaeus).....Loc. 87 (few)
Placamen tiara (Dilluwyn).....Loc. 87 (rare)
Circe (*Circe*) *scriptta* (Linnaeus).....Loc. 81 (rare), 88 (few)
Pitar (*Pitarina*) *japonicum* Kuroda and Kawamoto.....Loc. 81 (rare), 84 (few), 86 (few), 88 (rare)
Costellipitar cf. *chordatum* (Roemer).....Loc. 81 (rare), 88 (rare)
Pardosinia amphidesmoises (Reeve).....Loc. 81 (rare), 87 (rare)
Paphia (*Paphia*) *euglypta* (Philippi).....Loc. 81 (rare), 88 (rare)
Callista (*Callista*) *chinensis* (Holton).....Loc. 87 (rare), 88 (few)
Saxidomus purpuratus (Sowerby) .....Loc. 81 (rare)
Clementia (*Clementia*) *vatheleti* Mabille.....Loc. 81 (rare), 84 (rare), 87 (rare)
Eufistulana grandis (Deshaayes).....Loc. 81 (few), 87 (rare), 88 (rare)
Myadora fluctuosa Gould.....Loc. 87 (rare), 88 (rare)
Laternula (*Laternula*) *anatina* (Linnaeus).....Loc. 87 (rare)

Gastropoda

Fissuridea crucifera (Pilsbry).....Loc. 81 (rare)
Turbo (*Batillus*) *chinensis* Ozawa and Tomida.....Loc. 87 (common)
Clanculus bronni (Dunker).....Loc. 87 (rare)
Tosatrochus attenuatus (Jonas) .....Loc. 87 (rare)
Astralium (*Astralium*) *haematragum* (Menke).....Loc. 81 (rare), 87(few)
Marmorostoma (*Batillus*) *gemmata* (Reeve).....Loc. 81 (few), 84 (rare), 87 (rare), 88 (rare)
Turritella (*Kuroshioia*) *filiola* Yokoyama .....Loc. 81 (few), 84 (few), 87 (dominant), 88 (few)
Batillaria flectosiphonata Ozawa.....Loc. 109 (few)
Rhinoclavis (*Proclava*) *kochi* (Philippi) .....Loc. 88 (rare)
Cerithium (*Proclava*) *turritum* Sowerby.....Loc. 81 (rare)
Amalthea conica Schmacher.....Loc. 88 (rare)
Tugurium exutum (Reeve) .....Loc. 87 (few)
Terebellum terebellum (Linnaeus).....Loc. 88 (rare)
Strombus (*Labistrombus*) *japonicus* (Reeve).....Loc. 81 (common), 84 (few), 87 (few), 88 (common)
Strombus (*Euprotombus*) *aurisdianae* Linnaeus.....Loc. 84 (rare)
Polinices sagamiensis Pilsbry.....Loc. 81 (rare), 84 (rare)
Eunaticina papilla (Gmelin).....Loc. 109 (rare)
Erosaria (*Erosaria*) cf. *erosa phragedanina* Melvill.....Loc. 84 (rare)

Ovula sp.	Loc. 87 (rare)
Semicassis sp.	Loc. 81 (rare)
Bursa (*Bufonaria*) *rana* (Linnaeus)	Loc. 81 (rare)
Gyrineum pusillum (Broderlip)	Loc. 81 (rare), 84 (rare)
Cymatium (*Cymatriton*) *nicobaricum* (Roeding)	Loc. 84 (rare)
Volva (*Pellasimnia*) *macneili* Noda	Loc. 87 (rare)
Volva sp.	Loc. 84 (rare)
Crenavolva cf. *frumentum* (Sowerby)	Loc. 84 (rare)
Pollia martini Shuto	Loc. 84 (rare)
Hindsia sp.	Loc. 81 (rare)
Rostellaria cf. *spinifera* Martens	Loc. 87 (rare)
Nassarius (*Zeuixs*) *caelatus* (Gould)	Loc. 109 (few)
Nassarius (*Niotha*) *gemmulatus* (Lamarck)	Loc. 81 (rare)
Uromitra obeliscus (Reeve)	Loc. 81 (rare)
Pyrene flava (Bruguiere)	Loc. 81 (rare), 88 (rare)
Strioterebrum sp.	Loc. 88 (rare)
Fusinus perplexus (A.Adams)	Loc. 88 (rare)
Cancellaria (*Trigonostoma*) *taiwanensis* Nomura	Loc. 109 (rare)
Crassispira pseudoincipalis (Yokoyama)	Loc. 81 (rare)
Conus tesselatus Born	Loc. 81 (rare), 88 (rare)
Conus quercinus Lightfoot	Loc. 84 (rare), 88 (rare)
Myurella (*Clathroterebra*) *woodwardiana* (Martin)	Loc. 81 (rare)
Aliuculastrum cf. *cylindricum* (Helbering)	Loc. 87 (rare)

(rare = 1-5, few = 6-10, common = 11-20, dominant = 20 more)

Shinzato Formations underlying in Okinawa-jima Island, are of all more deep-sea species and association is quite far from the fauna of the Nakoshi. Those shallow infaunal species should be originated in the Ryukyu area or migrated from more south to alive in the embaymental shallow marine environment of Okinawa at the end of Pliocene to Pleistocene before the development of environmental condition of the coral reef environment as the depositional age of the Ryukyu Limestone.

The faunal discussion of the Nakoshi molluscan fauna in relation with the systematic and distribution will be followed on the other chances elsewhere in near future.

Systematic description

Bivalvia

Family Nuculidae Gray, 1824

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

Subgenus *Acila* H. and A. Adams, 1858

Acila (*Acila*) *divaricata* (Hinds, 1843)

Figs. 8-1a−1b.

Remarks; The present species was well discussed by Noda (1993) and Noda *et al.* (1995) who made synonymous list of the species. Thence after the following description and record of the species was published. The species is common in the northern part of Japan but the species was widely known down to the southern part of Japanese Islands as mentioned in the synonymous list. The specimens collected from the Nakoshi Formation are all small in size but the external sculptures, depressed posterior area and shell form are well identical with the named species. The following is additional to the Noda *et al.* (1995).

1986, *Acila* (*Acila*) *divaricata*, Masuda *et al.*, *in* Sato *et al.*, 8-9, pl. 1, figs. 1-2.

Table 3. Fossil localities of the Nakoshi Formation.

Loc. no. 81; Cliff behind of the Haneji Branch of Nago City Public Office, at Haneji, Nago City. Pebbly conglomerate bearing calcareous and foraminiferal (*Operculina*) sandstone. Nakoshi Formation.

Loc. no. 84; Small road side cliff at Kogachi, Nago City. Pebble bearing calcareous sandy siltstone. Nakoshi Formation. This locality is of quite near to the locality of Nomura and Zinbo (1934, 1936).

Loc. no. 87; North-side cliff of the Nakoshi River (Hanejiokawa), at Haneji, Nago City. Calcareous silty sandstone. Nakoshi Formation.

Loc. no. 88; School garden cliff of Haneji Middle High School, Nago City. Foraminiferal (*Operculina*) calcareous silty sandstone. Nakoshi Formation.

Loc. no. 91; Sea side cliff at Komisaki, Nakao, Nago City. Calcareous and fossiliferous sandstone. Nakoshi Formation.

Loc. no. 109 (Hill-side cliff at central part of Gabusoka, Nago City. Silty facies of the Nakoshi Formation. (Fossil locality no. 109 of Noda,1971)

Loc. no. 114; Small river (Gabusoka-gawa River) side cliff at central part of Nakoshi, Nago City, Nakoshi Formation. (Fossil locality no. 114 of Noda, 1971)

1988, *Acila* (*Acila*) *submirabilis*, Yoon, pl. 1, figs. 15, 28.
1989, *Acila* (*Acila*) *divaricata*, Ito, 57, pl. 17, fig. 13.
1990, *Acila divaricata*, Baba, 228, pl. 22, figs. 7a-b.
1991, *Acila* (*Truncacila*) *divaricata*, Noda, 9-10, fig. 6-2.
1992, *Acila divaricata*, Koizumi and Matsushima, 124, figs. 6-3-4.
1993, *Acila* (*Acila*) *divaricata*, Okumura and Takei, 156, pl. 33, figs. 5a-5b.
1993, *Acila* (*Acila*) *divaricata*, Katto and Masuda, 8-9, pl. 1, fig. 1.
1995, *Acila* (*Acila*) *divaricata submirabilis*, Noda *et al.*, 47-48, figs. 4-10-12, 16-8.
1998. *Acila* (*Acila*) *divaricata*, Okumura and Ueda, 69, pl. 8, fig. 14.

Locality; Loc. no. 87 (rare).

Family Arcidae Lamarck, 1809
Subfamily Arcinae Lamarck, 1809
Genus *Barbatia* Gray, 1842
Subgenus *Acar* Gray, 1842
Barbatia (*Acar*) cf. *reticulata* (Gmelin, 1792)
Fig. 8-7.

Compared with;
1792, *Arca reticulata* Gmelin, 3311. (*fide* Noda, 1966)
1966, *Arca* (*Acar*) cf. *reticulata*, Noda, 115, pl. 1, fig. 2.

Remarks; Only one imperfect specimen is at hand and has a reticulated structure on the external surface with posterior depressed area separated by posterior ridge running from near beak to posterior ventral margin.
Locality; Loc. no. 81 (rare).

Subgenus *Abarbatia* Dall, Bartsch and Rehder, 1938
Barbatia (*Abarbatia*) *decussata* (Sowerby, 1833)
Figs. 8-3a—3b.

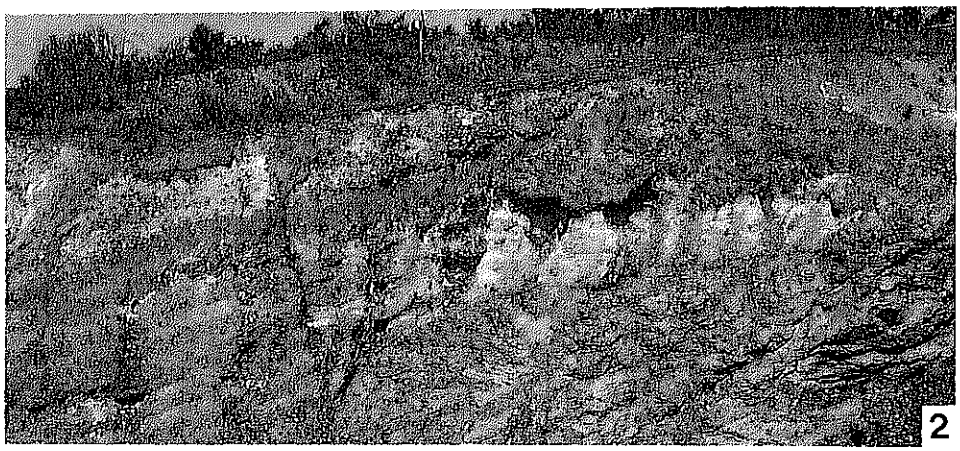
1833, *Byssoarca decussata* Sowerby, 22. (*non* Linnaeus, 1758)
1844, *Arca lima* Reeve, *Arca* sp. 101. (*fide* Noda, 1966)
1844, *Arca decussata*, Reeve, *Arca* sp. 81. (*non* Linnaeus, 1758; *fide* Noda, 1966)
1935, *Barbatia decussata*, Otuka, 884, pl. 55, fig. 118.
1941, *Barbatia decussata*, Hatai, 54-55, pl. 41, figs. 4-6, pl. 42, figs. 2-3.
1966, *Barbatia* (*Barbatia*) *decussata*, Noda, 59-60, pl. 1, figs. 1-3, 13-14, 17, pl. 6, figs. 17-18.
1967, *Barbatia* (*Abarbatia*) *decussata*, Habe and Kosuge, 123, pl. 45, fig. 18.
1971, *Barbatia* (*Abarbatia*) *lima*, Kuroda *et al.*, 329, 521, pl. 67, fig. 18.
1981, *Barbatia decussata*, Kira, 122, pl. 43, fig. 12.
1988b, *Barbatia* (*Barbatia*) *decussata*, Noda, 114, pl. 1, figs. 9a-12b.
1993, *Barbatia* (*Barbatia*) *decussata*, Okumura and Takei, pl. 33, figs. 9a-b.

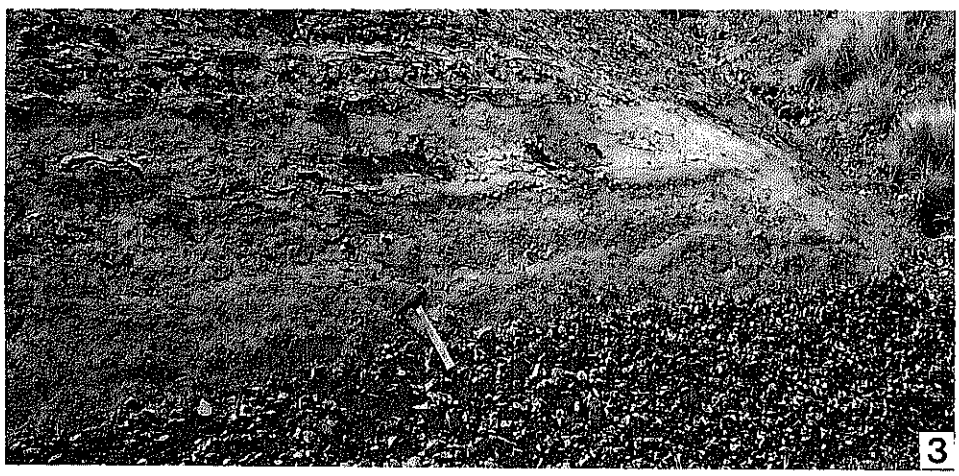
Remarks; The present species is already discussed by Noda (1966) and the synonymous list was presented by Noda (1988b). The species is defined by small in size and fine radial riblets crossed with concentric growth lines making granular structure at their crossing. The posterior radial ribs are rather wide and dichotomous but these on middle to anterior part are narrower.
Localities; Loc. nos. 81 (rare), 84, (rare).

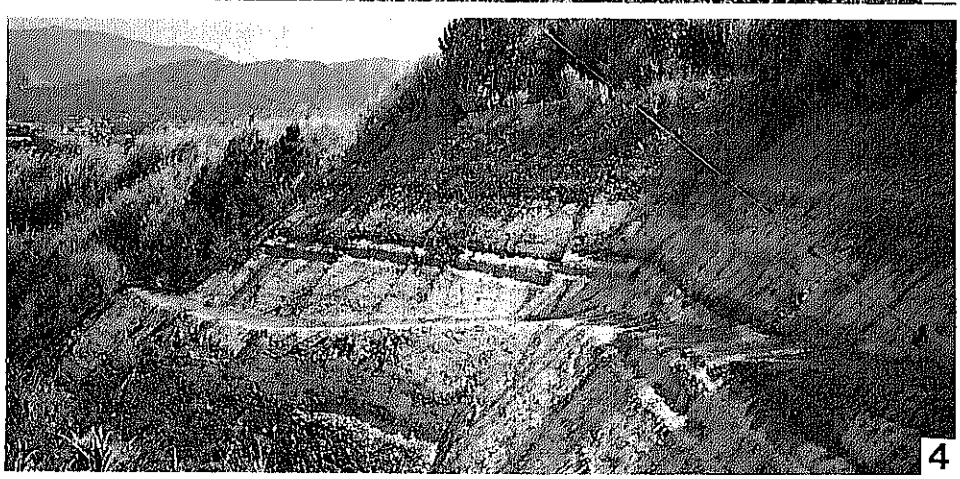
Subfamily Striarcinae Noetring, 1930
Genus *Spinearca* Iredale, 1939

Spinearca fausta (Habe, 1951)

1951, *Striarca (Spinearca) fausta* Habe, 38, fig. 62.
1964, *Striarca (Spinearca) fausta*, Habe, 163, pl. 49, fig. 3.
1971, *Spinearca fausta*, Kuroda *et al.*, 333, 527, pl. 117, figs. 13-14.
1988b, *Spinearca fausta*, Noda, 123, pl. 2, figs. 2a-3c.


2


3


4

Remarks; The present species was formerly reported from the Haneji Formation by Noda (1988b).

Locality; Loc. no. 81 (rare).

Genus *Verilarca* Iredale, 1939
Verilarca interplicata (Grabau and King, 1928)
Fig. 8-6.

1928, *Arca* (*Barbatia*) *interplicata* Grabau and King, 161, pl. 1, fig. 9. (*fide* Habe, 1958)
1933, *Arca* (*Barbatia*) *yokoyamai* Nomura, 41, pl. 1, figs. 3a-d.
1935, *Barbatia* (*Trigonostoma*) *yokoyamai*, Kuroda, 15, fig. 33.
1935, *Barbatia yokoyamai*, Otuka, 883, pl. 55, fig. 112.
1954, *Striarca* (*Galactella*) *yokoyamai*, Taki and Oyama, 32, pl. 18, figs. 7a-8b.
1958, *Striarca* (*Spinearca*) *interplicata*, Habe, 255, pl. 12, fig. 15.
1963, *Striarca interplicata*, Yamada, figs. 3a-b.
1966, *Striarca interplicata*, Noda, 72, pl. 11, figs. 16-18.
1968, *Striarca* (*Verilarca*) *interplicata*, O'Hara, 54, pl. 1, fig. 23.
1971, *Verilarca interplicata*, Kuroda *et al.*, 332, 526, pl. 67, fig. 8.
1973, *Striarca* (*Galactella*) *interplicata*, Oyama, 79, pl. 26, figs. 3-4.
1977, *Arcopsis interplicata*, Habe, 41, pl. 7, figs. 3-4.
1981, *Striarca* (*Spinearca*) *interplicata*, Kira, 108, pl. 41, fig. 1.
1985, *Striarca* (*Galactella*) *interplicata*, Matsuura, pl. 32, fig.16.
1988b, *Arcopsis interplicata*, Noda, 122, pl. 2, figs. 1a-c.
1990, *Verilarca interplicata*, Baba, 240, pl. 23, fig. 15.

Remarks; The present species is recorded from Pliocene to Recent. The species is distinguished *V. yokoyamai* in having high subquadrate form and ventral inner crenulations. The species is common in the warm water seas, however, there are some confusion for the classification in the genus level. The species has distinct and fine radial ribs, internal crenulations on the internal ventral margin, no ligamental grooves, and gape between anterior and posterior teeth. The species is distinguished from *Striarca symmetrica*.

Localities; Loc. no. 81, no. 84, no. 109 (rare).

Genus *Trisidos* Roeding, 1798
Trisidos sp.
Fig. 8-12.

Remarks; Only one imperfect specimen was examined. The anterior part is narrow and slender but the posterior flat part wide and swollen. The uneven external surface is sculptured with fine radial ribs. The ligamental area is low and narrow. The present unnamed species resembles *Trisidos kiyonoi* Kuroda but it was remained unnamed because of ill preservation.

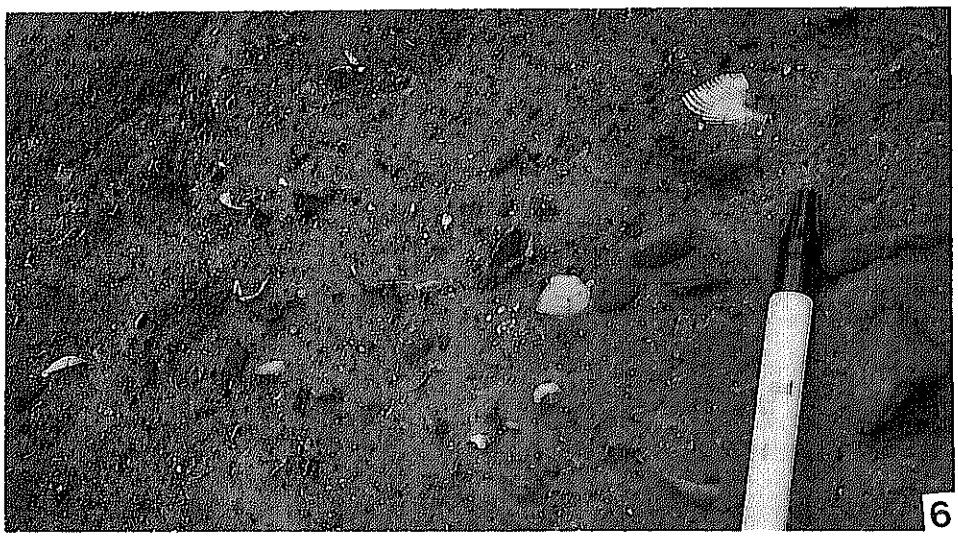
Locality; Loc. no. 87 (rare).

Subfamily Anadarinae Reinhart, 1935
Genus *Anadara* Gray, 1847
Subgenus *Scapharca* Gray, 1847
Anadara (*Scapharca*) *suzukii* (Yokoyama, 1926b)
Fig. 8−9.

1926b, *Arca suzukii* Yokoyama, 368, pl. 42, figs. 6-7.
1928b, *Arca* (*Scapharca*) *philippiana*, Yokoyama, 103-104, pl. 17, figs. 4-5.
1951, *Anadara* (*Dilvarca*) *suzukii*, Oyama, pl. 16, fig. 13.
1958, *Anadara tricenicosta*, Makiyama, pl. 54, figs. 6-7. (reproduction of Yokoyama's *Arca suzukii*, 1926)
1965, *Anadara* (*Scapharca*) *suzukii*, Noda, 100, pl. 10, figs. 3-7, 10-13, pl. 11, figs. 9-10.
1966, *Anadara* (*Scapharca*) *suzukii*, Noda, 111, pl. 8, fig. 2.
1981, *Anadara* (*Scapharca*) *suzukii*, Masuda and Ogasawara, pl. 2, fig. 1.
1986, *Anadara* (*Scapharca*) *suzukii*, Masuda *et al. in* Sato *et al.*, 12, pl. 1, fig. 13.
1988b, *Anadara* (*Scapharca*) *suzukii*, Noda, 118-119, pl. 4, figs. 11a-b.
1993, *Anadara* (*Scapharca*) *suzukii*, Okumura and Takei, 158, pl. 33, fig. 7. (non fig. 15).
1993, *Anadara* (*Tosarca*) *tosaensis*, Okumura and Takei, pl. 33, fig. 14. (missed for pl. 33, fig. 14).

Fig. 2. Unconformity and reddish weatherd zone of the basal part of Nakoshi Formation at the northern side cliff of Nasada River.
Fig. 3. Basal part of the Nakoshi Formation at north of Nasada River, from where *Anadara, Ostrea* and other embaymetal species were occurred.
Fig. 4. Siltstone facies at the lower part of the Nakoshi Formation at the same Locality of Fig. 3.

5



6

7

1993, *Anadara* sp., Okumura and Takei, pl. 34, figs. 5a-b.
1993, *Anadara suzukii*, Katto and Masuda, 9, pl. 1, figs. 4a-5b.
1998, *Anadara* (*Scapharca*) *suzukii* (Yokoyama), Ozawa *et al.*, 88-89, pl. 17, figs. 1a-b.

Remarks; After the original description from the Pliocene Ananai Formation in Kochi Prefecture by Yokoyama (1926), the species has been well known among the Pliocene-Pleistocene formations in the southwestern part of Japan. Though the present species resembles the Recent species *Anadara* (*Scapharca*) *tricenicosta* as mentioned by Makiyama (1958) and Noda (1963), *Anadara suzukii* has 24-25 non-dichotomous radial ribs and swollen shell. The species is an extinct species and is restricted to occur from the Pliocene to Pleistocene formations in the southwestern part of Japan. The most allied species, *Anadara ferruginea* is distinguished from the present species in having much more radial ribs. *Anadara suzukii* is also allied to *Anadara* (*S.*) *tricenicosta* as already mentioned by Noda (1963, 1966). Though Habe (1965) considered that *Anadara tricenicosta* is synonymous with *Anadara ferruginea* described four years prior to the former but is distinguished from the latter in having straight dorsal part. At the present, the species is known from the Takanabe, Ananai, Dainichi and Nakoshi Formations and its some correlated formations in southwest Japan. Schenck and Reinhart (1938) described *Anadara* (*Anadara*) *ferruginia waloensis* from the Pliocene to Pleistocene formation in Mindanao, the Philippines. At the time, they classified *Anadara ferruginea* into five subspecies as *A. f. ferruginea*, *A. f. dautzenbergi* (Lamy) from Caledonia, *A. f. timorensis* (Koperberg) from Timor, *A. f. waloensis*, n. subsp. from Philippines and *A. f. waylandi* (Cox) from Africa. The oldest comes from the Early Oligocene to Late Miocene in Africa. Number of radial ribs among these subspecies, the oldest subspecies has 21 and the youngest subspecies has 27 radial ribs. The number of radial ribs among these subspecies, increases from older to younger in age. This tendency is similar to these of *Anadara suzukii* to *Anadara tricenicosta* in southwest Japan (Noda, 1963).

Localities; Loc. no. 81 (rare), no. 84 (rare), no. 87 (rare), no. 88 (rare).

Anadara (*Scapharca*) *taiwanica* Noda, 1966
Figs. 8-11a－11b.

1966, *Anadara* (*Scapharca*) *taiwanica* Noda, 112-113, pl. 10, figs. 4-6.

Remarks; The present species was originally described from the Pliocene Miaoli Formation in Taiwan by Noda (1966). This is the first record from Japan, so the present occurrence from Okinawa expands the geographical distribution of the species. The Okinawan species is swollen inequivalve with 37-38 non-dichotomous radial ribs crossed with concentric growth line making small nodes structure on the sides of radial ribs. In comparison with both species from Okinawa and Formosa, the Okinawan specimen is smaller in size than the Formosan specimens.

Locality; Loc. no. 81 (rare).

Anadara (*Scapharca*) *kotakai* Noda, 1988
1988b, *Anadara* (*Scapharca*) *kotakai* Noda, 118.

Remarks; The present species was first described from the Haneji Formation by Noda (1988b). The present species is characterized by moderate swollen shell and 38-39 flat-topped radial ribs. The species is allied to *A. iwashibarensis* in shell form but has more larger number of radial ribs.

Locality; Loc. no. 81 (rare).

Subgenus *Hataiarca* Noda, 1966
Anadara (*Hataiarca*) *takaoensis* (Nomura, 1933)
Figs. 8-4a－4b

Fig. 5. Distant view of the fossil dominant locality (Loc. no. 84) at Kogachi.
Figs. 6-7. Fossiliferous calcareous sandstone with pebbles (Fig. 6) and massive siltstone but dominant in molluscan fossils (Fig. 7) of the Nakoshi Formation (Loc. no. 84).

1933, *Arca takaoensis* Nomura, 39, pl. 3, figs. 2-5.
1941b, *Anadara* (*Scapharca*) *takaoensis*, Yabe and Hatai, 73-74, pl. 7, figs. 2, 3, 6.
1965, *Anadara* (*Scapharca*) *takaoensis*, Noda, 101, pl. 10, fig. 14, pl. 11, figs. 3-6.
1966, *Anadara* (*Scapharca*) *takaoensis*, Noda, 112-113, pl. 10, fig. 1.
1984, *Anadara takaoensis*, Nohara and Miyagi, pl. 1, fig. 4.
1988b, *Anadara* (*Hataiarca*) *takaoensis*, Noda, 119, pl. 4, figs. 10a-b.
1990a, *Anadara* (*Scapharca*) *takaoensis*, Masuda and Huang, 142, pl. 1, figs. 8-10.

Remarks; The present species is characterized by having 24-25 non-dichotomous distinct radial ribs with nodes, and posterior keel running from near beak to posterior ventral corner. As well discussed by Noda (1988b), the species is distinguished from *A.* (*H.*) *nodai* in having elongated shell with distinct 24-25 radial ribs with no nodes on radial ribs. *Anadara* (*H.*) *kogachiensis* is distinguished from the present species in having a small umbonal angle and elongated posterior margin.

Localities; Loc. no. 81 (rare), no. 84 (common), no. 88 (common).

Anadara (*Hataiarca*) *kogachiensis* Noda, 1971
Figs. 8-5a−5b, 10, 9-7−8b.

1971, *Anadara* (*Hataiarca*) *kogachiensis* Noda, 37-38, pl. 6, figs. 1-5, 8-17.
1978, *Anadara* (*Hataiarca*) *kogachiensis*, Minoura, 1-8.
1988b, *Anadara* (*Hataiarca*) *kogachiensis*, Noda, 119, pl. 4, figs. 5-6.

Remarks; The present species is common in the lower part of Nakoshi Formation and is characterized by having 25-26 low, flat-topped radial ribs, depressed area on posterior side separated by longitudinal ridge running from near beak to posterior ventral corner, and narrow umbonal angle. The present species was well discussed morphologically by Noda (1971) and Minoura (1978). The present species resembles the Recent species, *Anadara subcrenata* in having similar shell form and posterior depressed part, but the present species has small number of radial ribs and elongated posterior side, particularly in genomic forms.

Localities; Loc. no. 81 (common), no. 83 (common), no. 84 (rare), no. 109 (few), no. 114 (few).

Subgenus *Tosarca* Noda, 1965
Anadara (*Tosarca*) *sedanensis* (Martin, 1910)
Fig. 8-8.

1910, *Arca* (*Scapharca*) *sedanensis* Martin, 381, pl. 54, figs. 125-127. (*fide* Noda, 1988b)
1933, *Arca* (*Arca*) *sedanensis*, Nomura, 38, pl. 4, fig. 16.
1941b, *Anadara* (*Scapharca*) *sedanensis*, Yabe and Hatai, 73, pl. 7, fig. 9.
1965, *Anadara* (*Tosarca*) *sedanensis*, Noda, pl. 11, figs. 1-2.
1966, *Anadara* (*Tosarca*) *sedanensis*, Noda, 123, tab. 26.
1986, *Anadara* (*Tosarca*) *sedanensis*, Masuda *et al.* *in* Sato *et al.*, 11, pl. 1, fig. 6.
1988b, *Anadara* (*Tosarca*) *sedanensis*, Noda, 120, pl. 3, figs. 6a-6b, 11.
1990a, *Anadara* (*Tosarca*) *sedanensis*, Masuda and Huang, 142, pl. 1, figs. 5-7.

Remarks; The present species is characterized by its large subquadrate shell with slightly elevated 45-50 radial ribs with flat-top and narrow ligamental area. The radial ribs of the ventral part are bi-furcated. The present species quite resembles *Anadara* (*Tosarca*) *tosaensis* described from the Plio-Pleistocene Ananai Formation in Kochi Prefecture but the latter has bifurcated ribs only on both sides of shell and small number (about 40) of radial ribs. *Anadara* (*Tosarca*) *vellicata* is an another allied species but the species is distinguished from *A.* (*T.*) *sedanensis* in having narrow anterior part and small number of radial ribs. The subgenus *Tosarca* is a quite distinguishable among the genus *Anadara* as Habe (1977) treated it as a genus. *Tosarca* is known only from the Late Miocene to Pleistocene formations in Japan and Southeast Asia. Also, Woodring (1973) mentioned that the some species of the subgenus *Tosarca* are distributed in the Late Miocene to Pliocene in the Panama region. Biogeographically, the present genus or subgenus is probably distributed in more wide.

Localities; Loc. no. 81 (rare), no. 84 (rare), no. 88 (rare).

Family Cucullaeidae Stewart, 1930
Genus *Cucullaea* Lamarck, 1802
Subgenus *Cucullaea* s.s.
Cucullaea (s.s.) *granulosa* Jonas, 1846
Fig. 8-14.

1846, *Cucullaea granulosa* Jonas, 36. (*fide* Habe, 1964)
1869, *Cucullaea granulosa*, Reeve, pl. 1, figs. 2a-b. (*fide* Noda, 1966)
1891, *Cucullaea granulosa*, Kobelt *in* Martin and Chemnitz, 6, pl. 1, fig. 5. (*fide* Noda, 1966)
1891, *Cucullaea concamerata*, Kobelt in Martini and Chemnitz, 5, pl. 1, figs. 3-4, pl. 5, figs. 1-2. (*fide* Noda, 1966)
1926a, *Cucullaea concamerata*, Yokoyama, 360, pl. 41, fig. 2.
1928a, *Cucullaea concamerata*, Yokoyama, 107, pl. 18, figs. 4-5.
1929, *Cucullaea concamerata*, Yokoyama, 17, pl. 8, fig. 2.
1930, *Cucullaea labiosa* var. *granulosa*, Kuroda, 34, fig. 40.
1933, *Cucullaea granulosa*, Nomura, 44, pl. 4, fig. 2.
1960, *Cucullaea granulosa*, Makiyama, pl. 104, figs. 4-5a.
1960, *Cucullaea granulosa*, Makiyama, pl. 115, fig. 2.
1964, *Cucullaea labiosa granulosa*, Habe, 261, figs. 1-2.
1971, *Cucullaea labiosa granulosa*, Kuroda *et al.*, 516, pl. 70, figs. 1-2.
1977, *Cucullaea labiosa granulosa*, Habe, 43, pl. 6, figs. 1-2.
1984, *Cucullaea labiosa granulosa*, Wang, pl. 5, figs. 1a-b.
1986, *Cucullaea granulosa*, Masuda *et al.*, *in* Sato *et al.*, 15, pl. 1, fig. 17.
1988b, *Cucullaea granulosa*, Noda, 124, pl. 2, figs. 13a-16.
1990a, *Cucullaea* (*Idonearca*) *granulosa*, Masuda and Huang, 143, pl. 2, figs. 3, 5, 7.
1993, *Cucullaea granulosa*, Okumura and Takei, 156, pl. 34, figs. 10a-c.
1993, *Cucullaea labiosa granulosa*, Katto and Masuda, 9, pl. 1, figs. 6a-b.
1993, *Bathyarca kyurokushimana*, Okumura and Takei, 156-157, pl. 34, fig. 10.
1994b, *Cucullaea granulosa*, Masuda and Huang, 391, pl. 1, figs. 10-11.
1995, *Cucullaea granulosa*, Nobuhara, fig. 7-6.
1998, *Cucullaea labiosa granulosa*, Ozawa *et al.*, 91-92, pl. 18, fig. 4.

Remarks; The present species is characterized by having large subquadrate shell with fine radial ribs crossed with concentric growth lines making a reticulated structure, fine crenulation on internal ventral margin, horizontal teeth on both extremities, narrow trigonal ligamental area with grooves and thin plate along the posterior muscle scar. The present species is distributed mainly in sandy bottom in worm water seas.

Localities; Loc. no. 81 (rare), no. 84 (few), no. 87 (rare).

Family Glycymeridae Newton, 1922
Subfamily Glycymeridinae Newton, 1922
Genus *Glycymeris* Da Costa, 1778
Subgenus *Glycymeris* Da Costa, 1778
Glycymeris (*Glycymeris*) *formosana* (Yokoyama, 1928a)
Fig. 8-13.

1928a, *Pectunculus formosanus* Yokoyama, 106, pl. 18, figs. 1-3.
1941b, *Glycymeris formosanus*, Yabe and Hatai, 72-73, pl. 7, figs. 5, 7-8.
1990a, *Glycymeris* sp., Masuda and Huang, 144, pl. 3, fig. 5.
1993b, *Glycymeris formosanus*, Masuda and Huang, 262-263, pl. 2, figs. 1-2b.

Remarks; The present species is characterized by its sub-rounded shell with almost flat radial ribs separated by linear interspaces. The flat radial ribs are very finely striated. The species resembles *Glycymeris albolineata* in form but the latter has a dotted structure on the external surface.

Localities; Loc. no. 81 (rare), no. 87 (few), no. 88 (dominant).

Genus *Tucetilla* Iredale, 1939
Tucetilla pilsbryi (Yokoyama, 1920)
Figs. 8-2a－2b.

1920, *Pectunculus pilsbryi* Yokoyama, 170, pl. 18, figs. 8a-c.
1922b, *Pectunculus pilsbryi*, Yokoyama, 190, pl. 16, figs. 8-9.
1961, *Glycymeris* (*Tucetilla*) *pilsbryi*, Habe, 112, pl. 50, fig. 1.
1968, *Glycymeris* (*Tucetilla*) *pilsbryi*, O'Hara, pl. 2, figs. 4a-b.
1971, *Glycymeris* (*Tucetilla*) *pilsbryi*, Kuroda *et al.*, 336-337, 533, pl. 71, figs. 7-8.
1973, *Glycymeris* (*Tucetilla*) *pilsbryi*, Oyama, 77, pl. 22, figs. 8-9.

1977, *Tucetilla pilsbryi*, Habe, 47, pl. 8, fig. 8.
1980, *Glycymeris* (*Tucetilla*) *pilsbryi*, Noda, 79-80.
1986, *Glycymeris* (*Tucetilla*) *pilsbryi*, Matsukuma and Okamoto, figs. 2-H.
1986, *Tucetilla pilsbryi*, Takayasu *et al*., pl. 55, figs. 6a-b, 9a-b.
1988a, *Glycymeris* (*Tucetilla*) *pilsbryi*, Noda, 65-66, pl. 16, fig. 21.
1989, *Tucetilla pilsbryi*, Ito, pl. 19, fig. 4.
1991, *Glycymeris* (*Tucetilla*) *pilsbryi*, Noda, 14, figs. 6-12, 14-17, 19a-20b.
1998, *Tucetilla pilsbryi*, Okumura and Ueda, 72, pl. 8, fig. 19.

Remarks; The present species is defined by its indistinct narrowly elevated radial ribs.

Locality; Loc. no. 87 (rare).

Family Mytilidae Rafinesque, 1815
Subfamily Musculinae Iredale, 1939
Genus *Musculista* Yamamoto and Habe, 1958
Musculista cf. *japonica* (Dunker, 1857)
Figs. 12-8−9.

Remarks; The present species is small and fragile but its fine radial riblets and obliquely elongated shell are well identical with the named species.

Locality; Loc. no. 88 (rare).

Subfamily Modiolinae Keen, 1958
Genus *Modiolus* Lamarck, 1799
Modiolus sp.
Figs. 12-11−12.

Remarks; Small specimens are collected and are defined by having thin obliquely elongated shell with very fine radial riblets. The present unnamed species is well identical with *Modiolus* sp. (Noda, 1971, p. 39, pl. 7, fig. 15) from the Nakoshi Formation.

Locality; Loc. no. 109 (rare).

Family Pteriidae Gray, 1847
Genus *Pteria* Scopoli, 1777
Pteria cf. *coturnix* (Dunker, 1882)

Compared with;
1882, *Avicula coturnix* Dunker, 288, pl. 10, figs. 1-2. (*fide* Noda, 1971)
1971, *Pteria* cf. *coturnix*, Noda, 38-39, pl. 7, fig. 16.

Remarks; The present species was recorded and illustrated from the Kogachi Member of the Nakoshi Formation by Noda (1971).

Locality; Loc. no. 84 (rare).

Family Pinnidae Leach, 1819
Genus *Atrina* Gray, 1847
Atrina sp.
Fig. 16-3.

Remarks; Only one incomplete joined shells was examined. The specimen is trigonally elongated with fine longitudinal ribs on anterior and concentric ribs on posterior side of shell, and narrow apical angle are referred to the genus *Atrina*. The present species resembles *Atrina pectinata* which was illustrated from the Pliocene to Pleistocene formations in southwest Japan (Okumura and Koyanagi, 1989, Okumura and Takei, 1993) in shell form but remained unnamed for more complete specimen.

Locality; Loc. no. 87 (rare).

Family Pectinidae Rafinesque, 1815
Subfamily Chlaminydinae Korobokov, 1960
Genus *Chlamys* Roeding, 1798
Subgenus *Azumapecten* Habe, 1977
Chlamys (*Azumapecten*) *subsquamatus* (Nomura, 1933)
Figs. 10-4−5,·7.

1933, *Pecten* (*Pecten*) *subsquamatus* Nomura, 53-54, pl. 1, figs. 11a-b.
1984, *Chlamys* sp. B., Nohara and Miyagi, pl. 1, fig. 6.

Remarks; The present species was originally described from the Pliocene Byoritsu Beds in Formosa by Nomura (1933). The present species is characterized by rather swollen left valve and flat right valve. The external surface of the left valve is sculptured by 4-5 elevated primary radial ribs with scales and secondarily 3-4 finer interstitial riblets.

The present species resembles the Recent species, *Ch. squamata* (Gmelin) in shell form and external sculptures, but it differs from the latter in having 1-3 smoothly rounded finer interstitial riblets. According to Masuda and

Huang (1993b), the present species is same with *Chlamys* (*C.*) *squamata* ranges from the Pliocene. However, the difference in the immature stage is quite clear as mentioned by Baba (1990, pl. 25, figs. 10a-b). *Chlamys nipponensis* (Kuroda, 1932) is another allied species but it is differentiated from the latter by having distinct primal ribs with scales. *Chlamys* (*Azumapecten*) *squamata* var. (Masuda, 1962, pl. 9, figs. 5-7) is quite similar to the present species but it has 5-6 scaly primal radial riblets on posterior and secondarily narrow elevated ribs with elongated anterior auricle.

Localities; Loc. no. 84 (rare), no. 87 (rare).

Subgenus *Mimachlamys* Iredale, 1929

Chlamys (*Mimachlamys*) *satoi* (Yokoyama, 1928)

Figs. 10－8-9c.

1928a, *Pecten* (*Chlamys*) *satoi* Yokoyama, 94, pl. 13, figs. 13-14, pl. 14, fig. 2.
1932, *Pecten kakisakiensis*, Nomura and Niino, 177, pl. 12, figs. 3, 4.
1960, *Gloripallium satowi*, (*sic*), Shuto, 119-120, pl. 12, fig. 5.
1960, *Mimachlamys* cf. *miniacea*, Shuto, 122, pl. 13, fig. 4.
1960, *Chlamys satoi*, Makiyama, pl. 99, figs. 13-14, pl. 100, fig. 2.
1962, *Chlamys* (*Mimachlamys*) *satoi*, Masuda, 189, pl. 19, figs. 18-19, pl. 22, fig. 14.
1980, *Chlamys satoi*, Masuda, pl. 3, fig. 1.
1981, *Chlamys satoi*, Masuda and Ogasawara, pl. 2, fig. 3.
1984, *Chlamys* sp. A., Nohara and Miyagi, pl. 1, fig. 5.
1986, *Chlamys* (*Mimachlamys*) *satoi*, Masuda *et al. in* Sato *et al.*, 21-23, pl. 2, figs. 9, 10.
1986a, *Chlamys satoi*, Masuda, pl. 10, fig. 3.
1986, *Chlamys satoi*, Takahashi, pl. 13, fig. 1.
?1988, *Chlamys satoi*, O'Hara and Nemoto, 488-489, pl. 1, figs. 4, 5.
1990a, *Chlamys* (*Mimachlamys*) cf. *satoi*, Masuda and Huang, 114, pl. 3, figs. 12-15.
1991, *Chlamys satoi*, Noda, 17-19, figs. 7-5, 10, 13.
1993b, *Chlamys* (*Mimachlamys*) *satoi*, Masuda and Huang, 263, pl. 2, figs. 4-9.
1993, *Chlamys satowi*, (*sic.*), Okumura and Takei, 163, pl. 36, figs. 4-5.
1993, *Chlamys satoi*, Katto and Masuda, 10, pl. 2, figs. 6-7.
1993, *Chlamys satoi*, Nobuhara, fig. 7-7.
1994b, *Chlamys* (*Mimachlamys*) *satoi*, Masuda and Huang, 509-510, pl. 2, figs. 1-7.
1998, *Chlamys* (*Mimachlamys*) *satoi*, Ozawa *et al.*, 96-97, pl. 23, fig. 7.

Remarks; The present species was originally described from the Upper Byoritsu Bed in Formosa by Yokoyama (1928a). Thenceafter the present species has been well known to occur from the Pliocene formations distributed along the southwestern Pacific Ocean side of Southwest Honshu, Japan (Masuda, 1962 and others). However, as Masuda and Huang (1994a, b) mentioned, the type locality of the species is unknown in stratigraphic horizon and also exact locality as mentioned by Yokoyama (1928a), they proposed the neotype collected from the Toukoushan Formation (Upper Byoritsu Beds) at Houlung, Miaoli Hsien. In addition, they concluded firstly that the species is come from Late Miocene Kueichulin Formation up to the Pleistocene. The species is defined by having 26-28 flat-topped radial ribs with scales on their top and both sides of them, and interstitial. According to the detail study on this species, Masuda (1962) mentioned that *Pecten kakizakiensis* and *Mimachlamys* cf. *minica* of Shuto (1960) are synonymous with the present species. The Nakoshi specimens attain more than 100 mm in size. *Chlamys gracilisquamosa* (Fischer, 1927) from the Seran Pliocene very resembles to the species in the scaly radial ribs and shell profile.

Localities; Loc. no. 84 (rare), no. 87 (few), no. 88 (rare).

Chlamys (*Mimachlamys*) *gracilisquamosus* (Fischer, 1927)

Figs. 10-1a－2b.

1927, *Pecten* (*Chlamys*) *gracilisquamosa* Fischer, 114, pl. 215, figs. 102a-c.
1936, *Pecten* (*Pecten*) *gracilisquamosus*, Nomura and Zinbo, 235, pl. 11, fig. 1.
1984, *Chlamys* sp. C, Nohara and Miyagi, pl. 1, fig. 7.

Remarks; The present species was originally described by Fischer (1927) from Pliocene in Seran. Thenceafter, the species was recorded from the Pliocene formation in Okinawa by

Nomura and Zinbo (1936). The left valve of the species is characteristic in having 29-30 radial ribs with fine scales, deep and wide byssal notch, trigonal anterior auricle ear, and distinct ctenolium. The species resembles *Ch. satoi* described in the earlier lines, but radial ribs are larger in number, and has finer scales. It is interesting to note that the Indonesian species, *Ch. gracilisquamosa* has 25 ribs (Fischer, 1927), Formosan species about 27-28 (Nomura and Zinbo, 1936), and Okinawan species has 28-30 though the ribs on both sides are quite fine.

Localities; Loc., no. 84 (rare), no. 87 (rare), no. 88 (rare).

Genus *Cryptopecten* Dall, Bartsch and Rehder, 1938

Cryptopecten cf. *nux nux* (Reeve, 1853)

Figs. 10-6a－6b.

Remarks; The present species was discussed in detailed by Hayami (1984) and complete synonymous list of the species was also made. The present species ranges from the Early Miocene in Tanzania (Eames and Cox, 1956) to Pliocene in Keniya (Cox, 1930).

The species is also described from the Pliocene Miaoli Formation in Formosa (Nomura, 1933) so that the distribution expands up to the southwest Japan via Okinawa.

Locality; Loc. no. 81 (rare).

Cryptopecten vesiculosus (Dunker, 1877)

Fig. 10-3

1988, *Cryptopecten vesiculosus*, Yoon, pl. 4, fig. 2.
1988, *Cryptopecten vesiculosus*, O'Hara and Nemoto, 489-490, pl. 2, figs. 1, 3.
1988, *Aequipecten vesiculosus*, Okumura, 41, pl. 13, figs. 6, 9-11.
1988, *Cryptopecten vesiculosus*, Mizuno and Amano, pl. 14, figs. 10, 15.
1990, *Cryptopecten vesiculosus*, Baba, 252, pl. 25, figs. 16a-b.
1991, *Cryptopecten vesiculosus*, Noda, 19, figs. 9-5, 8a－10b.
1993, *Cryptopecten vesiculosus*, Nobuhara, fig. 8-7.
1993, *Aequipecten vesiculosus*, Okumura and Takei, 164, pl. 36, figs. 2, 3, 6, 9.

Remarks; The synonymous list was already given by Hayami (1984). The present species was rare in the Nakoshi Formation.

Locality; Loc. no. 87 (rare).

Genus *Decatopecten* Sowerby, 1838

Decatopecten striatus (Schumacher, 1817)

Figs. 9-3a－3b, 6a－6b.

1817, *Pecten striatus* Schumacher, 120, pl. 4, fig. 4 (*fide* Oyama, 1973).
1922b, *Pecten subplicatus*, Yokoyama, 181, pl. 15, fig. 3.
1924, *Pecten plica*, Yokoyama, 56, pl. 4, fig. 11.
1951, *Decatopecten striatus*, Habe, 78, figs. 153-154.
1954, *Decatopecten striatus*, Taki and Oyama, pl. 35, fig. 3, pl. 41, fig. 11.
1961, *Decatopecten striatus*, Hayasaka, 30-31, pl. 3, figs. 11a-b.
1964, *Chlamys* (*Decatopecten*) *striatus*, Shikama, 51, pl. 31, figs. 1-5.
1968, *Decatopecten striatus*, O'Hara, 162, pl. 5, fig. 1.
1970, *Decatopecten striatus*, Habe and Kosuge, 135, pl. 50, fig. 16.
1971, *Decatopecten striatus*, Kuroda *et al.*, 365, 573, pl. 79, fig. 8.
1973, *Decatopecten striatus*, Oyama, 85, pl. 33, figs. 5-6.
1977, *Decatopecten striatus*, Habe, 85, pl. 16, figs. 1-2.
1990, *Decatopecten striatus*, Baba, 253, pl. 25, figs. 19a-b.

Remarks; The present species is rather common in the Nakoshi Formation. The species is defined by having subequilateral shell, well round ventral margin, flat umbonal area, 3-5 main radial ribs with concentric step and fine riblets on and internal ribs, 2-3 paired inner ribs on ventral border, fine crenulation on inner ventral margin, rather small muscle scar, trigonal ear, elongated cardinal crura and no byssal notch. The right valve is smoothly swollen but light valve has concentric gape at ventral margin and narrowly elevated ribs.

The present species resembles *Decatopecten amiculus* in shell form and external sculptures, but the latter has much number of radial ribs (7-8). *Decatopecten plica* also resembles the present species but the former has small number of radial ribs.

Localities; Loc. no. 81 (rare), no. 84 (few), no. 87 (rare), no. 88 (rare).

Decatopecten amiculum (Philippi, 1851)
Figs. 9-1−2, 4−5.

1851, *Pecten* (*Decatopecten*) *amicularis* Philippi (*non vidi*).
1933, *Pecten* (*Decatopecten*) *amiculum*, Nomura and Zinbo, 235, pl. 11, figs. 2a-b.
1984, *Chlamys* sp. D., Nohara and Miyagi, pl. 1, fig. 8.
1984, *Decatopecten plica*, Nohara and Miyagi, pl. 1, fig. 10.
1988a, *Decatopecten amicularis*, Noda, 69, pl. 17, fig. 11.

Remarks; The present species was already illustrated by Nomura and Zinbo (1933) from the Nakoshi Sand in Okinawa as also same of Noda (1988a). The species is defined by subcircular shell, round-topped 7-9 radial ribs, fine radial riblets in right valve and interribs on the internal margin, very fine ventral crenulations and paired internal ribs at inner ventral margin and no byssal notch. The present species resembles *Decatopecten striatus* in their similar radial ribs and shell form but the number of radial ribs is larger.

Localities; Loc. no. 81 (rare), no. 84 (common), no. 87 (rare), no. 88 (rare).

Subfamily Pectininae Rafinesque, 1815
Genus *Amussiopecten* Sacco, 1897
Amussiopecten praesignis (Yokoyama, 1922a)
Figs. 11-1a−1c.

1922a, *Pecten praesignis* Yokoyama, 1-2, pl. 5, figs. 1-3.
1926a, *Pecten* (*Amusium*) *praesignis*, Yokoyama, 357-358, pl. 40, figs. 1-2, pl. 41, fig. 1. (same with Yokoyama, 1922a)
1928a, *Pecten* (*Amusium*) *praesignis*, Yokoyama, 96, pl. 15, fig. 1.
1931, *Amusium* (*Amussiopecten*) *praesignis*, Kuroda, 77, fig. 80.
1938, *Amussiopecten praesignis*, Otuka, 6, pl. 1, fig. 2.
1941a, *Pecten praesignis*, Yabe and Hatai, 465-466, pl. 11, fig. 1.
1955, *Amussiopecten praesignis*, Shuto, 103-104, pl. 17, figs. 1, 3.
1957, *Amussiopecten praesignis*, Akiyama, 33-34, pl. 7, figs. 5-6.
1958, *Amussiopecten praesignis*, Makiyama, pl. 52, figs. 1-2, pl. 53, fig. 1.
1960, *Pecten* sp., Aoki, 304, pl. 34, figs. 7-9.
1962, *Amussiopecten praesignis*, Masuda, 226, pl. 27, figs. 4-5.
1966, *Amussiopecten praesignis*, Aoki, 255, pl. 31, figs. 8a-b.
1973, *Amussiopecten praesignis*, Hayasaka, 101, pl. 6, fig. 2.
1973, *Amussiopecten praesignis*, Kanno and Chang, pl. 30, fig. 11.
1978, *Amussiopecten praesignis*, Okamoto and Honza, fig. 3.
1978, *Amussiopecten praesignis*, Okamoto, figs. X-1, 1a−b.
1980, *Amussiopecten* sp., Noda, 83, pl. 4, fig. 17.
1980, *Amussiopecten praesignis*, Masuda, pl. 3, fig. 2.
1980, *Amussiopecten praesignis*, O'Hara and Ito, 131-132, pl. 14, figs. 5-7, pl. 15, figs. 1-5.
1981, *Amussiopecten praesignis*, Masuda and Ogasawara, pl. 2, fig. 4.
1981, *Amussiopecten praesignis*, Tsuchi, pl. 4, fig. 2.
1984, *Amussiopecten praesignis*, Nohara and Miyagi, pl. 1, figs. 1a-2.
1984, *Amussiopecten* sp., Nohara and Miyagi, pl. 1, fig. 3.
1986, *Amussiopecten praesignis*, Masuda *et al. in* Sato *et al.*, 19-21, pl. 2, figs. 3a-b.
1986b, *Amussiopecten praesignis*, Masuda, pl. 10, fig. 1.
1988, *Amussiopecten praesignis*, Tsuchi *ed.*, pl. 4, fig. 2.
1988a, *Amussiopecten* sp., Noda, 69, pl. 17, fig. 12.
1990, *Amussiopecten praesignis*, Baba, 255, pl. 26, figs. 5a-b.
1991, *Amussiopecten praesignis*, Noda, 21-22, figs. 9-12−13.
1993, *Amussiopecten praesignis*, Okumura and Takei, 162-163, pl. 36, fig. 1.
1993, *Amussiopecten praesignis*, Katto and Masuda, 10, pl. 3, figs.1-2b.
1993, *Amussiopecten praesignis*, Nobuhara, figs. 7-9.
1998, *Amussiopecten praesignis*, Ozawa *et al.*, 95-96, pl. 22, figs. 1a-b.

Remarks; The present species is a well-known Pliocene extinct pelecypod in Japan. There is some variation in number of radial ribs but its characteristic features as internal paired ribs, flat-topped radial ribs ranging from 15-18 in number and shallowly angled hinge line are distinctive. Recently, Ozawa *et al.* (1998) examined the geological age as Late Miocene for those assemblage of the Majya Formation in Kume-jima Island, Ryukyu. The Majya Formation was formerly assigned to Pliocene to occur the present species and other extinct peculiar species known among the Kakegawa Fauna. The specimen illustrated from Asuka, Dainichi Formation by Ozawa *et al.* (1998) has high shell and small number of radial ribs.

Localities; Loc. no. 81 (abundant), no. 84 (few), no. 87 (rare), no. 88 (abundant).

Chlamys sp.
Fig. 11-3.

The present species is characterized by fine radial ribs and elongated anterior auricle with wide and rather deep notch as like *Chlamys nipponensis* but it remained unnamed because of indistinct preservation.

Locality; Loc. no. 88. (rare).

Family Plicatulidae Watson, 1930
Genus *Plicatula* Lamarck, 1801
Plicatula simplex Gould, 1861
Fig. 11-4.

Remarks; Only one imperfect specimen, which identified to *P. simplex* in having elongated shell with 3-4 radial ribs. Noda made the synonymous list in 1991 and 1988.

Locality; Loc. no. 87 (rare).

Family Anomiidae Rafinesque, 1815
Subfamily Anomiinae Rafinesque, 1815
Genus *Anomia* Linnaeus, 1758
Anomia chinensis Philippi, 1849
Figs. 11-2a－2b.

1849, *Anomia chinensis* Philippi, 130. (*fide* Kuroda *et al.*, 1971)
1850, *Anomia cytaeum*, Reeve, pl. 2, figs. 10a-b. (*fide* Kuroda *et al.*, 1971)
1851, *Anomia chinensis*, Philippi, 131, pl. 1, fig. 1. (*fide* Kuroda *et al.*, 1971)
1868, *Anomia chinensis*, Philippi *in* Martin and Chemnitz, 58, pl. 6, figs. 1-2. (*non vidi*)
1907, *Anomia lischkei*, Dautzenberg and Fischer, 210, pl. 5, figs. 8-11. (*non vidi*)
1920, *Anomia cytaeum*, Yokoyama, 146, pl. 11, figs. 17a-b.
?1920, *Anomia nipponensis*, Yokoyama, 146, pl. 11, figs. 18a-b.
1928a, *Anomia lischkei*, Yokoyama, 91-92, pl. 14, figs. 4-5.
1951, *Anomia lischkei*, Habe, 90, fig. 185.
1960, *Anomia sinensis*, Habe, pl. 4, figs. 4, 7.
?1961, *Anomia chinensis*, Hayasaka, 33, pl. 3, fig. 7.
?1965, *Anomia sinensis*, Habe and Ito, 125, pl. 42, figs. 1-2.
?1967, *Anomia chinensis*, Habe and Kosuge, 137, pl. 51, figs. 5-7.
1969, *Anomia chinensis*, Hayasaka, 42, pl. 2, figs. 3a-b.
1969, *Anomia chinensis*, Matsushima, pl. 10, fig. 4.
1971, *Anomia chinensis*, Kuroda *et al.*, 378, 590-591, pl. 84, figs. 12-14.
1974, *Anomia chinensis*, Shibata *in* Itoigawa *et al.*, 71, pl. 15, figs. 5-7b.
1977, *Anomia chinensis*, Habe, 97, pl. 18, figs. 3-4.
1981, *Anomia chinensis*, Kira, 118, pl. 46, fig. 8.
1981, *Anomia chinensis*, Kira, 195, pl. 71, fig. 10.
1986, *Anomia chinensis*, Masuda *et al. in* Sato *et al.*, 26-28, pl. 3, figs. 3a-b.
1986, *Anomia chinensis*, Takayasu *et al.*, pl. 31, figs. 9a-b.
1988, *Anomia chinensis*, Okumura, 43, pl. 14, fig. 12.
1990, *Anomia chinensis*, Baba, 257, pl. 28, figs. 4a-b.
1993, *Anomia chinensis*, Noda *et al.*, 143-145, figs. 16-9a, b.
1993, *Anomia chinensis*, Okumura and Takei, 167, pl. 35, fig. 7.
1995, *Anomia chinensis*, Nakao, pl. 1, figs. 6-7.
1998, *Anomia chinensis*, Ozawa *et al.*, 98-99, pl. 23, figs. 1a-2b, 4a-5b.
1998, *Anomia chinensis*, Okumura and Ueda, 75, pl. 11, fig. 5.

Remarks; The present species is common in shallow sandy facies but there are some confusion in classification due to the preservation. The present species is defined by having one pedical impression and two small round muscle scars in middle part of shell. The present species is distinguished from *Pododesmus noharai* by having small shell with subrounded pedical scar and small round muscle scar in the middle part of the inner surface.

Localities; Loc. no. 81 (rare), no. 84 (rare), no.87 (rare), no. 88 (rare).

Genus *Pododesmus* Philippi, 1837
Subgenus *Monia* Gray, 1849
Pododesmus (*Monia*) *noharai* Noda, 1971
Figs. 12-10a－10b.

1971, *Pododesmus* (*Monia*) *noharai* Noda, 39-40, pl. 7, fig. 17.

Remarks; The present species was originally described from the Haneji Formation by the present writer. The species is quite dominant in the Nakoshi Formation and is defined by large

subrounded shell with fine and irregular radial ribs and three muscle scars (one pedical and two muscle scars). The species of *Pododesmus* has a variable external surface and shell forms due to their adherent habitat. The present species distinguished from *P.* (*M.*) *macroschismus* in having finer radial striations on uneven surface and two moderate muscle scars. Noda (1971) also distinguishes the present species from *P.* (*M.*) *macroschismus ezoanus* as already mentioned.

Localities; Loc. no. 84 (rare), no. 109 (common), no. 114 (common).

Family Ostreidae Rafinesque, 1815
Genus *Ostrea* Linnaeus, 1758
Ostrea denselamellosa Lischke, 1869
Figs. 11-5a－5b.

1869, *Ostrea denselamellosa* Lischke, 177-179, pl. 13, figs. a-b, pl. 14, fig. 1.
1906, *Ostrea denselamellosa*, Tokunaga, 68, pl. 4, fig. 6.
1922, *Ostrea denselamellosa*, Yokoyama, 162, pl. 16, fig. 6.
1922a, *Ostrea denselamellosa*, Yokoyama, 375, pl. 43, fig. 11.
1928a, *Ostrea denselamellosa*, Yokoyama, 100, pl. 16, fig. 1.
1930, *Ostrea denselamellosa*, Hirase, 5-18, figs. 4-30.
1933, *Ostrea denselamellosa*, Nomura, 46-47, pl. 4, fig. 6.
1951, *Ostrea* (*Ostrea*) *denselamellosa*, Habe, figs. 187-188 on 92.
1954, *Ostrea denselamellosa*, Taki and Oyama, pl. 16, figs. 1-2.
1963, *Ostrea denselamellosa*, Yamada, figs. 5a-b.
1965, *Ostrea denselamellosa*, Habe and Ito, 126, pl. 42, fig. 10.
1967, *Ostrea denselamellosa*, Habe and Kosuge, 137, pl. 51, fig. 9.
1971, *Ostrea* (*Ostrea*) *denselamellosa*, Noda, 40-41, pl. 7, figs. 10, 18.
1971, *Ostrea denselamellosa*, Kuroda *et al.*, 381, 595, pl. 86, figs. 2, 3.
1973, *Ostrea denselamellosa*, Oyama, 89, pl. 30, figs. 1a－b.
1977, *Ostrea denselamellosa*, Habe, 110, pl. 20, fig. 5.
1986, *Ostrea denselamellosa*, Masuda *et al. in* Sato *et al.*, 28, pl. 3, figs. 5a－b.
1988, *Ostrea denselamellosa*, Matsukuma *et al.*, pl. 3, fig. 5.
1994, *Ostrea denselamellosa*, Masuda and Huang, pl. 1, fig. 13.

Remarks; The present species is easily distinguished from allied oyster species in having irregularly radiated ribs on left valve and flat shell with concentric growth lines on left flat shell surface and finely crenulation on both sides of small ligamental pit. The present species resembles *Ostrea promensis* Noetling described from Burma in external sculptures but the Japanese species is distinguished from Burma species in having more large and distinct radial ribs.

Localities; Loc. no. 81 (rare), no. 84 (rare).

Genus *Pretostrea* Iredale, 1939
Pretostrea imbricata (Lamarck, 1819)
Figs. 12-13a－13b.

1819, *Ostrea imbricata* Lamarck, 213. (*non vidi*)
1873, *Ostrea imbricata*, Reeve, pl. 17, figs. 36a－b. (*fide* Kuroda *et al.*, 1971)
1930, *Ostrea* (*Lopha*) *imbricata*, Kuroda, 53, 33-35, figs. 44-47.
1982, *Pretostrea imbricata*, Habe, 120, pl. 54, fig. 17.
1967, *Pretostrea imbricata*, Habe and Kosuge, 138, pl. 51, fig. 14.
1971, *Pretostrea imbricata*, Kuroda *et al.*, 380, 593, pl. 85, fig. 8.

Remarks; As *Ostrea hyotis* quite resembles *Ostrea imbricata* in the external sculptures, Nomura (1933) stated that both species may prove to be synonym in his description of *Ostrea hyotis* collected from Formosa. Hirase (1930) prior to Nomura three years, treated it to be a subspecies of *Ostrea hyotis* and Taki (1954, 1960) supported this. The present species resembles *Ostrea junghuhni* Martin in having narrow ligamental area and blunt crenulations on both sides of ligamental pit but the latter has more irregularly elevated radial ribs and partially spinose.

Localities; Loc. no. 81 (rare), no. 84 (rare), no. 87 (rare), no. 109 (rare).

Family Lucinidae Fleming, 1828
Subfamily Lucininae Fleming, 1828
Genus *Lucina* Bruguière, 1797
Lucina kuninagaensis Nomura and Zinbo, 1936
Figs. 12-1a－1b.

1936, *Lucina kuninagaensis* Nomura and Zinbo, 241-242, pl. 11, figs. 10a-11b.

Remarks; The present species was originally described from the Nakoshi Sand by Nomura and Zinbo (1936) and is defined by concentric lamellae-like striation on external surface, blunt longitudinal ridge from near beak to postero-dorsal margin, small and smooth lunule, longitudinal narrow escutcheon, and elongated anterior muscle scar. *Lucina tenuicresta* Martin of Tesch (1920) from the Pliocene in Timor, resembles the present species but differs from the latter in having rougher concentric lamellated plicae.

Localities; Loc. no. 81 (rare), no. 87 (rare).

Genus *Epicodakia* Iredale, 1930
Epicodakia delicatula (Pilsbry, 1904)
Fig. 15-1.

1904, *Epicodakia delicatula* Pilsbry (*fide* Kuroda *et al.*, 1971)
1924, *Codakia bella* var. *delicatula*, Yokoyama, 50, pl. 3, fig. 8.
1954, *Ctena delicatula*, Taki and Oyama, 40, pl. 40, fig. 8.
1961, *Ctena delicatula*, Habe, 125, pl. 56 fig. 23.
1971, *Epicodakia delicatula*, Kuroda, *et al.*, 392, 610, pl. 118, fig. 13.
1973, *Epicodakia delicatula*, Oyama, 97, pl. 40, fig. 4.
1990, *Epicodakia delicatula*, Baba, 262, pl. 29, fig. 10.

Remarks; Only one small specimen was collected but it has characteristic radial ribs crossed with concentric growth lines. *Codakia okinawajimana* Nomura and Zinbo is allied to the present species but the external sculptures is differentiated from the latter species.

Locality; Loc. no. 81 (rare).

Subfamily Milthinae Chavan, 1969
Genus *Anodontia* Link, 1807
Anodontia stearensiana (Oyama, 1954)
Figs. 12-2a–2b.

1927, *Loripes philippiana*, Yokoyama, 434, pl. 50, figs. 1-2.
1935, *Anodontia bialata*, Otuka, 892, pl. 56, figs. 153-154.
1954, *Lucina* (*Lucina*) *stearensiana* Oyama, *in* Taki and Oyama, 40, pl. 47, figs. 1-2.
1961, *Anodontia stearensiana*, Hayasaka, 39, pl. 4, fig. 4.
1973, *Anodontia stearensiana*, Oyama, 95, pl. 40, figs. 1-2.
1977, *Anodontia stearensiana*, Omori, pl. 1, fig. 2.
1977, *Anodontia stearensiana*, Habe, 128-129, pl. 23, fig. 13.
1981, *Anodontia stearensiana*, Kira, 134, pl. 53, fig. 7.
1985, *Anodontia stearensiana*, Matsuura, pl. 32, fig. 25.
1990, *Anodontia stearensiana*, Baba, 267, pl. 31, fig. 1.

Remarks; Only one immature specimen was collected and is swollen shell with concentric growth lines, elongated anterior muscle scar and indistinct cardinal teeth.

Locality; Loc. no. 109 (rare).

Genus *Wallucina* Iredale, 1930
Wallucina sp.
Figs. 16-2a–2b.

Remarks; Only one small specimen was collected and is defined by small shell with concentric growth lines, small lunule, and fine crenulations on inner ventral margin.

Locality; Loc. no. 81 (rare).

Family Chamidae Lamarck, 1809
Genus *Chama* Linnaeus, 1758
Chama sp.
Fig. 16-10.

Remarks; Thick subrounded shell with irregular radial riblets crossed with concentric growth lines. Hinge structure is incomplete.

Locality; Loc. no. 81 (rare).

Family Carditidae Fleming, 1828
Subfamily Carditinae Fleming, 1828
Genus *Cardita* Bruguière, 1792
Cardita leana Dunker, 1860
Figs. 12-8–9.

1860, *Cardita leana* Dunker, 223. (*fide* Hayasaka, 1961)
1871, *Cardita leana*, Lischke, 140.
1954, *Cardita leana*, Taki and Oyama, 38, pl. 11, fig. 15, pl. 12, fig. 1.
1959, *Cardita leana*, Yamamoto and Habe, 85, pl. 12, fig. 20.
1961, *Cardita leana*, Hayasaka, 36-37, pl. 3, figs. 2a-b.
1993, *Cardita leana*, Okumura and Takei, pl. 36, fig. 8.

Remarks; The synonymous list was already made by Noda (1991) and is defined by small obliquely elongated shell with distinct radial ribs on posterior and finer riblets on anterior parts.

Locality; Loc. no. 88 (rare).

Subfamily Venericardiinae Chavan, 1969
Genus *Glans* Megerle von Mühlfeld, 1811
Glans granulosus Noda, n. sp.
Figs. 12-3a－4b.

Description; Shell medium in size, subrounded and inequilateral. Anterior part slightly narrower than posterior. External surface sculptured with 21-23 narrowly elevated radial ribs being squirt in cross section. Radial ribs on posterior become narrower than those of middle to anterior ones. Granular structure on radial ribs rather distinct. Interstitial of radial ribs narrow and sculptured with concentric growth lines. Beak situated anteriorly and pointed. Cardinal teeth distinct and lateral teeth narrowly elongated. Inner ventral margin crenulated according to external radial ribs. Lunule small and deeply depressed in heart shape.

Measurements (in mm);

Holotype IGUT no. 12354, Length 16.3, Height 16.8, Depth 6.8

Paratype IGUT no. 12353, Length 13.4, Height 14.3, Depth 5.4

Comparison and affinities; The present new species is characterized by its high shell and small number of narrowly elevated radial ribs (21-23) with distinct granules. The present new species resembles *Cyclocardia millegrana* Nomura and Zinbo (1934) described from the Ryukyu Limestone in Kikaijima (1936) in shell form and number of radial ribs but the new species is distinguished from the latter in having distinct granules on the radial ribs and more swollen shell. *G. sagamiensis* is more elongated.

Localities; Loc. no. 81 (rare).

Family Crassatelliidae Ferussac, 1822
Genus *Nipponocrassatella* Kuroda and Habe, 1971
Nipponocrassatella nana (Adams and Reeve, 1850)
Figs. 12-5a－7b.

1850, *Crassatella nana* Adams and Reeve, 15, pl. 23, fig. 2. (*fide* Noda, 1980)
1920, *Crassatella hetroglypta*, Yokoyama, 141, pl. 11, figs. 11-12.
1922b, *Crassatella hetroglypta*, Yokoyama, 164, pl. 13, fig. 8.
1927, *Crassatella hetroglypta*, Yokoyama, 134, pl. 49, fig. 11.
1935, *Crassatellites nanus*, Otuka, 889, pl. 56, figs. 146-147.
1936, *Crassatellites nanus*, Nomura and Zinbo, 339, pl. 11, figs. 6a-6b.
1954, *Crassatellites* (*Crassatellites*) *nanus*, Taki and Oyama, 38, pl. 12, figs. 10-11, pl. 33, fig. 8, pl. 46, fig. 11.
1961, *Crassatellites nanus*, Hayasaka, 36, pl. 3, fig. 3.
1967, *Crassatellites nanus*, Habe and Kosuge, 141, pl. 53, figs. 4-5.
1973, *Crassatellites* (*Nipponocrasatella*) *nana*, Oyama, 90, pl. 37, figs. 5, 8-10.
1980, *Crassatellites* (*Crassatellites*) *nanus*, Noda, 86-87.
1981, *Crassatellites nanus*, Kira, 130, pl. 52, fig. 13.
1984, *Crassatellites nanus*, Nohara and Miyagi, pl. 1, fig. 9.
1985, *Crassatellites* (*Nipponocrasatella*) *nana*, Matsuura, pl. 32, fig. 24.
1986, *Crassatellites nanus*, Takayasu *et al.*, pl. 62, fig. 12.
1988, *Nipponocrasatella nana*, Yoon, pl. 1, figs. 22-23.
1990, *Crassatella nana*, Baba, 276, pl. 32, fig. 12.
1991, *Eucrasatella nana*, Chen *et al* pl. 2, fig. 6a-6b.
1991, *Eucrasatella* (*Nipponocrasatella*) *nanus*, Noda, 25-26, figs. 11-1a-1b, 4a－b.

Remarks; The present species is distinguished from *Nipponocrassatella takanabensis* (Shuto, 1957) in having higher shell and distinct posterior depressed area. Noda (1991) already made the synonym list of the species. There are some allied species described from the Shinzato Formation as *N. kotakai* and *N. quadrata* but these are distinguished from the present species in having more swollen and wide posterior part. There are some variations in the shell form as high trigonal form (Figs. 14-7a－7b) with narrow apical angle to elongated trigonal form (Figs. 12-5a－7b, Figs. 14-5a－6b). Both types are associated in occurrence as like the Nobori Formation (Aoki and Baba, 1984a).

Locality; Loc. no. 81 (dominant), no. 84 (dominant).

Family Cardiidae Lamarck, 1809
Subfamily Trachycardiinae Stewart, 1930
Genus *Vasticardium* Iredale, 1928
Subgenus *Vasticardium* Iredale, 1928
Vasticardium (*Vasticardium*) *burchardi* (Dunker, 1877)
Figs. 13-8a–8c.

1877, *Cardium burchardi* Dunker, 67. (*fide* Kuroda *et al.*, 1971)
1882, *Cardium burchardi*, Dunker, 210-211, pl. 18, figs. 4-6. (*fide* Kuroda *et al.*, 1971)
1906, *Cardium tokyoensis*, Tokunaga, 51, pl. 3, fig. 12.
1922b, *Cardium burchardi*, Yokoyama, 153, pl. 12, fig. 3.
?1926, *Cardium burchardi*, Yokoyama, 134, pl. 19, figs. 3-4.
1928a, *Cardium burchardi*, Yokoyama, 84, pl. 9, fig. 7.
1936, *Cardium* (*Trachycardium*) *burchardi*, Nomura and Zinbo, 243.
1951, *Vasticardium* (*Vasticardium*) *burchardi*, Habe, 145, figs. 331-332.
1954, *Acrosterigma* (*Vasticardium*) *burchardi*, Taki and Oyama, 42, pl. 32, fig. 3.
1958, *Trachycardium burchardi*, Makiyama, pl. 37, figs. 3-4.
1961, *Vasticardium* (*Vasticardium*) *burchardi*, Hayasaka, 41, pl. 42, figs. 13a-b.
1968, *Vasticardium* (*Vasticardium*) *burchardi*, O'Hara, 72, pl. 9, fig. 9.
1971, *Vasticardium burchardi*, Kuroda *et al.*, 399, 620, pl. 39, fig. 4.
1971, *Laevicardium* sp., Noda, 41, pl. 7, fig. 11.
1973, *Acrosterigma* (*Vasticardium*) *burchardi*, Oyama, 99, pl. 42, fig. 9.
1977, *Trachycardium* (*Vasticardium*) *burchardi*, Habe, 165, pl. 32, figs. 1-2.
1981, *Vasticardium burchardi*, Kira, 135, pl. 53, fig. 16.
1990, *Vasticardium burchardi*, Baba, 277, pl. 32, fig. 5.
1993, *Vasticardium burchardi*, Okumura and Takei, 174, pl. 37, figs. 1a-b.

Remarks; The present species has 40-43 distinct radial ribs. In particular, the posterior ten radial ribs carry distinct spines. *Vasticardium arenicola* (Reeve) and *V. enode* (Sowerby) are distinguished from the present species in having more characteristic spines on anterior part and wide, flat-topped radial ribs. Akutsu (1964) renamed the specimen described under the present species from the Miocene Kanomatazawa Formation in Tochigi Prefecture by Yokoyama (1926) as *Vasticardium arenicoloides*.

Accordingly, the present species is restricted from only Pliocene to Recent.

Localities; Loc. no. 81 (rare), no. 84 (rare), no. 87 (few), no. 88 (few), 109 (rare).

Subfamily Fraginae Stewart, 1930
Genus *Lunulicardia* Gray, 1853
Lunulicardia subretusa (Sowerby, 1840)
Figs. 13-3a–5b.

1840, *Cardium subretusa* Sowerby (*non vidi*)
1844, *Cardium hemicardium*, Reeve, pl. 7, fig. 38. (*non vidi*)
1858, *Cardium guichardi*, Bernardi, 53, pl. 2, fig. 4. (*non vidi*)
1927, *Cardium* (*Fragum*) *guichardi*, Bernardi, 122-123, pl. 241, figs. 112-113. (*non vidi*)
1928a, *Hemicardium hemicardium*, Yokoyama, 84, pl. 9, fig. 10.
1936, *Cardium* (*Fragum*) *hemicardium*, Nomura and Zinbo, 243.
1941, *Cardium guichardi*, Hatai, pl. 61, figs. 4-6.
1977, *Lunulicardia subretusa*, Habe, 168, pl. 32, figs. 3, 4.

Remarks; The present species has cordite quadrilateral shell, distinct ridge along the posterior part from umbo to ventral corner, 22-23 flat topped radial ribs separated by linear grooves with tubercles on anterior to middle part of shell and narrow radial ribs on posterior part. The cardinal tooth obliquely inclined and both lateral teeth are small. The ventral margin is crenulated. No lunule is developed. *Cardium tumoriferum* Lamarck is probably synonym with the present species. *Hemicardium fragum* is distinguished from the species in having subquadrate shell form. *Lunulicardia retusa* (Kira, 1981) resembles the present species but the latter has deep interspaces, subrounded posterior ridge and swollen umbonal part.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Genus *Fragum* Röding, 1798
Fragum alfuricum (Fischer, 1927)
Figs. 13-1–2b.

1927, *Cardium* (*Fragum*) *alfuricum* Fischer, 123, pl. 216, fig. 11.
1933, *Cardium* (*Fragum*) *alfuricum* (Fischer), Nomura, 80, pl. 3, fig. 22.

Remarks; Up to date, the present fossil species was recorded only from the Pliocene of Serra in Timor (Fischer, 1927) and Byoritsu Bed in Formosa (Nomura, 1933). The species is defined by inequilateral shell, distinct posterior ridge running from near beak to posterior ventral corner, 33-35 squarish radial ribs with scaly tubercles particularly on anterior, two small cardinal teeth under the beak, and crenulated ventral margin. The present species resembles *Fragum adamsi* (Adams and Reeve) but the latter has no distinct scaly tubercles on radial ribs.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Family Laevicardiinae Keen, 1936
Genus *Laevicardium* Swainson, 1840
Laevicardium biradiatum (Bruguière, 1798)
Figs. 13-9a—10b.

1789, *Cardium biradiatum* Bruguière (*fide* Nomura, 1936).
1844, *Cardium biradiatum*, Reeve, pl. 10, fig. 49.
1933, *Cardium* (*Laevicardium*) *biradiatum*, Nomura, 76, pl. 4, fig. 17.
1936, *Cardium* (*Laevicardium*) *biradiatum*, Nomura and Zinbo, 243, pl. 11, figs. 13a-b.
1941, *Cardium biradiatum*, Hatai, 71, pl. 35, figs. 6, 9.
1966, *Laevicardium biradiatum*, Habe and Kosuge, 154, pl. 59, fig. 11.
1971, *Laevicardium* sp., Noda, pl. 7, fig. 11.
?1984, *Laevicardium* (*Laevicardium*) *attenuatum*; Nohara and Miyagi, pl. 2, figs. 3a—3b.

Remarks; The present species is characterized by narrow umbonal area, small cardinal teeth, distinct lateral teeth, 40 flat-topped radial ribs with no scales. The present species is distinguished from *Laevicardium rubropictum* Habe and Kosuge in its longer shell form, rather swollen shell, and more distinct radial ribs. *Laevicardium* sp. reported from the Nakoshi Formation under the name of *Laevicardium* sp. (Noda, 1971) is referred to the present species.

Localities; Loc. no. 81 (rare), no. 84 (rare).

Genus *Fulvia* Gray, 1853
Fulvia sp.
Figs. 13-6-7.

Remarks; The present species resembles *Fulvia tenuicostata* (Lamarck) and *Fulvia mutica* (Reeve) but remained unnamed because of ill preservation. *Fulvia* sp. (Noda, 1971, 41-42, pl. 7, fig. 8, Loc. 109) recorded from the same formation is same with the present unnamed species.

Localities; Loc. no. 81 (rare), no. 87 (rare), no. 114 (few).

Family Mactridae Lamarck, 1809
Subfamily Lutraiinae H. and A. Adams, 1856
Genus *Lutraria* Lamarck, 1799
Subgenus *Psamophila* Brown, 1827
Lutraria (*Psamophila*) *sieboldi* Deshayes, 1854
Figs. 14-11a—11b.

1854, *Lutraria sieboldii* Reeve (sic), sp. 15. (*fide* Kuroda *et al.*, 1971)
1855, *Lutraria sieboldi*, Reeve, pl. 4, fig. 15. (*non vidi*)
1920, *Lutraria radiata*, Yokoyama, 110, pl. 7, figs. 11a-b.
1927a, *Lutraria sieboldi*, Yokoyama, 429, pl. 49, figs. 8-9.
1954, *Lutraria sieboldi*, Taki and Oyama, 46, pl. 8, figs. 11a-b, pl. 46, figs. 8a-b.
1961, *Lutraria sieboldi*, Hayasaka, 53-54, pl. 6, figs. 4a-b.
1967, *Lutraria sieboldi*, Habe and Kosuge, 158, pl. 59, fig. 12.
1971, *Lutraria* (*Psamophila*) *sieboldi*, Kuroda *et al.*, 672, 439, pl. 97, figs. 7-8.
1977, *Lutraria* (*Psamophila*) *sieboldi*, Habe, 183, pl. 35, fig. 3.
1981, *Lutraria sieboldi*, Kira, 150, pl. 58, fig. 5.
1990, *Lutraria sieboldi*, Baba, 281-282, pl. 33, fig. 9.
1994, *Lutraria sieboldi*, Masuda and Huang, pl. 1, fig. 30.

Remarks; The present species is rather common in the Nakoshi Formation and is characterized by its elongated shell with small spoon like chondrophore before the cardinal tooth. *Lutraria lucida* and *L. radiata* are included to the present species as synonymous one by Kuroda *et al.* (1971).

Localities; Loc. no. 81 (rare), no. 84 (rare), no. 87 (rare), no. 88 (few).

Family Tellinidae de Blainville, 1814
Subfamily Tellininae Blainville, 1814
Genus *Tellinella* Mörch, 1853

Tellinella verrucosa (Hanley, 1844)
Figs. 14-1a−1b.

1844, *Tellina verrucosa* Hanley. (*fide* Nomura, 1933)
1847, *Tellina verrucosa*, Sowerby, pl. 68, fig. 77. (*fide* Nomura, 1933)
1867, *Tellina verrucosa*, Sowerby, pl. 19, fig. 96. (*fide* Nomura, 1933)
1871, *Tellina verrucosa*, Roemer, 23, pl. 9, figs. 1-3. (*fide* Nomura, 1933)
1933, *Tellina verrucosa*, Nomura, 102, pl. 4, fig. 21.

Remarks; The present species is characterized by elliptically elongated form with narrowly rostrated posterior side, small dotted beads along the growth lines particularly in anterior and posterior sides, keel along the posterior margin from near beak to posterior ventral corner, and deeply sinuate pallial line. The present species is distinguished from *Tellinella pulcherrima* (Matsukuma, 1984) by its distinct posterior keel and rostrated posterior part. *Tellinella squammulosa* is another allied species but the species has more higher shell and widely rounded posterior border.

Measurement (in mm); Length 34.1, Height 16.9, Width 4.6.

Localities; Loc. no. 81 (rare), no. 87 (rare).

Subfamily Macominae Olsson, 1961
Genus *Macoma* Leach, 1819
Subgenus *Macoma* Leach, 1819
Macoma (*Macoma*) *praetexta* (Martens, 1865)
Fig. 14-10.

1971, *Macoma* (*Macoma*) *praetexta*, Noda, 42, pl. 7, fig. 2.
1977, *Macoma* (*Macoma*) *praetexta*, Habe, 209, pl. 42, figs. 5-6.
1998, *Macoma praetexta*, Okumura and Ueda, 81, pl. 14, fig. 7.

Remarks; Only one conjoined specimen was collected. The present species was once recorded from this formation by Noda (1971, p. 42, pl. 7, fig. 12).

Locality; Loc. no. 109 (rare).

Family Psammobiidae Fleming, 1828
Subfamily Psammobiinae Fleming, 1828
Genus *Grammatomya* Dall, 1898
Grammatomya squamosa (Lamarck, 1818)
Figs. 14-3−4.

1818, *Psammobia squamosa* Lamarck, 176. (*non vidi.*)
1848, *Psammobia rugulosa*, Adams and Reeve *(non vidi.)*
1857, *Psammobia squamosa*, Reeve, pl. 7, fig. 50. (*fide* Habe, 1977)
1974, *Gari* (*Grammatomya*) *squamosa*, Habe, 135, pl. 61, fig. 2.

Remarks; The present species is uncommon in fossil record. The species is characterized by its oblique striations crossed fine growth lines on middle to anterior part of external surface, and 11-13 radial ribs on posterior part, wide and deep pallial sinus, and crenulations on posterior internal margin. *Grammatomya plulcherrina* resembles the species but the former has more elongated shell, finer transverse striations, and roundly elevated radial ribs in immature stage.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Family Solecurtidae d'Orbigny, 1846
Genus *Solecurtus* Blainville, 1824
Solecurtus divaricatus (Lischke, 1869)
Fig. 14-12.

1869, *Macha divaricata* Lischke, 108-109.
1869, *Macha divaricata* Lischke, 142, pl. 10, figs. 1-2.
1882, *Macha divaricata*, Dunker, 175, pl. 7, fig. 26. (*non vidi*)
1888, *Solecurtus divaricatus*, Clessin in Martin and Chemnitz, 87, pl. 21, fig. 4. (*fide* Kuroda *et al.*,1971)
1906, *Macha divaricata*, Tokunaga, 36, pl. 2, fig 20.
1920, *Solecurtus divaricatus*, Yokoyama, 112, pl. 7, fig. 14.
1952, *Solecurtus divaricatus*, Habe, 206, figs. 494-495.
1961, *Solecurutus divaricatus*, Hayasaka, 56, pl. 7, figs. 3a-b.
1967, *Solecurtus divaricatus*, Habe and Kosuge, 160, pl. 60, fig. 20.
1968, *Solecurtus divaricatus*, O'Hara, 86, pl. 16, fig. 5.
1971, *Solecurtus divaricatus*, Kuroda *et al.*, 444-445, 680, pl. 99, fig. 7.
1973, *Solecurtus divaricatus*, Oyama, 111, pl. 54, fig. 7.
1977, *Solecurtus divaricatus*, Habe, 224, pl. 47, figs. 7-8.
1977, *Solecurtus divaricatus*, Matsuura, pl. 5, fig. 3.
1978, *Solecurtus divaricatus*, Kanno *et al.*, pl. 4, fig. 1.
1979, *Solecurtus divaricatus*, Mori and Nagata, pl. 13, fig. 10.
1981, *Solecurutus divaricatus*, Kira, 152, pl. 58, fig. 23.
1988, *Solecurtus divaricatus*, Mizuno and Amano, pl. 14,

fig. 14.
1990, *Solecurtus divaricatus*, Baba, 290, pl. 35, figs. 13a-b.
1993, *Solecurtus divaricatus*, Noda *et al.*, 158, figs. 19—1-2.
1994a, *Solecurtus divaricatus*, Masuda and Huang, pl. 1, fig. 35.
1995, *Solecurtus divaricatus*, Nakao, pl. 1, figs. 1-2.
1998, *Solecurtus divaricata*, Ozawa *et al.*, 113, pl. 30, fig. 2.
1998, *Solecurtus divaricata*, Okumura and Ueda, 81, pl. 15, fig. 1.

Remarks; The present species is frequently recorded from the late Neogene to Pleistocene formations in the middle to southwestern parts of Japan. *Solecurtus dunkeri* and *S. wilsoni* resemble the present species but are distinguished from the present species in having more dense oblique striations.

Localities; Loc. no. 81 (rare), no. 87 (rare), 88 (rare).

Genus *Azorinus* Recluz, 1869
Azorinus abbreviatus (Gould, 1861)
Figs. 14-8a—9b.

1861, *Solecurtus abbreviatus* Gould (*fide* Shuto, 1971)
1920, *Solecurtus abbreviatus*, Yokoyama, 11, pl. 7, figs. 12a-13b.
1928a, *Solecurtus abbreviatus*, Yokoyama, 124, pl. 9, fig. 12.
1936, *Solecurtus abbreviatus*, Suzuki and Ichimura, pl. 29, figs. 1-9.
1954, *Azorius abbreviatus*, Taki and Oyama, pl. 8, figs. 12a-13b.
1967, *Azorinus abbreviatus*, Habe and Kosuge, 160, pl. 60, fig. 18.
1968, *Azorinus abbreviatus*, O'Hara, 86, pl. 16, fig. 4.
1970, *Azorinus abbreviatus*, Hayasaka and Hashimoto, 20, pl. 1, figs. 10-11
1971, *Azorinus abbreviatus*, Kuroda *et. al.*, 681, 446, pl. 98, fig. 6.
1973, *Azorinus abbreviatus*, Oyama, 111, pl. 54, figs. 4-5.
1977, *Azorinus abbreviatus*, Habe, 225, pl. 47, figs. 9, 10.
1981, *Azorinus abbreviatus*, Kira, 152, pl. 58, fig. 21.
1985, *Azorinus abbreviatus*, Matsuura, pl. 32, fig. 29.
1986, *Azorinus abbreviatus*, Masuda *et al. in* Sato *et al.*, 34-35, pl. 4, figs. 10-12.
1989, *Azorinus abbreviatus*, Ito, 64, pl.26, fig. 1.
1990, *Azorinus abbreviatus*, Baba, 290-291, pl. 35, fig. 14.
1992, *Azorinus abbreviatus*, Okumura and Yamaguchi, 1021, figs. 3-7, 10.
1994a, *Azorinus abbreviatus*, Masuda and Huang, 393-394, pl. 1, fig. 30.

Remarks; The present species has thin fragile shell with a medial depression on near middle part of the shell, deeply sinuated pallial line and entruded cardinal teeth.

Locality; Loc. no. 88 (few).

Family Solenidae Lamarck, 1809
Genus *Solen* Linnaeus, 1758
Subgenus *Solen* s.s.
Solen (*Solen*) cf. *strictus* Gould, 1861
Fig. 16-11.

Remarks; Imperfect specimens are examined but its slender shell, truncated posterior part and deep pallial sinuation are referred to the species.

Locality; Loc. no. 88 (rare).

Family Veneridae Rafinesque, 1815
Subfamily Venerinae Rafinesque, 1815
Genus *Ventricolaria* Keen, 1954
Subgenus *Ventricoloidea* Sacco, 1900
Ventricolaria (*Ventricoloidea*) *foveolata* (Sowerby, 1853)
Figs. 15-5a—5b, 7.

1966, *Ventricoloidea foveolata*, Aoki, pl. 31, fig. 9.
1977, *Ventricolaria foveolata*, Habe 246, pl. 51, fig. 1.
1986, *Ventricolaria* (*Ventricoloidea*) *foveolata*, Sato *et al., in* Shuto *et al.*, 35-36, pl. 5, figs. 2-4.
1988, *Ventricolaria* (*Ventricoloidea*) *foveolata*, Yoon, pl. 2, figs. 6-7.
1989, *Venus* (*Ventricoloidea*) *foveolata*, Ito, 64, pl. 26, fig. 1.
1990, *Ventricolaria* (*Ventricoloidea*) *foveolata*, Baba, 294, pl. 36, fig. 8.
1991b, *Venus* (*Ventricoloidea*) *foveolata*, Noda, 30, fig. 11-11.
1983, *Venus foveolata*, Aoki and Baba, 55, figs. 48a-b.
1991, *Venus foveolata*, Chen *et al.*, pl. 2, figs. 9a-9b.
1993, *Ventricolaria foveolata*, Nobuhara, fig. 8-8.
1993, *Venus* (*Ventricoloidea*) *foveolata*, Katto and Masuda, 13, pl. 5, figs. 5a-b.
1994, *Venus foveolata*, Masuda and Huang, pl. 2, fig. 8.
1998, *Venus foveolata*, Okumura and Ueda, 79-80, pl. 13, fig. 7.

Description; The present species was discussed by Noda (1991b) and the synonymous

list was also mentioned up to 1991. After the description of Noda (1991b), the above cited papers recorded the present species. Shell medium in size, sub-rounded in form somewhat produced anteriorly. Anterior margin well rounded and posterior part somewhat angulated. Ventral margin well rounded. Beak small prominent, turned anteriorly and situated at near one-third anteriorly. Escutcheon narrow, lunule rather wide with concentric growth lines. External surface sculptured with concentric lamellae. Anterior cardinal tooth in three cardinal teeth on left valve bipartite, middle one obliquely and posterior one long. Cardinal socket rather deep. Both anterior and posterior muscle scars well impressed in subround. Pallial sinus rather wide and shallow. Internal margin crenulated finely.

Measurements (in mm);

IGUT no. 12383, Length 26.1 Height 23.3 Depth 7.8

IGUT no. 12382, Length 15.6 Height 14.9 Depth 4.5

Comparison; The present species is identical *Venus* (*Ventricoloidea*) *foveolata* Sowerby in having similar cardinal teeth, external sculptures and has regular concentric lamellae like structure. *V. (V.) treuma* differs from the present species in having more indistinct concentric lamellae.

Localities; Loc. no. 81 (rare), no. 87 (rare), no. 88 (rare).

Genus *Periglypta* Jukes-Brown, 1914
Subgenus *Tigammona* Iredale, 1930
Periglypta (*Tigammona*) *chemnitzi* (Hanley, 1844)
Fig. 15-12.

1977, *Periglypta* (*Tigammona*) *chemnitzi*, Habe, 247, pl. 51, figs. 8, 9.

Remarks; The external surface is reticulated by crossing of concentric fine lamellae like structure and fine radial ribs. The present species resembles *P.* (*P.*) *resticulata* Reeve but it differs from the latter in having elongated shell with lamellated growth line, and narrowly rounded pallial line.

Localities; Loc. no. 84 (rare), no. 87 (rare).

Subfamily Chioninae Frizzel, 1936
Genus *Glycydonta* Cotton, 1936
Glycydonta marica (Linnaeus, 1758)
Figs. 15-3a–4b.

1758, *Venus marica* Linnaeus, 685.
1863, *Venus marica*, Reeve, 104. (*fide* Kuroda *et al.*, 1971)
1951, *Leukoma marica*, Habe, figs. 393, 399.
1967, *Glycydonta marica*, Habe and Kosuge, 155, pl. 58, fig. 14.
1971, *Glycydonta marica japonica*, Kuroda *et al.*, 430, 662, pl. 93, fig. 4.
1977, *Glycydonta marica*, Habe, 250, pl. 53, figs. 1-2.
1981, *Glycydonta marica*, Kira, 147, pl. 57, fig. 18.
1993, *Glycydonta marica*, Noda *et al.*, 161, figs. 18-1a–2b, 20-3a–b.

Remarks; All specimens collected are immature form and resembles *G. marica japonica* Kira in having reticulated sculpture on external surface, but the latter has distinct scaly structure on posterior part.

Locality; Loc. no. 87 (few).

Genus *Placamen* Iredale, 1925
Placamen tiara (Dillwyn, 1816)
Figs. 15-2a–2b.

1817, *Chione tiara* Dillwyn, 162. (*fide* Kuroda *et. al.*, 1971)
1846, *Venus foliacea*, Philippi, 107, pl. 5, fig. 1. (*fide* Kuroda *et al.*, 1971)
1855, *Venus tiara*, Sowerby, 722, pl. 158, figs. 125-130. (*non vidi*)
1863, *Venus tiara*, Reeve, sp. vol. 14, 109, pl. 23, figs. 109-110. (*non vidi*)
1869, *Venus isabellum*, Pfeifferi, 133, pl. 7, figs. 9-11. (*non vidi*)
1869, *Venus isabellum*, Martin and Chemnitz, 194, pl. 25, fig. 9. (*non vidi*)
1906, *Venus foliacea*, Tokunaga, 46 pl. 3, fig. 3.
1920, *Chione isabellina*, Yokoyama, 121, pl. 8, fig. 13.
1928a, *Chione foliacea*, Yokoyama, 80, pl. 7, fig. 7.
1941, *Venus tiara*, Hatai, pl. 48, figs. 2, 4, 5.
1951, *Placamen tiara*, Habe, 175, figs. 376-377.
1954, *Clausinella* (*Placamen*) *tiara*, Taki and Oyama, 44, pl. 9, fig. 13.
1958, *Placamen tiara*, Habe, 37, pl. 2, fig. 7.
1959, *Placamen tiara*, Tsuchi, pl. 8, fig. 28.
1960, *Placamen tiara*, Shuto, 142-143, pl. 14, fig. 14.

1961, *Placamen tiara*, Hayasaka, 47, pl. 4, figs. 11a-b.
1967, *Placamen tiara*, Habe and Kosuge, 155, pl. 58, fig. 18.
1968, *Placamen tiara*, O'Hara, 74, pl. 110, fig. 10.
1971, *Placamen tiara*, Kuroda *et al.*, 660, 429, pl. 93, figs. 8-9.
1973, *Claisinella* (*Placamen*) *tiara*, Taki and Oyama, 104, pl. 47, fig. 9.
1974, *Claisinella* (*Placamen*) *tiara*, Omori, pl. 51, figs. 5, 9.
1978, *Placamen tiara*, Kanno *et al.*, pl. 2, fig. 5.
1981, *Placamen tiara*, Kira, 147, pl. 57, fig. 20.
1986, *Placamen tiara*, Takayasu, *et al.*, pl. 61, fig. 1.
1988, *Placamen tiara*, Matsukuma and Yoosukh, 574-575, pl. 2, figs. 1-4.
1989, *Placamen tiara*, Ito, 65, pl. 26, fig. 7.
1990, *Placamen tiara*, Masuda, 294-295, pl. 36, fig. 9.
1990, *Placamen tiara*, Baba, 294-295, pl. 36, figs. 9a-b.
1993, *Placamen tiara*, Noda *et al.*, 159-161, figs. 21-9a-b.
1993, *Placamen tiara*, Majima and Honme, fig. 5-4.
1993, *Placamen tiara*, Okumura and Takei, pl. 39, fig. 3.
?1993, *Placamen isabellina*, Katto and Masuda, 13, pl. 5, figs. 6a-b.

Remarks; The present species is common in the tropical to subtropical seas in the low latitudes. Only a small shell is collected, but is well identical with the named species by concentric and laminated plicae.

Locality; Loc. no. 87 (rare).

Subfamily Circinae Dall, 1898
Genus *Circe* Schumacher, 1817
Subgenus *Circe* Schumacher, 1817
Circe (*Circe*) *scripta* (Linnaeus, 1758)
Figs. 15-6a—6c, 8a—8b.

1758, *Venus scripta* Linnaeus, 689.
1851, *Circe scripta*, Sowerby, 1, pl. 139, figs. 38-43. (*non vidi*)
1928a, *Circe scripta*, Yokoyama, 81-82, pl. 8, figs. 7-8.
1928c, *Circe scripta*, Yokoyama, pl. 20, fig. 2.
1929, *Placamen tiara*, Yokoyama, 123, pl. 8, figs. 15-16.
1971, *Circe* (*Circe*) *scripta*, Kuroda *et al.*, 413, 640, pl. 90, fig. 6.
1977, *Circe* (*Circe*) *scripta*, Habe, 253, pl. 52, figs. 10-11.
1981 *Circe scripta*, Kira, 146, pl. 57, fig. 7.
1995, *Circe* (*Circe*) *scripta*, Nakao, pl. 1, figs. 9-10.

Remarks; The shell is subround in form, equivalve, and slightly inequilateral. The beak is small and umbonal area is flat. The external surface is sculptured with narrowly elevated concentric ribs and its interspaces are rather smooth but with fine growth lines. Both anterior and posterior margins are sculptured with fine radial ribs. Three cardinal teeth on right valve, and two in left valve. Lateral teeth is distinct. Lunule narrow, and escutcheon weakly defined. The present species is defined by its flat umbonal part, and fine radial ribs on the sides.

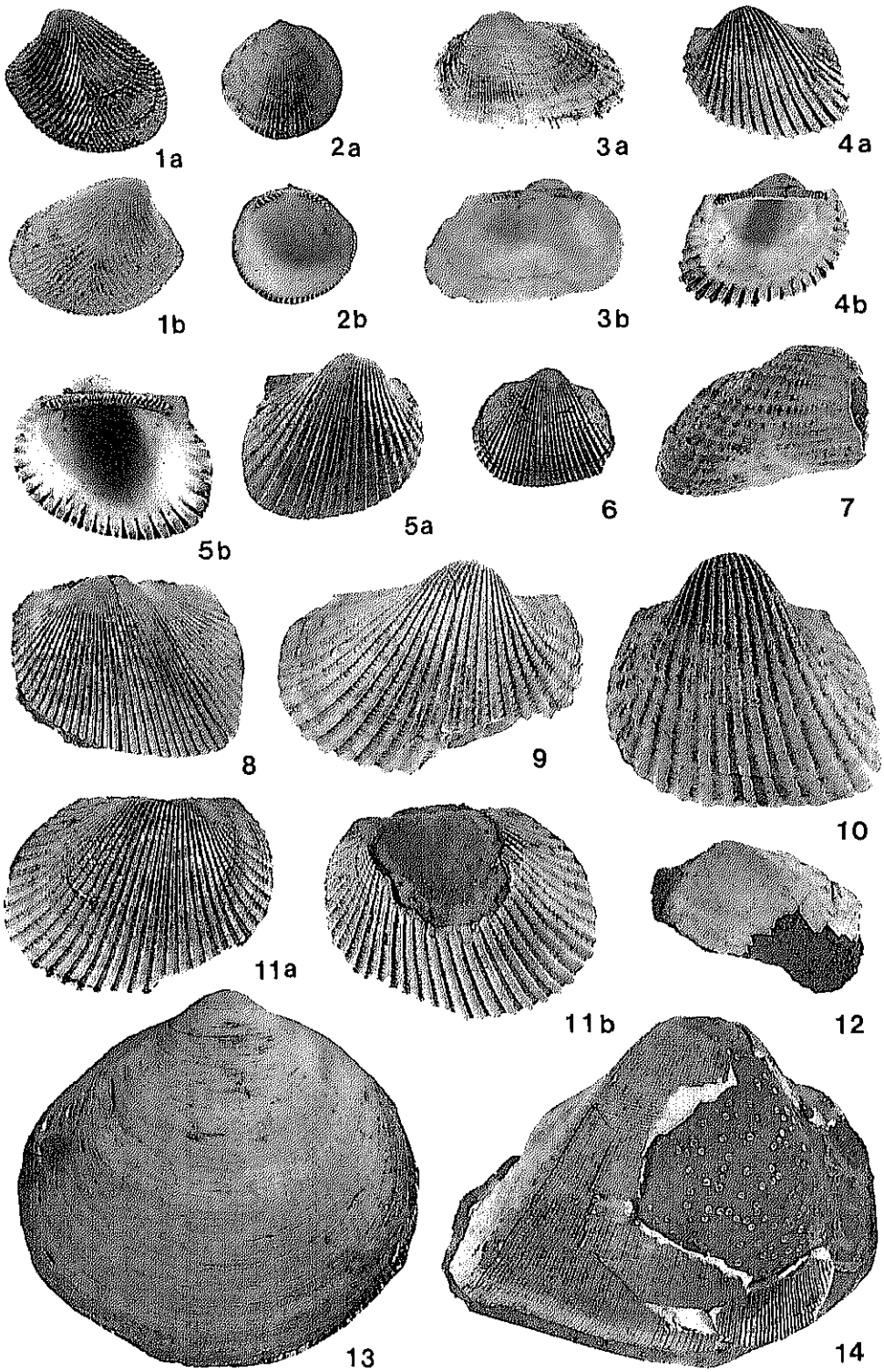
Measurements (in mm); IGUT no. 12384-1, Length 33.6, Height 20.3, Depth 6.8, IGUT no. 12384-2, Length 18.3, Height 16.3, Depth 2.9. Largest specimen (IGUT no. 12385) is Length 46.2, Height 36.0, Depth 9.6, in mm.

Localities; Loc. no. 81 (rare), no. 88 (few).

Subfamily Pitarinae Stewart, 1930
Genus *Pitar* Roemer, 1857
Subgenus *Pitarina* Jukes-Brown, 1913
Pitar (*Pitarina*) *japonicum* Kuroda and Kawamoto, 1956
Figs. 15-13a—14.

1954, *Pitar* (*Agriopoma*) *japonica* (Kuroda), Hirase, pl. 35, fig. 1. (*nomen nudum*)
1956, *Pitar* (*Agriopoma*) *japonicum* Kuroda and Kawamoto, in Kawamoto and Tanabe, 89, figs. 1-4. (Frontispiece).
1960, *Pitar* (*Agriopoma*) *japonicum*, Taki *in* Okada *et al.*, 59, pl. 30, fig. 10.
1961, *Pitar* (*Agriopoma*) *japonica*, Hayasaka, 42-43, pl. 4, figs. 8a—b.
1967, *Pitar* (*Pitarina*) *japonicum*, Habe and Kosuge, 153, pl. 58, fig. 1.
1971, *Pitar* (*Pitarina*) *japonicum*, Kuroda *et al.*, 415, pl. 90, fig. 11.
1974, *Pitar* (*Agriopoma*) *japonica*, Habe, 130, pl. 58, fig. 19.
1986, *Pitar* (*Agriopoma*) *japonica*, Kuroda and Kawamoto, pl. 31, figs. 3-4.

Remarks; The present species was first illustrated by Hirase (1934) with no original description. Thenceafter, Kuroda and Kawamoto (*in* Kawamoto and Tanabe, 1956) described it in association with same figure of Hirase (1934). Hayasaka (1961) first translated their Japanese description to English. When he first recorded the fossil species from the Pleistocene Toshima Sand in Aichi Prefecture, the species is subtrigonal shell with fine concentric growth lines


1a
2a
3a
4a
1b
2b
3b
4b
5b
5a
6
7
8
9
10
11a
11b
12
13
14

and distinct cardinal teeth. The present species is defined by its sub-trigonal shell with smooth growth lines, small beak, depressed lunule restricted by weak line, wide and moderate sinuation, elevated cardinal teeth, and linear lateral teeth. The species resembles *Pitar* (*Pitarina*) *striatus* but the present species has more slender umbonal part and sub-trigonal shell form.

Measurements (in mm);

IGUT no. 12390, Length 28.6, Height 24.1, Depth 9.4.

Localities; Loc. no. 81 (rare), no. 84 (few), 86 (few), no. 88 (rare).

Subgenus *Costellipitar* Habe, 1951
Pitar (*Costellipitar*) cf. *chordatum* (Roemer, 1876)
Figs. 15-10a－10b, 16-1a－1b.

1977, *Costellipitar chordatum*, Habe, 258, pl. 53, figs. 19-21.

Remarks; Only one small specimen which has concentric ribs, small lunule on anterior and three cardinal teeth on left valve, is referred to the species *Pitar chordatum* (Roemer).

Locality; Loc. no. 81 (rare), no. 88 (rare).

Subfamily Dosiniinae Deshayes, 1853
Genus *Pardosinia* Iredale, 1929
Pardosinia amphidesmoides (Reeve, 1850)
Figs. 15-9a－9b.

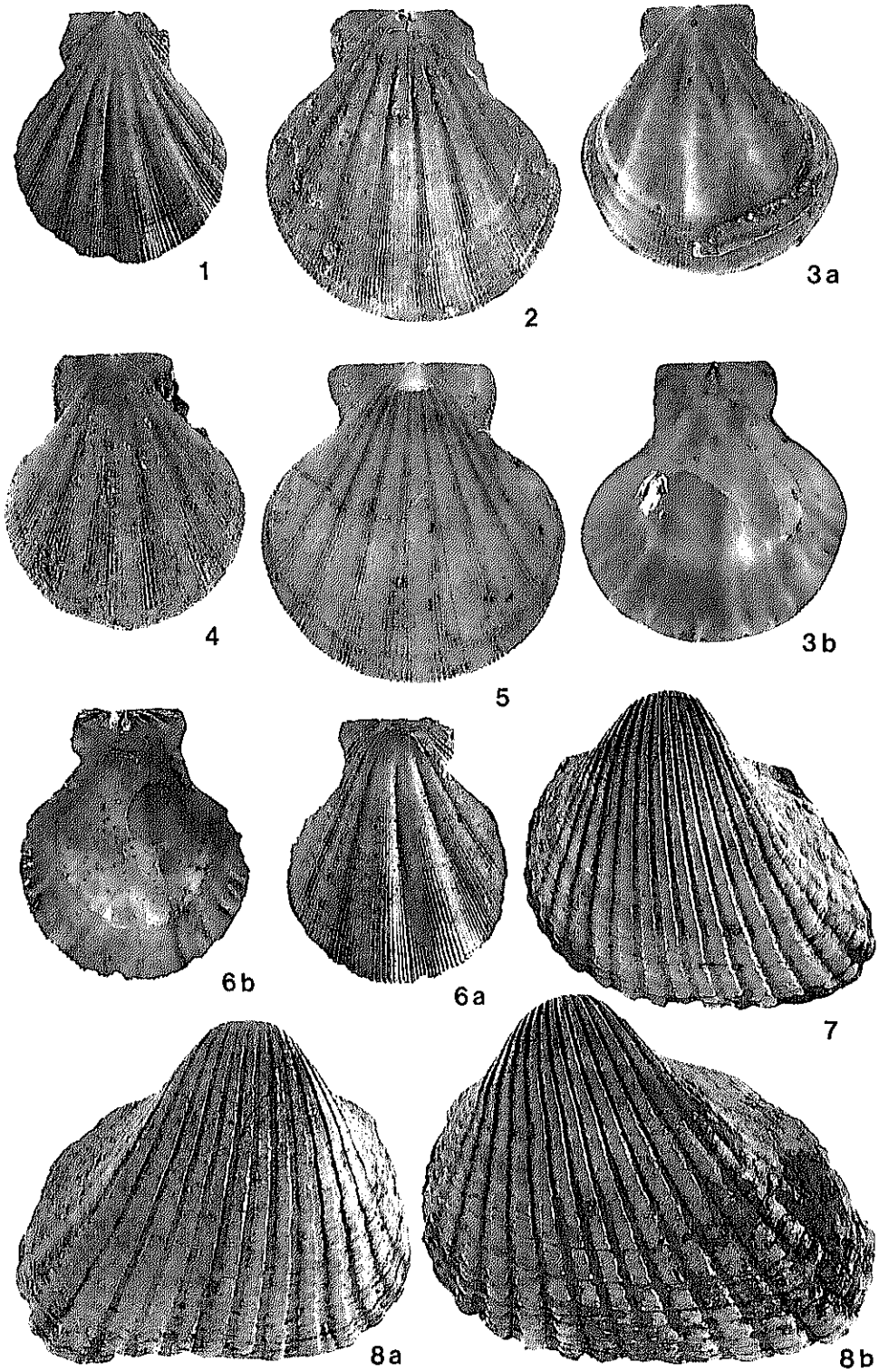
1850, *Artmis amphidesmoides* Reeve, 48, pl. 8, fig. 48. (*fide* Nomura, 1933)
1855, *Artmis amphidesmoides*, Sowerby, 659, pl. 141, fig. 19. (*fide* Nomura, 1933)
1933, *Dosinia amphidesmoides*, Nomura, 96, pl. 4, fig. 18.
1974, *Dosinia* (*Paradosinia*) *amphidesmoides*, Habe, 131, pl. 59, fig. 19.
1986, *Dosinia* (*Paradosinia*) *amphidesmoides*, Masuda *et al.*, *in* Sato *et al.*, 39-40, pl. 5, figs. 9-10.

Remarks; The present species is characterized by its small subround shell with fine concentric growth lines, shortly rounded both dorsal margins, no escutcheon, narrow but distinct longitudinal depressed area along the posterior dorsal margin, and small lunule. The present species is quite characteristic in having a longitudinal depressed area along the posterior dorsal margin and no escutcheon, so it is easily distinguished from the other small subrounded shell among *Dosinia*.

Locality; Loc. no. 81 (rare), no. 87 (rare).

Subfamily Tapetinae H. and A. Adams, 1857
Genus *Paphia* Roeding, 1798
Subgenus *Paphia* Roeding, 1798
Paphia (*Paphia*) *euglypta* (Philippi, 1847)
Figs. 16-5－6.

←Fig. 8
1a-1b. *Acila* (*Acila*) *divaricata* (Hinds).....p. 58
Loc. no. 87, x 2, IGUT coll. cat. no. 12321.
2a-2b. *Tucetilla pilsbryi* (Yokoyama).....p. 65
Loc. no. 87, x 1, IGUT coll. cat. no. 12322.
3a-3b. *Barbatia* (*Abarbatia*) *decussata* (Sowerby).....p. 59
Loc. no. 84, x 1, IGUT coll. cat. no. 12323.
4a-4b, *Anadara* (*Hataiarca*) *takaoensis* (Nomura).....p. 63
Loc. no. 84, IGUT coll. cat. no. 12324.
5a-5b, 10. *Anadara* (*Hataiarca*) *kogachiensis* Noda.....p. 64
5a-5b, Loc. no. 109, x 2, IGUT coll. cat. no. 10727, 10, x 1, Loc. 109, IGUT coll. cat. no. 12327.
6. *Verilarca interplicata* (Grabau and King).....p. 61
Loc. no. 109, x 1.5, IGUT coll. cat. no. 10345.
7. *Barbatia* (*Acar*) cf. *reticulata* (Gmelin)
Loc. no. 81, x 3, IGUT coll. cat. no. 10729.
8. *Anadara* (*Tosarca*) *sedanensis* (Martin).....p. 64
Loc. no. 88, x 1, IGUT coll. cat. no. 12325.
9. *Anadara* (*Scapharca*) *suzukii* (Yokoyama).....p. 61
Loc. no. 81, x 1, IGUT coll. cat. no. 12326.
11a-11b. *Anadara* (*Scapharca*) *taiwanica* Noda.....p. 63
Loc. no. 81, x 1, IGUT coll. cat. no. 12328.
12, *Trisidos* sp. .....p. 61
Loc. no. 87, x 1.5, IGUT coll. cat. no. 12329.
13, *Glycymeris* (*Glycymeris*) *formosana* (Yokoyama).....p. 65
Loc. no. 87, x 1, IGUT coll. cat. no. 12330.
14. *Cucullaea* (*s.s.*) *gramulosa* Jonas.....p. 65
Loc. no. 81, x 0.7, IGUT coll. cat. no. 12331.


1
2
3a
4
5
3b
6b
6a
7
8a
8b

1847, *Venus euglypta* Philippi, 89. (*fide* Kuroda *et. al.*, 1971)
1848, *Venus euglypta*, Philippi, 76, pl. 7, fig. 3. (*fide* Kuroda *et. al.*, 1971)
1864, *Tapes euglypta*, Roemer, 26-27, pl. 8, figs. 1-1b, 80, pl. 29, figs. 1-b. (*non vidi.*)
1874, *Tapes euglypta*, Lischke, 80-82, pl. 6, figs. 8-11.
1906, *Tapes euglypta*, Tokunaga, 50, pl. 3, fig. 8. non 1920, *Paphia* (*Paphia*) *euglypta*, Yokoyama, 152, pl. 12, fig. 8.
1935, *Paphia euglypta*, Otuka, 896, pl. 56, figs, 172-173.
1965, *Paphia euglypta*, Habe and Ito, 135, pl. 45, fig. 7.
1967, *Paphia euglypta*, Habe and Kosuge, 150, pl. 56, fig. 15.
1968, *Paphia* (*Paphia*) *euglypta*, O'Hara, 76, pl. d, fig. 6.
1971, *Paphia euglypta*, Kuroda *et al.*, 652, 423, pl. 92, fig. 2.
1977, *Paphia* (*Paphia*) *euglypta*, Habe, 264, pl. 54 figs. 6-7.
1980, *Paphia euglypta*, Aoki and Baba, fig. 8 (10).
1981, *Paphia euglypta*, Kira, 144, pl. 56, fig. 25.
1985, *Paphia* (*Paphia*) *euglypta*, Matsuura, pl. 32, fig. 22.
1989, *Paphia* (*Paphia*) *euglypta*, Ito, 65, pl. 27, fig. 4.
1990, *Paphia euglypta*, Baba, 300, pl. 37, fig. 12.
1995, *Paphia* (*Paphia*) *euglypta*, Nakao, pl. 7, figs. 3-4.

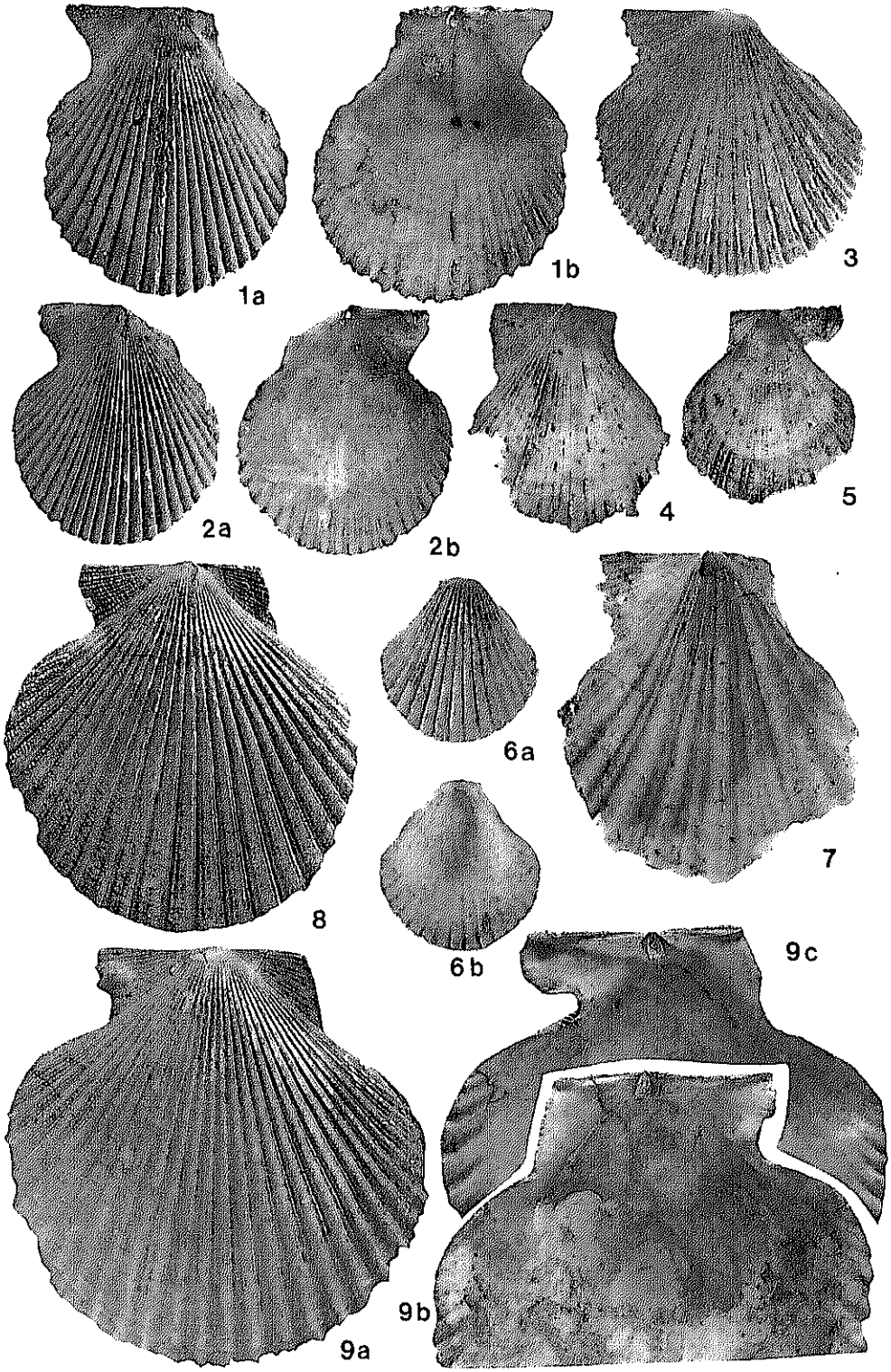
Remarks; The present species resembles *Paphia nagamumanum* Otuka described for the Yokoyama's (1920) *Tapes amabilis* which is distinguished from the present species in having different form of lunule and escutcheon. *Paphia schnelliana* also resembles the present species but the former distinguished from the present species in having much number of concentric ribs. The present species occurs from also the Ryukyu Limestone in Taiwan.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Subfamily Callistinae Nordsieck, 1969
Genus *Callista* Poli, 1791
Subgenus *Callista* Poli, 1791
Callista (*Callista*) *chinensis* (Holten, 1803)
Figs. 16-4a－4b.

1803, *Venus chinensis* Holton, 20. (*fide* Kuroda *et al.*, 1971).
1855, *Cytherea sinensis* Sowerby, 624, pl. 131, figs. 80-81. (*fide* Kuroda *et al.*, 1971).
1864, *Dione chinensis*, Reeve, *Dione*, pl. 1, fig. 4. (*fide* Kuroda *et al.*, 1971).
1864, *Dione festiva*, Reeve, pl. 1, fig. 2. (*fide* Kuroda *et al.*, 1971).
1869, *Cytherea chinensis*, Pfeiffer *in* Martin and Chemnitz, 31, pl. 11, fig. 2. (*non vidi.*)
1869, *Cytherea* (*Callista*) *chinensis*, Roemer, 66, pl. 19, fig. 3. (*non vidi.*)
1906, *Cytherea chinensis*, Tokunaga, 46, pl. 3, figs. 4a－b.
1920, *Meretrix* (*Callista*) *chinensis*, Yokoyama, 120, pl. 8, figs. 9-10.
1922b, *Meretrix* (*Callista*) *chinensis*, Yokoyama, 146, pl. 11, fig. 5.
1928, *Meretrix* (*Macrocallista*) *ezoensis*, Yokoyama, 77, pl. 8, fig. 1. (non *Tapes ezoensis* Yokoyama, 1890).
1935, *Callista pacifica*, Otuka, 895, pl. 56, fig. 181.
1951, *Callista* (*Callista*) *chinensis*, Habe, 164, figs. 372-373.
1954, *Callista* (*Callista*) *chinensis*, Taki and Oyama, 43, pl. 9, figs. 9-10.
1960, *Callista* (*Callista*) *chinensis*, Shuto, 131-132, pl. 13, fig. 2.
1961, *Callista* (*Callista*) *chinensis*, Hayasaka, 43-44, pl. 4, figs. 10a－b.
1965, *Callista chinensis*, Kaseno and Matsuura, pl. 14, fig. 2.
1967, *Callista chinensis*, Habe and Kosuge, 150, pl. 56, fig. 10.
1968, *Callista chinensis*, O'Hara, 76, pl. 11, fig. 5.
1971, *Callista chinensis*, Kuroda *et al.*, 644, 417, pl. 90, fig. 9.
1973, *Callista chinensis*, Oyama, 101, pl. 45, figs. 1-2.
1977, *Callista* (*Callista*) *chinensis*, Habe, 269, pl. 56, fig. 2.
1977, *Callista chinensis*, Matsuura, pl. 9, fig. 9.
1977, *Callista* (*Callista*) *chinensis*, Ogasawara, 116-117, pl. 12, fig. 5.
1979, *Callista chinensis*, Mori and Nagata, pl. 12, fig. 5.
1980, *Callista chinensis*, Aoki and Baba, fig. 18 (18).
1980, *Callista chinensis*, Takayasu, 144, pl. 6, figs. 1a－b.
1980, *Callista chinensis*, Aoki and Baba, fig. 18(18).
1981, *Callista chinensis*, Ogasawara, pl. 1, fig. 3.
1981, *Callista chinensis*, Kira, 141, pl. 56, fig. 3.
1985, *Callista* (*Callista*) *chinensis*, Matsuura, pl. 32, fig. 28, pl. 39, fig. 10, pl. 42, fig. 9.
1986, *Callista chinensis*, Takayasu *et al.*, pl. 23; fig. 20,

←Fig. 9
1-2, 4-5, *Decatopecten amiculum* (Philippi).....p. 69
Loc. no. 84, IGUT coll. cat. no. 12332-12335.
3a-3b, 6a-6b, *Decatopecten striatus* (Schumacher).....
.....p. 68
3a-3b, Loc. no. 87, x 1, IGUT coll. cat. no. 12336, fig 6a-6b, loc. 84, IGUT coll. cat. no. 12337.
7-8b, *Anadara* (*Hataiarca*) *kogachiensis* Noda.....
.....p. 64
Loc. no. 109, x 1, IGUT coll. cat. no. 12327.


1a
1b
3
2a
2b
4
5
6a
8
7
6b
9c
9a
9b

pl. 64, fig. 15, pl. 81, figs. 22, 24a−25b.
1987, *Callista chinensis*, Amano *et al.*, pl. 1, fig. 13.
1989, *Callista chinensis*, Ito, pl. 27, fig. 7.
1990, *Callista chinensis*, Baba, 302, pl. 38, figs. 6a−b.
1993, *Callista* (*Callista*) *chinensis*, Noda *et al.*, 163-164, figs. 21-11a−b.
1993, *Callista chinensis*, Katto and Masuda, 13, pl. 5, figs. 1a−b.
1993, *Callista* (*Callista*) *chinensis*, Okumura and Takei, pl. 39, fig. 9.
1995, *Callista* (*Callista*) *chinensis*, Nakao, pl. 8, figs. 1-2.
1998, *Callista chinensis*, Ozawa *et al.*, 104-105, pl. 26, figs. 10a−b.
2001, *Callista* (*Callista*) *chinensis*, Nakao, pl. 4, figs. 3a−b.

Remarks; The present species is rather common in shallow sandy facies of the Pliocene and Pleistocene formations as cited in synonymous list. The species is elliptical in form with smooth external surface and distinct cardinal teeth.

Localities; Loc. no. 87 (rare), no. 88 (few).

Genus *Saxidomus* Conrad, 1837

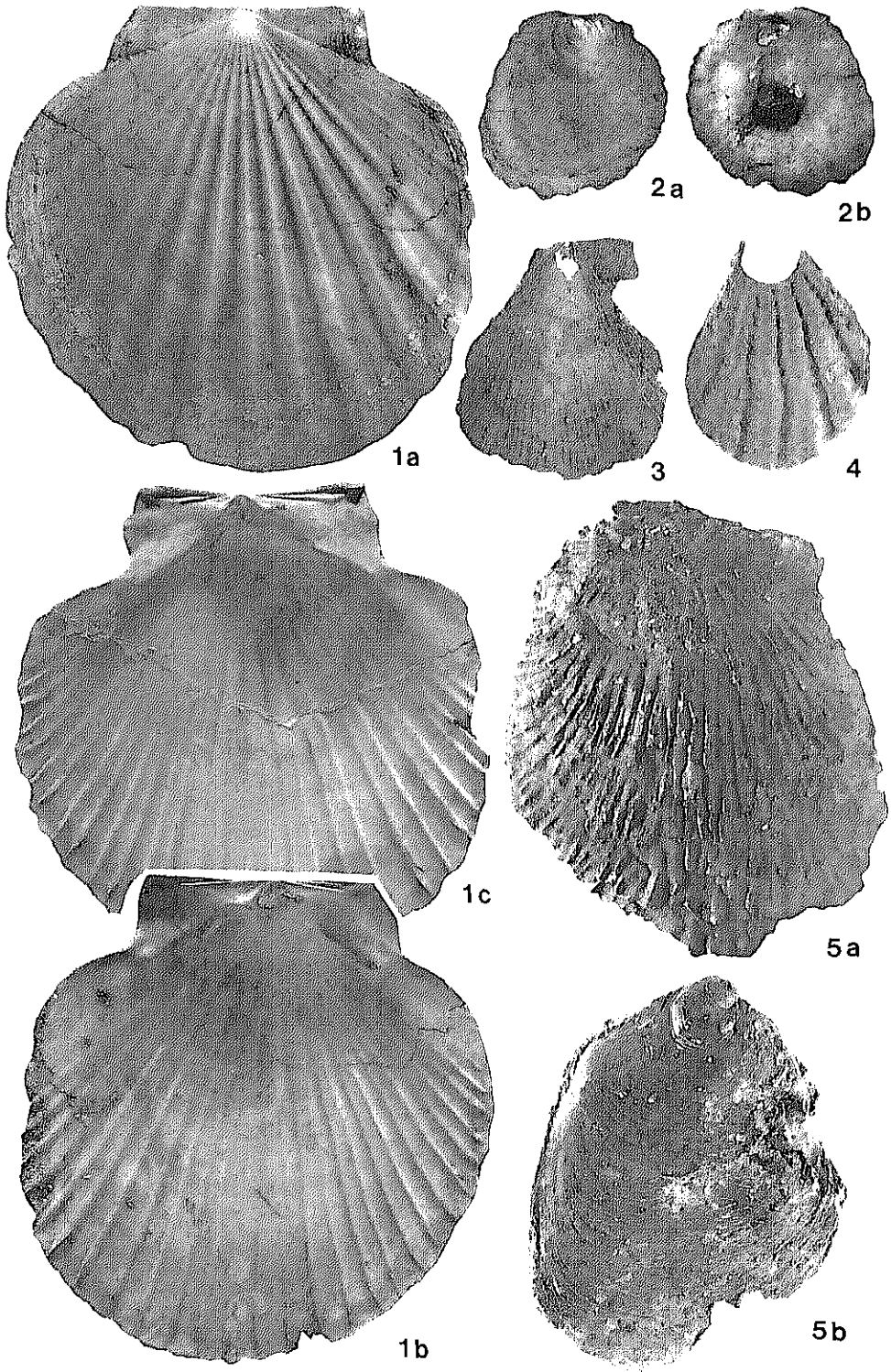
Saxidomus purpuratus (Sowerby, 1852)

1852, *Tapes purpuratus* Sowerby, 692, pl. 150, figs. 124-125. (*fide* Noda, 1972)
1869, *Saxidomus purpuratus*, Lischke, 127, pl. 4 , figs. 4-5.
1881, *Saxidomus purpuratus*, Brauns, 40, pl. 5, fig. 20.
1920, *Saxidomus purpuratus*, Yokoyama, 127, pl. 9, figs. 8-9.
1922b, *Saxidomus purpuratus*, Yokoyama, 153, pl. 12, fig. 9.
1934, *Saxidomus purpuratus*, Kinoshita and Isahaya, 16, pl. 12, fig. 88.
1954, *Saxidomus purpuratus*, Taki and Oyama, 43, pl. 10, figs. 8-9, pl. 32, fig. 9.
1958, *Saxidomus purpuratus*, Ozaki, 128, pl. 23, fig. 1.
1959, *Saxidomus purpuratus*, Yamamoto and Habe, 95, pl. 7 , figs. 7-8.
1960, *Saxidomus purpuratus*, Habe, 7, pl. 3, figs. 1-2.
1962, *Saxidomus purpuratus*, Sawada, 84, pl. 17, fig. 6.
1965, *Saxidomus purpuratus*, Kaseno and Matsuura, pl. 19, fig. 14.
1965, *Saxidomus purpuratus*, Habe and Ito, 138, pl. 46, fig. 5.
1966, *Saxidomus purpuratus*, Sakagami *et al.*, pl. 8, fig. 2.
1967, *Saxidomus purpuratus*, Habe and Kosuge, 152, pl. 57, fig. 8.
1968, *Saxidomus purpuratus*, Noda and Masuda, 5 , pl. 1, fig. 9.
1968, *Saxidomus purpuratus*, O'Hara, 82, pl. 14, fig. 4.
1969, *Saxidomus purpuratus*, Iwai and Siobara, pl. 2, fig. 7.
1971, *Saxidomus purpuratus*, Kuroda *et al.*, 418, 645, pl. 93, figs. 5-7.
1972, *Saxidomus purpuratus*, Noda, 685-687, pl. 4, figs. 1a−2b.
1973, *Saxidomus purpurata*, Oyama, 102, pl. 45, fig. 8, pl. 46, figs. 4-5.
1977, *Saxidomus purpuratus*, Habe, 270, pl. 56, fig. 3.
1977, *Saxidomus purpuratus*, Matsuura, pl. 4, fig. 7.
1980, *Saxidomus purpuratus*, Takayasu, 144-145, pl. 4, figs. 2-5b, pl. 5, fig. 4.
1981, *Saxidomus purpuratus*, Scalrato, 380, photo. 383.
1981, *Saxidomus purpuratus*, Kira, 142, pl. 56, fig. 9.
1983, *Saxidomus purpuratus*, Masuda *et al.*, 21, pl. 4, fig. 15.
1986, *Saxidomus purpuratus*, Takayasu *et al.*, pl. 76, fig. 1.
1988, *Saxidomus purpuratus*, Okamoto and Ibaraki, pl. 1, figs. 10-11, pl. 2, figs. 1-2.
1990, *Saxidomus purpuratas*, Nemoto and Akimoto, pl. 13, fig. 3.
1990, *Saxidomus purpuratus*, Baba, 302-303, pl. 38, fig. 8.
1993, *Saxidomus purpuratus*, Noda *et al.*, 164, figs. 21-2a−3b.
1995, *Saxidomus purpuratus*, Noda *et al.*, 68, figs. 9-10.

Remarks; The present species was already discussed for the rare occurrence in the southern part of Japan by Noda (1972) because of the species is dominantly distributed in the northern part of Japan. The species collected from the Nakoshi Formation is quite identical of the species, so that the distribution of the species is

---

←Fig. 10
1a-2b, *Chlamys* (*Mimachlamys*) *gracilisquamosus* (Fischer).....p. 67
Loc. no. 84, x 1, IGUT coll. cat. no. 12338.
3, *Cryptopecten vesiculosus* (Dunker).....p. 68
Loc. no. 87, x 3, IGUT coll. cat. no. 12339.
4,5,7, *Chlamys* (*Azumapecten*) *subsquamatus* (Nomura).....p. 66
4, Loc. no. 84, x 1.5, IGUT no. 12340, 5, 7 x 1, IGUT coll. cat. no. 12341-42.
6a-6b, *Cryptopecten* cf. *nux nux* (Dunker).....p. 68
Loc. no. 81, x 1,5, IGUT coll. cat. no. 12343.
8-9c, *Chlamys* (*Mimachlamys*) *satoi* (Yokoyama).....p. 67
Loc. no. 84, x 0.7, IGUT coll. cat. no. 12344-12345.


1a
2a
2b
3
4
1c
5a
1b
5b

rather broad in geographical distribution.

Locality; Loc. no. 81 (rare).

Subfamily Clementinae Frizzel, 1936
Genus *Clementia* Gray, 1842
Subgenus *Clementia* Gray, 1842
Clementia (*Clementia*) *vatheleti* Mabille, 1901
Figs. 16-7a－7b.

1901, *Clementia vatheleti* Mabille, 57. (*fide* Kuroda *et al.*, 1971)
1913, *Clementia vatheleti*, Jukes-Browne, 61-62, pl. I, figs. 3-4. (*non vidi*)
1941b, *Clementia* (*Clementia*) *vatheleti*, Yabe and Hatai, 74-75, pl. 7, fig. 4.
1951, *Clementia* (*Clementia*) *vatheleti*, Habe, 185, fig. 423 on 183.
1957, *Clementia vatheleti*, Makiyama, pl. 10, figs. 14-15.
1958, *Clementia vatheleti*, Habe, 185, figs. 423.
1959, *Clementia vatheleti*, Yamamoto and Habe, 99, pl. 7, fig. 14.
1960, *Clementia vatheleti*, Shuto, 140-142, pl. 13, figs. 3-11, pl. 15, fig. 15.
1961, *Clementia* (*Clementia*) *vatheleti*, Hayasaka, 51, pl. 6, figs. 7a－b.
1965, *Clementia vatheleti*, Kaseno and Matsuura, pl. 16, figs. 5-6.
1971, *Clementia vatheleti*, Kuroda *et al.*, 663, 431, pl. 94, fig. 7.
1971, *Clementia* (*Clementia*) *vatheleti*, Noda, 42-43, pl. 7, fig. 13.
1977, *Clementia* (*Clementia*) *vatheleti*, Habe, 274, pl. 56, fig. 9.
1983, *Clementia vatheleti*, Aoki and Baba, 55, fig. 50.
1986, *Clementia vatheleti*, Masuda *et al. in* Sato *et al.*, 42-43.
1988, *Clementia* (*Clementia*) *vatheleti*, Okumura, 46, pl. 16, fig. 11.
1993, *Clementia* (*Clementia*) *vatheleti*, Okumura and Takei, 172, pl. 37, figs. 12, 14, 17-18.
1990, *Clementia* (*Clementia*) *vatheleti*, Ito, 127, pl. 33, fig. 4.
1993, *Clementia* (*Clementia*) *papyracea*, Ogasawara, 54-55, pl. 3, figs. 19-22.
1998, *Clementia* (*Clementia*) *papyrasea*, Ozawa *et al.*, 108-109, pl. 28, fig. 2.

Remarks; Several conjoined valves are collected. The shell is well swollen with concentric ribs on immature stage and finer growth lines in later stage. Mabille originally described the present species incompletely with no figure in 1902 but Jukes-Brown (1913) redescribed and illustrated the species. *Clementia papyracea* as Nakamura *et al.* (1999) mentioned resembles the present species but the former has more swollen and narrow posterior border.

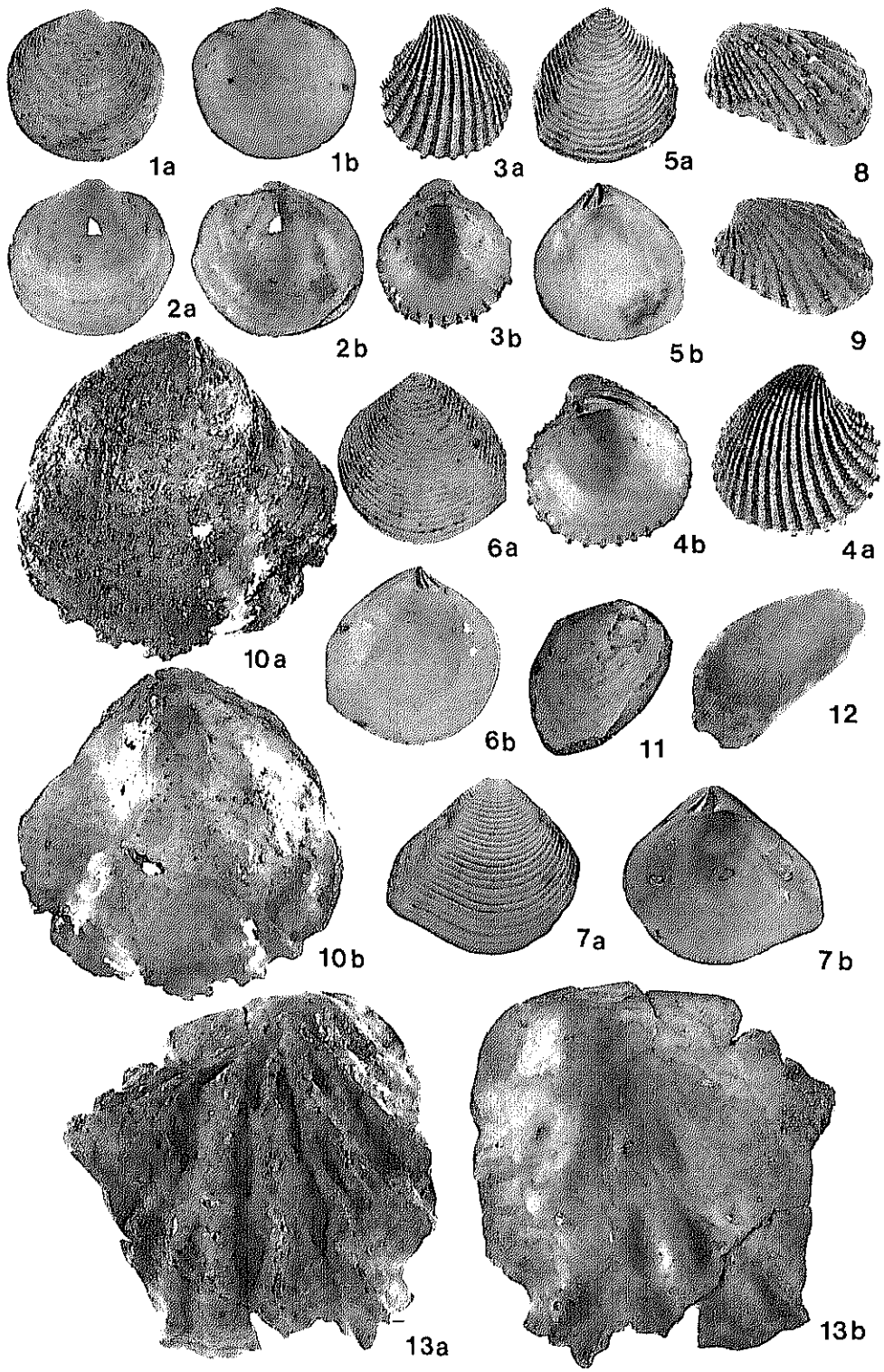
Localities; Loc. no. 81 (rare), no. 84 (rare), no. 87 (rare).

Family Gastrochaenidae Gray, 1840
Genus *Eufistulana* Eames, 1951
Eufistulana grandis (Deshayes, 1854)
Figs. 16-12a－13.

1854, *Chaena grandis* Deshayes, 330. (*non vidi*)
1862, *Gastrochaena grandis*, Tryon, 476. (*non vidi*)
1866, *Fistulana grandis*, Fischer, 321, pls. 12, 13. (*non vidi*)
1878, *Fistulana grandis*, Sowerby, pl. I, fig. 3. (*non vidi*)
1884, *Fistulana grandis*, Sowerby, 132, pl. 471, fig. 16. (*non vidi*)
1895, *Fistulana grandis*, Clessin, 23, pl. I, figs. 6-8. (*non vidi*)
1927a, *Vermetus ebaranus*, Yokoyama, 417, pl. 46, figs. 15-16. (not of fig. 17)
1952, *Gastrochaena grandis*, Habe, 240, figs. 647-649.
1955, *Gastrochaena grandis*, Taki and Habe in Kuroda, 5-6, pl. I, figs. 1-4, pl. 2, figs. 12-18.
1961, *Gastrochaena grandis*, Habe, 140, pl. 63, fig. 14.
1977, *Eufistulana grandis*, Habe, 288, pl. 60, figs. 8-12.
1995, *Eufistulana grandis*, Nakao, pl. 8, fig. 5.

Remarks; The present species was discussed in detail by Taki (1943), and Taki and Habe in Kuroda (1955). According to them, the present species is mainly distributed in fine sandy bottom in shallow sea in the southern warm water regions. Taki and Habe (1955) included the fossil species *Vermetus ebaranus* Yokoyama (1927a), which was only one fossil species as a

←Fig. 11
1a-1c, *Amussiopecten praesignis* (Yokoyama).....p. 69
Loc. no. 88, x 0.7, IGUT coll. cat. no. 12346.
2a-2b, *Anomia chinensis* Philippi.....p. 70
Loc. no. 88, x 1, IGUT coll. cat. no. 12347.
3, *Chlamys* sp. .....p. 70
Loc. no. 88, x 1.5, IGUT coll. cat. no. 12348.
4, *Plicatula simplex* (Smith).....p. 70
Loc. no. 87, x 2.5, IGUT coll. cat. no. 12349.
5a-5b, *Ostrea denselamellosa* Lischke.....p. 71
Loc.no. 84, x 0.7, IGUT coll. Cat. no. 12350.


1a
1b
3a
5a
8
2a
2b
3b
5b
9
10a
6a
4b
4a
6b
11
12
10b
7a
7b
13a
13b

synonymous species with the present species. However, Taki and Oyama (1954) remained Yokoyama's species as a valid species. The Nakoshi specimens are almost tubes but fragmental shell showing elongated shell with anteriorly beak and elongated shell was also collected. Both shell and tube are identical with *F. grandis*. *F. heyseana* Philippi (Koenen, 1894, 87-88, pl. 95, figs. 10a-c) resembles the present species but slightly different from Okinawan species in its shape of calcareous tube.

Localities; Loc. no. 81 (few), no. 87 (rare), no. 88 (rare).

Family Myochamidae Bronn, 1862
Genus *Myadora* Gray, 1840
Myadora fluctuosa Gould, 1861
Figs. 16-8a－9b.

1861, *Myadora fluctuosa* Gould (*non vidi*)
1861, *Myadora triangularis*, A. Adams (*non vidi*)
1882, *Myadora triangularis*, A. Adams, Dunker, 181-182, pl. 7, figs. 11-12. (*non vidi*)
1906, *Myadora fluctuosa*,Tokunaga, 39, pl. 2, fig. 24.
1920, *Myadora trianglularis*, Yokoyama, 144, pl. 11, figs. 14-15.
1922b, *Myadora fluctuosa*, Yokoyama, 170, pl. 14, figs. 6-7.
1935, *Myadora fluctuosa*, Otuka, 901, pl. 57, fig. 209.
1950, *Myadora yokoyamai*, Habe, 28, figs. 7-9.
1950, *Myadora japonica*, Habe, 27, pl. 4, figs. 4-6.
1950, *Myadora proxima*, Habe, 27, pl. 4, figs. 1-3, 19-1.
1954, *Myadora japonica*, Taki and Oyama, 51, pl. 34, figs. 6-7.
1958, *Myadora japonica*, Ozaki, 121, pl. 22, fig. 7.
1964, *Myadora fluctuosa*, Johnson, 78, pl. 26, fig. 2.
1965, *Myadora japonica*, Kaseno and Matsuura, pl. 19, figs. 5-8.
1968, *Myadora japonica*, O'Hara, 89, figs. 10, 17.
1971, *Myadora japonica*, Kuroda *et al.*, 726, pl. 103, fig. 12, 429.
1973, *Myadora japonica*, O'Hara, 119, pl. 57, figs. 1, 4.
1977, *Myadora japonica*, Omori, pl. 1, fig. 10.
1977, *Myadora yokoyamai*, Habe, 307, pl. 65, figs. 1-2.
1985, *Myadora japonica*, Matsuura, pl. 39, fig. 17, pl. 41, fig. 17.
1986, *Myadora fluctuosa*, Takayasu *et al.*, pl. 34, fig. 2, pl. 39, fig. 11, pl. 55, fig. 5, pl. 64, figs. 12-13.
1988, *Myadora japonica*, Yoon, pl. 3, figs. 3, 11.
1990, *Myadora fluctuosa*, Baba, 310, pl. 40, fig. 8.
1993, *Myadora fluctuosa*, Okumura and Takei, pl. 40, fig. 1.

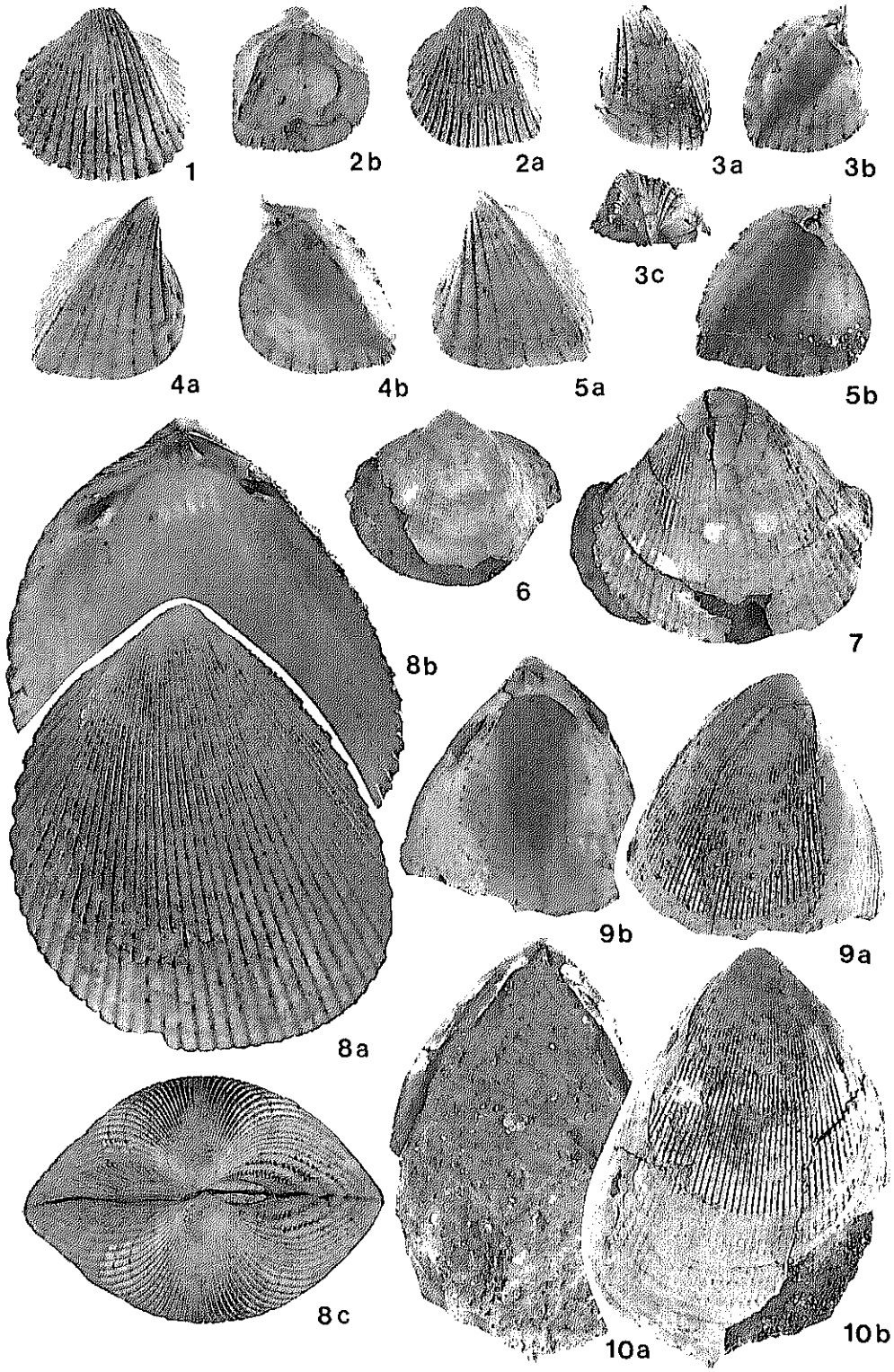
Remarks; The present species is flat, and trigonal in shape. The external surface is sculptured by concentric growth lines. The lateral teeth are distinct. Yokoyama (1920) described the present species in association with *Myadora triangularis* from the Naganuma Formation in Kanagawa Prefecture. Habe (1950) once proposed the new species *M. yokoyamai* but is included the present species as synonym.

Localities; Loc. no. 87 (rare), no. 88 (rare).

Family Laternulidae Hedley, 1918
Genus *Laternula* Roeding, 1798
Subgenus *Laternula* Roeding, 1798
Laternula (*Laternula*) *anatina* (Linnaeus, 1758)
Figs. 15-11a－11b.

1758, *Anatina anatina* Linnaeus, 88.
1863, *Anatina flexuosa*, Reeve, sp. 2. (*non vidi*)
1874, *Anatina japonica*, Lischke, 101, pl. 9, figs. 7-10.
1952, *Laternula flexuosa*, Habe, 267, fig. 707.
1967, *Laternula* (*Laternula*) *flexuosa*, Habe and Kosuge, 170, pl. 63, fig. 23.
1977, *Laternula* (*Laternula*) *anatina*, Habe, 311, pl. 65, figs. 13-14.

←Fig. 12
1a-1b, *Lucina kuninagaensis* Nomura and Zinbo.....p. 71
Loc. no. 87, x 2, IGUT coll. cat. no. 12351.
2a-2b, *Anodontia stearensiana* (Oyama).....p. 72
Loc. no. 109, x 1.5, IGUT coll. cat. no. 12352.
3a-4b, *Glans granulosus* n. sp. .....p. 73
3a-3b, Paratype (IGUT coll. cat. no. 12353), 4a-4b, Holotype, Loc. no. 81, x 1.5, IGUT coll. cat. no. 12354.
5a-7b, *Nipponocrassatellites nana* (Adams and Reeve) .....p. 73
Loc. no. 84, 5a-6b, x 1.5, 7a-7b, x 1, IGUT coll. cat. no. 12355.
8-9, *Musuculites* cf. *japonica* (Dunker).....p. 66
Loc. no. 88, x 3, IGUT coll. cat. no. 12356 (8), 12357 (9).
10a-10b, *Pododesmus* (*Monia*) *noharai* Noda.....p. 70
Loc. no. 109, x 0.7, IGUT coll. cat. no. 12358.
11-12, *Modiolus* sp. .....p. 66
Loc. no. 88, x 3, IGUT coll. cat. no. 12359 (11), Loc. 88, no. 12360 (12).
13a-13b, *Pretostrea imbricata* (Lamarck).....p. 71
Loc. no. 87, x 0.7, IGUT coll. cat. no. 12361.


1
2b
2a
3a
3b
3c
4a
4b
5a
5b
6
7
8b
8a
8c
9b
9a
10a
10b

1981, *Laternula* (*Laternula*) *flexuosa*, Kira, 166, pl. 62, fig. 11.

Remarks; The present species is elongatedly swollen with rostrated posterior border, fine growth lines on external surface, and spoon-like chondrophore. Habe (1952) included *L. japonica* and *L. flexuosa* to the species as synonymous species with the present species. Accordingly the distribution of the species is expanded from southwestern Japan to more southern parts.

Locality; Loc. no. 87 (rare).

Gastropoda

Family Trochidae Rafinesque, 1815
Subfamily Trochinae Rafinesque, 1815
Genus *Clanculus* Montfort, 1810
Clanculus margaritarius (Philippi)
Figs. 17-7a–b.

1961, *Clanculus margaritarius*, MacNeil, 27, pl. 18, figs. 14-15.

Remarks; The present species resembles *Clanculus microdon ater* iullustrated by MacNeil (1961, p. 27, pl. 16, figs. 4, 9) from the Pleistocene Ryukyu Limestone but the present species has more distinct nodous external surface. The shell is small in size with seven rows of dotted spiral ribs, four teeth on internal side of external aperture and narrow and deep umbilicus opening.

By having similar external sculptures of lines of dotted spiral cords, the present species seems to be swollen whorl in trigonal shell form. The apical angle of the present species is slightly large in comparison with those of *C. microdon* which has small nodous external structure. Up to the present, the species is only recorded from the Pleistocene to Recent.

Locality: Loc. no. 87, rare.

Genus *Tosatrochus* MacNeil, 1961
Tosatrochus attenuatus (Jonas, 1844)
Figs. 17-4a–4b.

1828, *Trochus elongatus* Wood (*non* Sowerby), 17, pl. 5, fig. 19. (*fide* MacNeil, 1961)
1844, *Trochus attenuatus* Jonas, 170. (*fide* MacNeil, 1961)
1879, *Trochus elongatus* Fischer, 281, pl. 92, fig. 1.
1889, *Cantharidus* (*Thalotia*) *elongatus*, Pilsbry, 143, pl. 45, fig. 56.
1961, *Tosatrochus attenuatus*, MacNeil, 26-27, pl. 10, figs. 16, 22-23.
1981, *Tosatrochus attenuata*, Kira, 14, pl. 7, fig. 10.
1984, *Tosatrochus attenuatus*, Nohara and Miyagi, pl. 2, figs. 12a-b.

Remarks; The present species was first recorded from the Nakoshi Sand in Okinawa as a fossil record by MacNeil (1961). The shell is moderate in size, and subtrigonal in shape. The external surface is sculptured with 5 rows of fine spiral lirae crossing with obliquely elevated longitudinal riblets. At the crossing with the spiral lirae, the longitudinal ribs are developed at the lower most of suture. The base is slightly swollen with 17 tuberculous riblets.

Loc. no. 87 (rare).

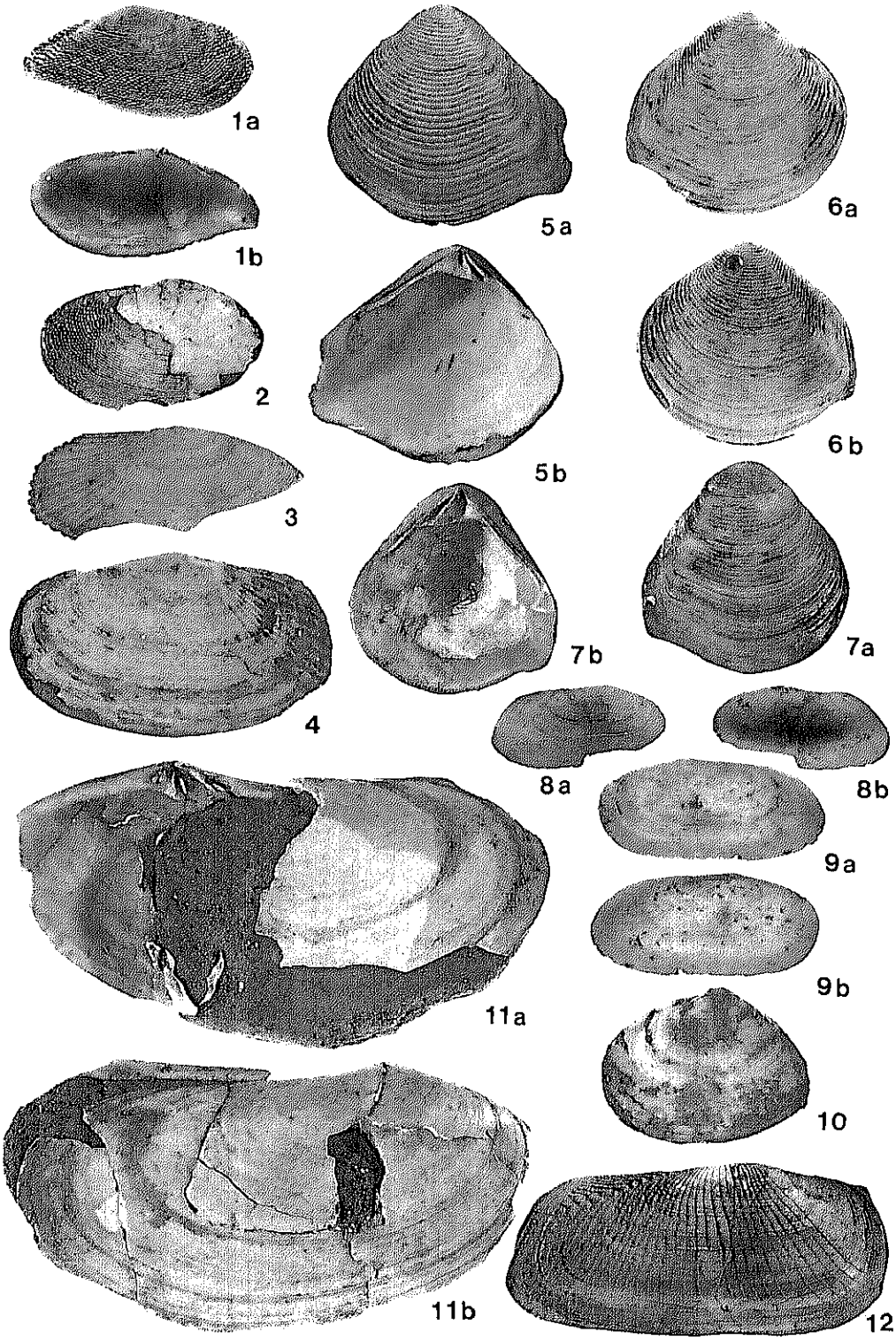
Family Fissurellidae Fleming, 1822
Subfamily Fissurellinae Fleming, 1822
Genus *Fissuridea* Swainson, 1840
Fissuridea crucifera (Pilsbry, 1890)
Fig. 17-12.

1890, *Glyphis crucifera* Pilsbry in Tryon, 275, pl. 32, figs. 27-30. (*fide* Nomura, 1935)
1935, *Fissuridea crucifera*, Nomura, 220, pl. 10, figs. 50a-b.

Remarks; The present species is characterized by small cone-shaped shell with reticulated external sculptures by crossing of fine concentric

---

←Fig. 13
1-2b, *Fragum alfuricum* (Fischer).....p. 74
Loc. no. 88, x 2, IGUT coll. cat. no. 12362.
3a-5b, *Lunulicardia subretusa* (Sowerby).....p. 74
Loc. no. 81, x 2, IGUT coll. cat. no. 12363.
6-7, *Fulvia* sp. .....p. 75
6, Loc. no. 81, x1, IGUT coll. cat. no. 12364.
7, Loc. no. 114, x1, IGUT coll. cat. no. 12365.
8a-8c, *Vasticardium* (*Vasticardium*) *burchardi* (Dunker) .....p. 74
Loc. no. 87, x1, IGUT coll. cat. no. 12366.
9a-10b, *Laevicardium biradiatum* (Bruiguière).....p. 75
Loc. no. 84, x 1, IGUT coll. cat. no. 12367.


1a
1b
2
3
4
5a
5b
6a
6b
7a
7b
8a
8b
9a
9b
10
11a
11b
12

lirae and distinct but fine 39-40 radial ribs. Nomura (1935) mentioned some confusion of the identification. *Diodora yokoyamai* Otuka (1937) has more finer and radial ribs.

Locality; Loc. no. 81 (rare).

Family Turbinidae Rafinesque, 1815
Subfamily Turbininae Rafinesque, 1815
Genus *Turbo* Linnaeus 1758
Subgenus *Batillus* Schumacher, 1817
Turbo (*Batillus*) *chinensis* Ozawa and Tomida, 1995
Figs. 17-1a—1b.

1995, *Turbo* (*Batillus*) *chinensis* Ozawa and Tomida, 269-275, pl. 1, figs. 1a-5.

Remarks; *Marmorostoma* (*Batillus*) cf. *cornata* described from the Nakoshi Sand by MacNeil (1961, Loc. no. 17440) is well identical with the present species. At the time, MacNeil described the species from the Nakoshi, he remained it under the name of *M.* (*B.*) cf. *cornata*. When he mentioned that the species from the Nakoshi is a new species, he remained it unnamed because it is an immature form. The specimens have small tubercles at the crossing of the primary and secondary spiral ribs and riblets. *Turbo chinensis* is differentiated from *Turbo yabei* in having no dotted sculptures on primary spiral ribs and has swollen base.

Locality; Loc. no. 87 (common).

Genus *Marmorostoma* Swainson, 1829
Subgenus *Batillus* Schumacher, 1817
Marmorostoma (*Batillus*) *gemmata* (Reeve, 1848)
Figs. 17-2a—3c.

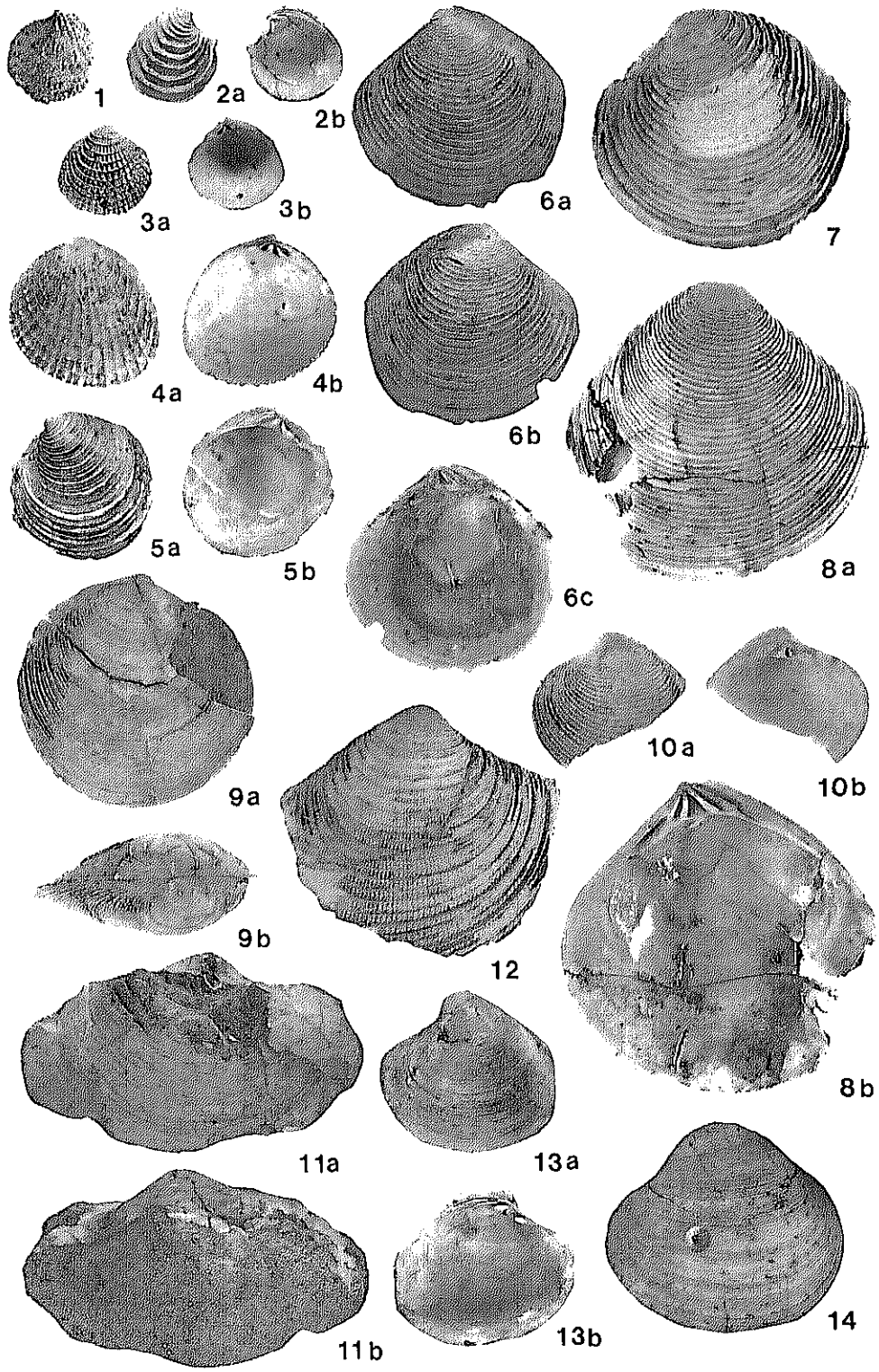
1848, *Turbo gemmatus* Reeve, pl. 12, fig. 62. (*fide* MacNeil, 1961)
1888, *Turbo gemmatus*, Pilsbry, 216, pl. 44, figs. 68-69. (*fide* MacNeil, 1961)
1908, *Turbo* (*Senectus*) *gemmatus*, Schepman, 25, pl. 6, fig. 11. (*fide* MacNeil, 1961)
1922, *Turbo*? sp., Dickerson, pl. 5, fig. 17.
1936, *Turbo yabei* Nomura and Zinbo, 263-264, pl. 11, figs. 34a-b.
1938, *Turbo* (*Marmorostoma*) *gemmatus*, Altena, 288-289, fig. 12.
1948, *Turbo* (*Marmorostoma*) *gemmatus*, Cox, 17, pl. 1, figs. 2a—b.
1961, *Marmorostoma* (*Batillus*) *gemmata*, MacNeil, 31, pl. 11, fig. 4.

Remarks; The present species is characterized by moderate to small in size for the genus. The species is characterized by having moderate to small shell with 4 nodous spiral ribs crossing longitudinal striae. The secondary spiral ribs are developed from the penultimate whorl. On the body whorl, the main spiral ribs are associated with interstitial riblets. The body whorl is rather swollen and the base is also well rounded. The inner lip is smooth and thick. The longitudinal color pattern is still pressed in the specimen collected from Loc. no. 88. The species is distinguished from *T. chinensis* by its longitudinal and spiral sculptures.

The present species is recorded from the Pliocene to Recent. In Okinawa Island, the present species already known from the Nakoshi Formation by Nomura and Zinbo (1936) under the name of *Turbo yabei* which was identical with the present species as mentioned by MacNeil (1961). However, the geological ranges of the species is limited from the Pliocene to

---

←Fig. 14
1a-1b, *Tellinella verrucosa* (Hanley).....p. 76
Loc. no. 81, x 1, IGUT coll. cat. no. 12368.
2, *Tellitella pulcherima* (Sowerby)
Loc. no. 84, x 1, IGUT coll. cat. no. 12369.
3-4, *Grammatomya squamosa* (Lamarck).....p. 76
Loc. no. 81, x 1, IGUT coll. cat. no. 12370, 71.
5a-6b, 7a-7b, *Nipponocrassatella nana* (Adams and Reeve).....p. 73
5a-6b, Loc. no. 84, x 1, IGUT coll. cat. no. 12372a, 7a-7b, x 1, IGUT coll. cat. no. 12372b.
8a-9b. *Azorinus abbreviatus* Gould.....p. 77
8a-8b, Loc. no. 88, x 1.5, IGUT coll. cat. no. 12374, 9a-9b, Loc. 88, IGUT coll. cat. no. 12375.
10, *Macoma* (*Macoma*) *praetexta* (Martens).....p. 76
Loc. no. 109, x 1, IGUT coll. cat. no. 12376.
11a-11b, *Luttraria* (*Psamophila*) *sieboldi* Deshayes.....p. 75
Loc. no. 81, x 1, IGUT coll. cat. no. 12377.
12, *Solecurtus divaricatus* (Linnaeus).....p. 76
Loc. no. 87, x 1, IGUT coll. cat. no. 12378.


1
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
6c
7
8a
8b
9a
9b
10a
10b
11a
11b
12
13a
13b
14

Recent in Okinawa to SE Asia. The earliest appearance of the present species is of Dickerson (1922) from the Miocene Vigo Formation in the Philippines. As already discussed by Aoki and Espiritu (1977), the Vigo Formation is of the Pliocene or mixed formation with the Miocene species. The geological age of the species is Pliocene to Pleistocene.

Localities: Loc. no. 81 (few), no. 84 (rare), no. 87 (rare), no. 88 (rare).

Subfamily Astreinae Davies, 1933
Genus *Astralium* Link, 1807
Subgenus *Astralium* Link, 1807
Astralium (*Astralium*) *haematragum* (Menke, 1829)
Figs. 17-8a−9b.

1971, *Astralium haematragum*, Kuroda *et. al.*, 47, 72, pl. 15, fig. 3.
1981, *Astralium haematragum*, Taki *in* Okada and Taki, 175, pl. 81, fig. 22.
1985, *Astraea* (*Astralium*) *haematraga*, Dance, Compendium of sea shells, fig. on p. 55.

Remarks; The present species is defined by trochoidal shell with granular rows on suture, and 19-20 longitudinal spines at the lowest margin of the basal suture. The base is rather flat with 7 spiral rows of nodous ribs. The present species is said to be common at the rocky shores. Loc. no. 81 (rare), 87 (few).

Family Turritellidae Woodward, 1851
Genus *Turritella* Lamarck, 1790
Subgenus *Kurosioia* Ida, 1952
Turritella (*Kurosioia*) *filiola* Yokoyama, 1928a
Figs. 19-4−5.

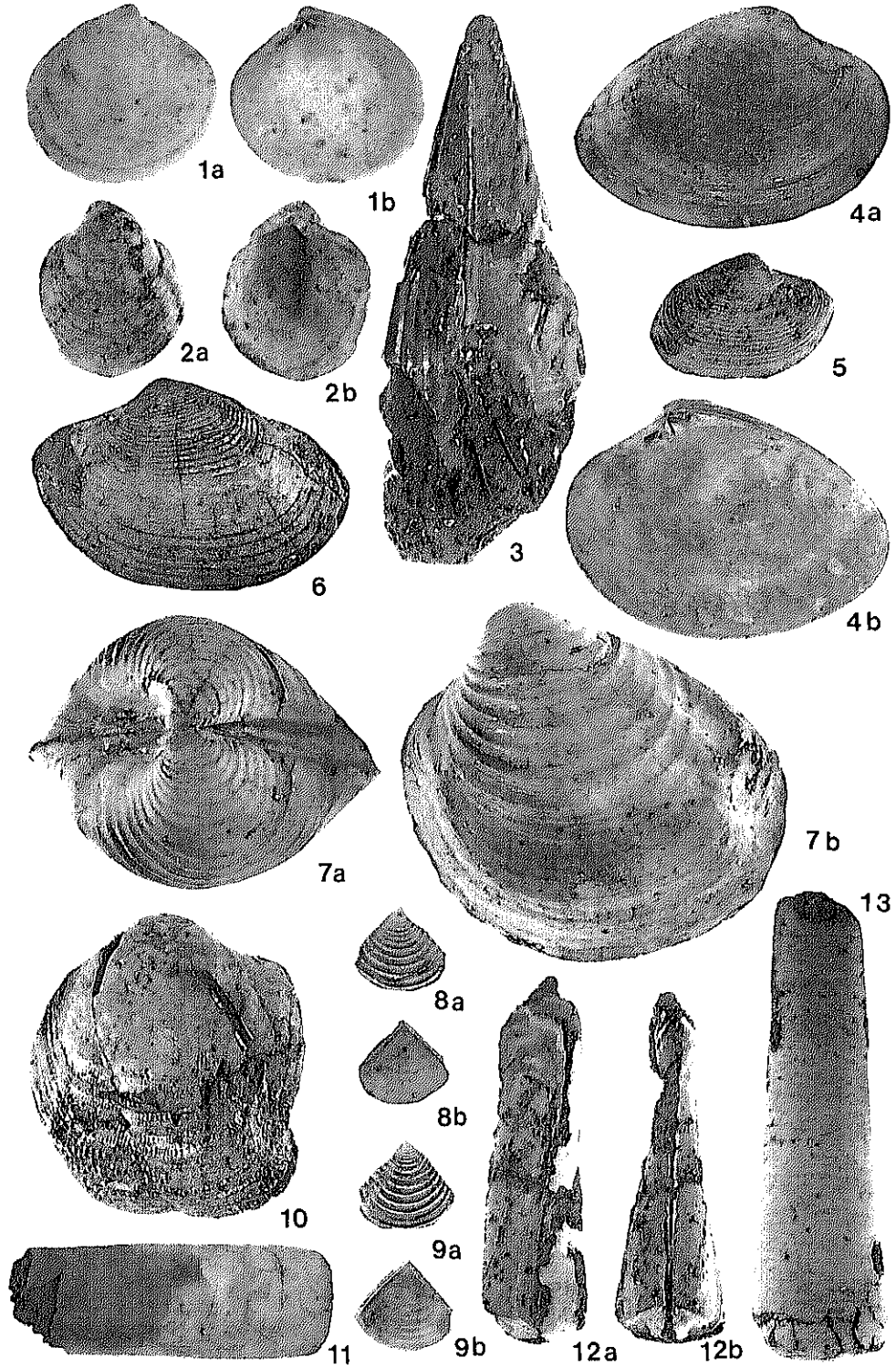
1928a, *Turritella filiola* Yokoyama, 57, pl. 4, fig. 7.
1938, *Turritella filiola*, Otuka, 39, fig. 13 on pl.
1952, *Turritella* (*Kurosioia*) *filiola*, Ida, 44, pl. 1, figs. 5-6, pl. 7, fig. 7.
1959, *Turritella* (*Kurosioia*) *filiola*, Kotaka, 85, pl. 3, figs. 6-8, pl. 11, figs. 1, 3.
1961, *Turritella* (*Haustator*) *filiola*, MacNeil, 36, pl. 1, fig. 20, pl. 11, figs. 22-26.
1969, *Turritella* (*Kurosioia*) *filiola*, Shuto, 59, pl. 2, figs. 14-15, text-fig. 17.
1984, *Turritella filiola*, Nohara and Miyagi, pl. 2, fig. 13.

Remarks; MacNeil (1961) reported the present species from the Yonabaru Formation and Nakoshi Sand. As the direct examination of the specimens from the Miocene Yonabaru Clay which is the earliest occurrence of the species, it is hard to conclude the range of the species. The Yonabaru specimens (MacNeil, 1961, pl. 1, fig. 20) seem to have different external sculptures to those of *Turritella filiola* from the Nakoshi. This is a future problem to discuss together with the occurrence of *Turritella cingulifera* Sowerby as mentioned by Beets (1950a, p. 330). The species has beaded spiral ribs in association with 10-15 secondary dotted spiral ribs.

Localities: Loc. no. 81 (few), 84 (few), 87 (dominant), 88 (few).

Family Potamididae H. & A. Adams, 1854
Genus *Batillaria* Benson, 1842

←Fig. 15
1, *Epicodakia delicatula* Pilsbry.....p. 72
Loc. no. 87, x 1, IGUT coll. cat. no. 12379.
2a-2b, *Placamen tiara* (Dilwyn).....p. 78
Loc. no. 87, x 1, IGUT coll. cat. no. 12380.
3a-4b, *Glycydonta marica* (Linnaeus).....p. 78
Loc. no. 87, 3a-3b, x 1, 4a-4b, x 5, IGUT coll. cat. no. 12381.
5a-5b, 7, *Ventricolaria* (*Ventricoloidea*) *foveolata* (Sowerby).....p. 77
5a-5b, Loc. no. 87, x 1, IGUT coll. cat. no. 12382, 7, Loc. no. 88, x 1, IGUT coll. cat. no. 12383.
6a-6c, 8a-8b, *Circe* (*Circe*) *scripta* (Linnaeus).....p. 79
6a-6c, Loc. no. 81, x 1, IGUT coll. cat. no. 12384.
8a-8b, IGUT. coll. cat. no. 12385.
9a-9b, *Pardosinia amphidesmoides* (Reeve).....p. 81
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12386.
10a-10b, *Pitar* (*Costellipitar*) cf. *chordatum* (Roemer).....p. 81
Loc. no. 88, x 1, IGUT coll. cat. no. 12387.
11a-11b, *Laternula* (*Laternula*) *anatina* (Linnaeus).....p. 89
Loc. no. 87, x 1, IGUT coll. cat. no. 12388.
12, *Pelyglypta* (*Tigammona*) *chemnitzi* (Hanley)...p. 78
Loc. no. 84, x 1, IGUT coll. cat. no. 12389.
13a-14, *Pitar* (*Pitarina*) *japonica* Kuroda and Kawamoto.....p. 79
13a-13b, Loc. no. 88, x 1, IGUT coll. cat. no. 12390, 14, Loc. no. 81, x 1, IGUT coll. cat. no. 12391.


1a
1b
4a
2a
2b
3
5
6
4b
7a
7b
13
8a
8b
10
9a
11
9b
12a
12b

Batillaria flectosiphonata Ozawa, 1996
Figs. 20-18a－18b.

?1950, *Batillaria* aff. *zonalis* (Bruguière), MacNeil, 39, pl. 16, fig. 25, pl. 18, fig. 13.
1971, *Batillaria zonalis*, Noda, 45-46, pl. 7, figs. 2-3.
1995, *Batillaria multiformis*, Kubo and Kurozumi, 43, fig. 2.
1996, *Batillaria flectosiphonata* Ozawa, 190-194, pl. 1, figs. 1-12.
1995, *Batillaria multiformis*, Nakao, pl. 1, fig. 8.
2001, *Batillaria multiformis*, Nakao, pl. 1, fig. 4.

Remarks; The present species was originally described by the Recent specimens distributed in Iriomote-jima Island, the Ryukyus by Ozawa (1996). As some Pliocene to Pleistocene species were included the species at the original description, the species ranges from the Pleistocene to Recent in the Ryukyus. *Batillaria zonalis* is the most allied species and has 12-13 longitudinal folds crossed with spiral ribs. The folds on the body whorl become nodouse at the shoulder.

Locality; Loc. no. 109 (few)

Family Cerithidae Fleming, 1822
Genus *Rhinoclavis* Swainson, 1840
Subgenus *Proclava* Thiele, 1929
Rhinoclavis (*Proclava*) *kochi* (Philippi, 1848)
Figs. 19-2a－b.

1848, *Rhinoclavis kochi* Philippi, 153 (*fide* Oyama, 1980)
1927, *Cerithiopsis kochi*, Yokoyama, 450, pl. 51, fig. 7.
1980, *Rhinoclavis kochi*, Oyama, 26, pl. 5, figs. 26-27.

Remarks; The external sculpture of the upper three spiral cords cutted by longitudinal lines and interspacial fine spiral cords. Two columner folds are well recognized. The present species is distinguished from *Rhinoclavis articulata* (Adamns and Reeve) in having nearly straight columner folds and narrow aperture.

Locality; Loc. no. 88 (rare)

Genus *Cerithium* Bruguière, 1789
Cerithium (*Proclava*) *turritum* Sowerby, 1855
Figs. 20-7a－b.

1855, *Cerithium turritum* Sowerby, 860, sp. 47, pl. 158, fig. 101. (*fide* MacNeil, 1961)
1882, *Vertagus pfefferi* Dunker, 108, pl. 4, figs. 12-14.
1887, *Cerithium turritum*, Tryon, 147, pl. 28, figs. 55-56.
1936, *Cerithium turritum*, Nomura and Zinbo, 260, pl. 11, fig. 28.
1961, *Cerithium* (*Proclava*) *turritum*, MacNeil, 41, pl. 12, fig. 3.

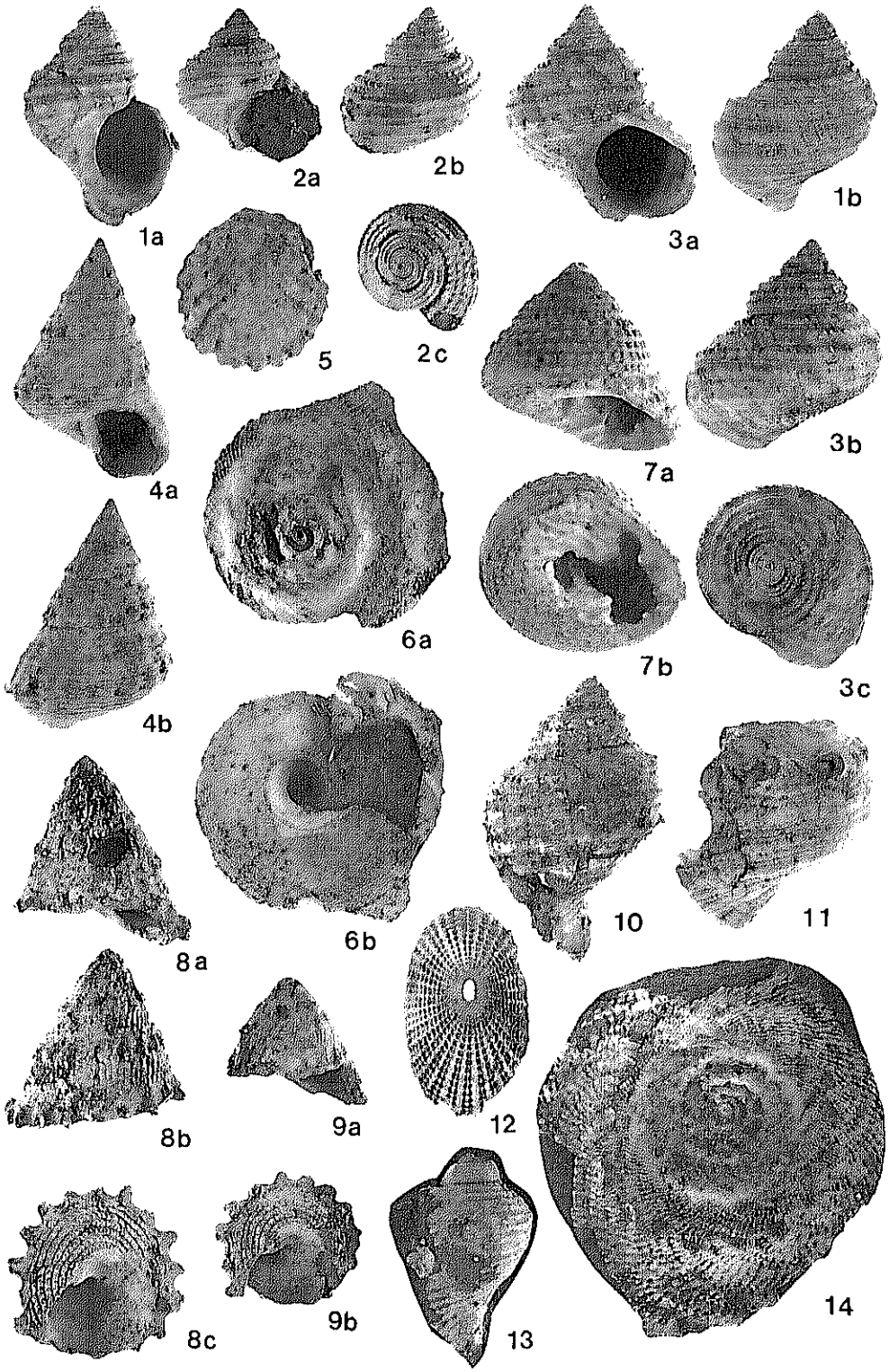
Remarks; According to Kuroda and Habe (1952, p. 45), the both species *Cerithium turritum* and *C. pfefferi* are synonymous. The present species is characterized by having four spiral ribs and two internal lirae being crossed with longitudinal folds. Two columeller folds are recognized and the lower fold is weaker than the upper one.

Locality; Loc. no. 81 (rare)

Family Hipponicidae Troschel, 1861
Genus *Amalthea* Schumacher, 1817
Amalthea conica Schumacher, 1817
Fig. 17-5.

1817, *Amalthea conica* Schumacher, 181, pl. 21, fig. 4. (*fide* Kuroda *et al.*, 1971)
1886, *Hipponix australis*, Tryon, 136, pl. 41, figs. 9-15. (*fide* Kuroda *et al.*, 1971)

←Fig. 16
1a-1b, *Pitar* (*Costellipitar*) cf. *chordatum* (Roemer) ..... p. 81
Loc. no. 81, x 5, IGUT coll. cat. no. 12392.
2a-2b, *Wallucina* sp. ..... p. 72
Loc. no. 81, x 3, IGUT coll. cat. no. 12393.
3, *Atrina* sp. ..... p. 66
Loc. no. 87, x 1, IGUT coll. cat. no. 12394.
4a-4b, *Callista* (s. s) *chinensis* (Hanley)..... p. 83
Loc. no. 88, x 1, IGUT coll. cat. no. 12395.
5-6, *Paphia* (*Paphia*) *euglypta* (Philippi)..... p. 83
6. Loc. no. 81, x1, IGUT coll.cat. no. 12397. 5. Loc. no. 94 (IGUT coll. cat. no. 12396)
7a-7b, *Clementia* (*Clementia*) *vatheleti* Mabille..... p. 87
Loc. no. 81, x 1, IGUT coll. cat. no. 12398.
8a-9b, *Myadora fluctosa* Gould ..... p. 89
Loc. no. 87, x 1, IGUT coll. cat. no. 12399.
10, *Chama* sp. ..... p. 72
Loc. no. 88, x 1, IGUT coll. cat. no. 12400.
11, *Solen* sp..... p. 77
Loc. no. 88, x 1, IGUT coll. cat. no. 12401.
12a-13, *Entfistulana grandis* (Deshayes)..... p. 87
Loc. no. 87, x 1.5, IGUT coll. cat. no. 12402.


1a
2a
2b
3a
1b
5
2c
4a
7a
3b
6a
7b
3c
4b
6b
10
11
8a
9a
12
8b
14
9b
13
8c

1936, *Hipponix conicus*, Nomura and Zinbo, 262, pl. 6, figs. 31-32.
1962, *Sabia conica*, Habe, 28, pl. 14, fig. 3.
1967, *Sabia conica*, Habe and Kosuge, 40, pl. 15, fig. 15-16.
1971, *Amalthea conica*, Kuroda *et al.*, 128, 84, pl. 23, figs. 18-19.
1981, *Sabia conica*, Kira, 30, pl. 13, fig. 3.
1993, *Amalthea conica*, Okumura and Takei, pl. 27, fig. 10.

Remarks; Only one specimen was collected at hand. The species is conical in form with irregularly elevated 22 radial ribs. The fossil records are quite scarce.

Locality; Loc.no. 88 (rare)

Family Xenophoridae Troschel, 1852
Genus *Tugurium* Fischer, 1880
Tugurium exutum (Reeve, 1843)
Figs. 17-6a－b, 14.

1842, *Phorus exutus* Reeve, pl. 2, fig. 7. (*fide* MacNeil., 1961)
1858, *Onustus exutus*, H. and A. Adams, 362, pl. 40, figs. 1a-b. (*fide* MacNeil, 1961)
1879, *Onustus exutus*, Fischer, 430, pl. 22, figs. 1-2. (*fide* MacNeil, 1961)
1886, *Xenophora* (*Tugurium*) *exuta*, Tryon, 161, pl. 46, figs. 90-91. (*fide* MacNeil,1961)
1927c, *Xenophora exuta*, Yokoyama, 176, pl. 47, fig. 10.
1935, *Xenphora exuta*, Nomura, 198, pl. 10, figs. 35a-b.
1953, *Onustus exutus*, Habe, 179, figs. 7-8.
1959, *Tugurium exutum*, Makiyama, pl. 58, fig. 10.
1961, *Tugurium exutum*, MacNeil, 47-48, pl. 12, fig. 10.
1961, *Onustus exutus*, Hayasaka, 73, pl. 9, figs. 6a-b.
1971, *Tugurium exutum*, Kuroda *et al.*, 92, 139, pl. 20, figs. 1-2.
1993, *Tugurium exutum*, Okumura and Takei, 141, pl. 28, figs. 1a－2b. (non pl. 27, fig. 9.)
1989, *Tugurium exutum*, Ito, 46, pl. 5, fig. 2.
1993, *Onustus exutus*, Katto and Masuda, 16, pl. 7, fig. 9.
1993a, *Onustus exutus*, Masuda and Huang, 118-119, pl. 1, figs. 15-17.
1994a, *Onustus exutus*, Masuda and Huang, pl. 2, fig. 20.
1995, *Onustus exutus*, Nakao, pl.1, fig. 20.

Remarks; The present species is rather frequently described as mentioned by Masuda and Huang (1993) who made a synonymous list of the species. However, the fossil records are rather scarce. According to Ponder (1983), the present species is defined by having peripheral flange with scalloped edge and with no objects attached. In the earlier stage, the shell attains small pelecypods, flat formed *Operculina* (foraminifers), but middle to final stage, no shells materials attached. The radial fine folds are well presented.

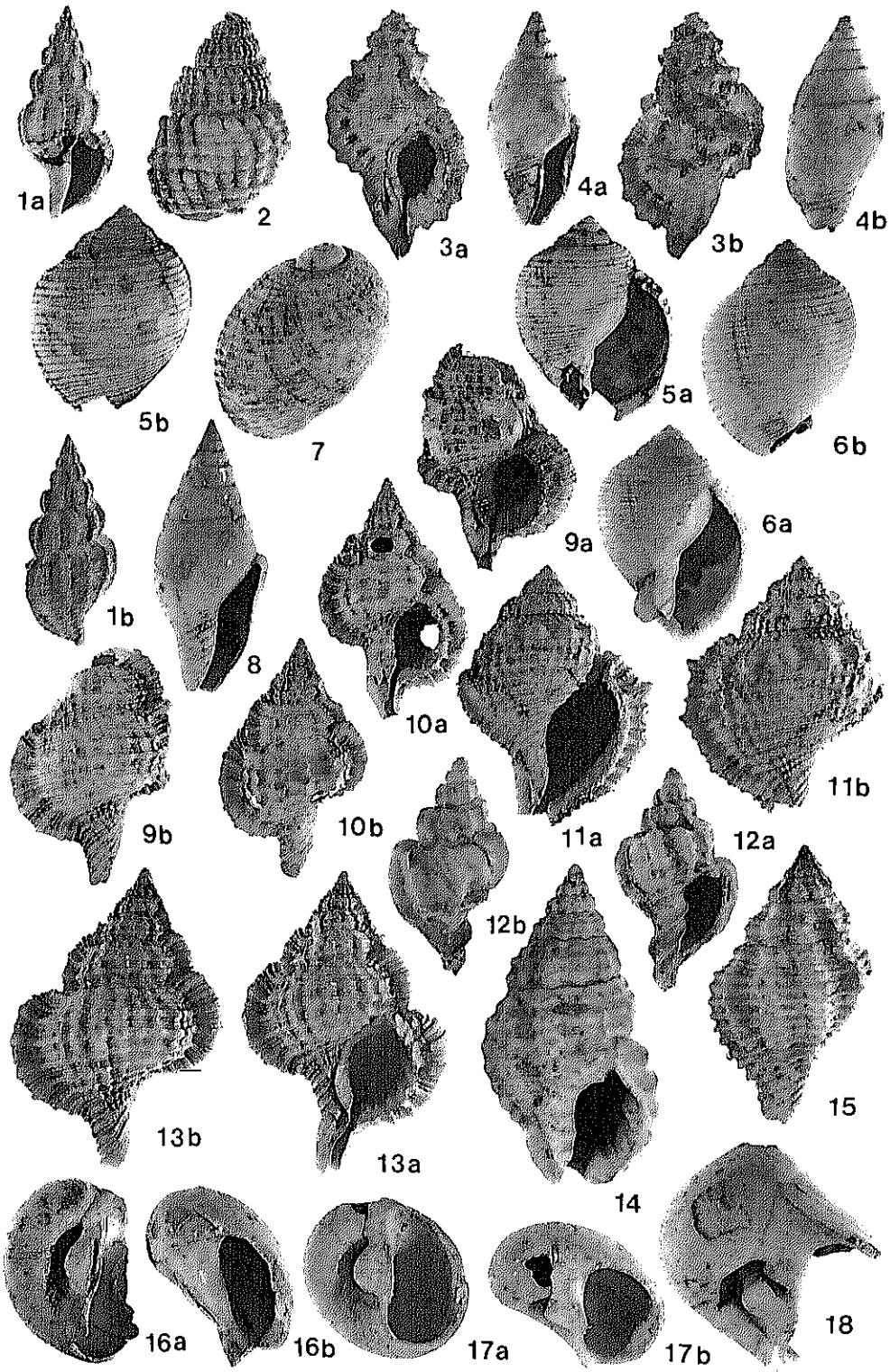
Locality; Loc. no. 87 (few)

Family Strombidae Rafinesque, 1815
Genus *Terebellum* Roeding, 1798
Terebellum terebellum (Linnaeus, 1758)
Figs. 20-12a－b

1758, *Conus terebellum* Linnaeus, 718, no. 284.
1956, *Terebellum terebellum*, Kuroda and Kawamoto, 27, 87, pl 10, fig. 91.
1960, *Terebellum terebellum delicatum*, Abbott, 449, pls. 321, figs. 10-11.
1964, *Terebellum terebellum delicatum*, Habe, pl. 17, fig. 1.
1967, *Terebellum terebellum*, Jung and Abbott, 449-454, pls. 322-326.
1971, *Terebellum terebellum delicatum*, Kuroda *et al.*, 82,

---

←Fig. 17
1a-1b, *Turbo* (*Batillus*) *chinensis* Ozawa and Tomida .....p. 93
1a-1b, Loc. no. 87, x 1.5, IGUT coll. cat . no. 12403.
2a-3c, 11, *Marmorostoma* (*Batillus*) *gemmata* (Reeve) .....p. 93
2a-2b, Loc. no. 81, x 1, IGUT coll. cat. no. 10404; 3a-3c, Loc. no. 88, x 1, IGUT coll. cat. no. 10405. 11, Loc. no. 87, x 1, IGUT coll. cat. no. 12413.
4a-4b, *Tosatrochus attenuatus* (Jones) .....p. 91
Loc. no. 87, x 1.5, IGUT coll. cat. no. 12406.
5, *Amaltha conica* Schumacher.....p. 97
Loc. no. 88, x 3, IGUT coll. cat. no. 12407.
6a-6b, 14, *Tugurium exutus* Reeve.....p. 99
Loc. no. 87, x 1, IGUT coll. cat. no. 12408.
7a-7b, *Clanculus margaritarius* (Philippi).....p. 91
Loc. no. 87, x 3, IGUT coll. cat. no. 12409.
8a-9b, *Astralium* (*Astralium*) *haematragum* (Menke) .....p. 95
8a-8c, Loc. no. 81, x 1, IGUT coll. cat. no. 12410; 9a-9b, Loc. 87, x 1, IGUT coll. cat. no. 12411.
10, *Mario pamotanensis* Martens.....p. 106
Loc. no. 109, x 1, IGUT coll. cat. no. 12412.
12. *Fissuridea crucifera* (Pilsbry).....p. 91
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12414.
13. *Semicassis* sp. .....p. 106
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12415.


1a
2
3a
4a
3b
4b
5b
7
5a
6b
1b
8
9a
6a
10a
11b
9b
10b
11a
12a
12b
13b
13a
14
15
16a
16b
17a
17b
18

125, pl. 22, figs. 6-7.
1981, *Terebellum terebellum*, Taki in Okada and Taki, 159, pl. 76, fig. 11.
1995, *Terebellum terebellum delicatum*, Nakao, pl. 1, fig. 21.

Remarks; According to Jung and Abbott (1967), *Terebellum terebellum* (Linnaeus, 1758) includes the following five forms, *T. terebellum terebellum*, *T. t. lineatum* Roding, 1758, *T. t. nebulosum* Roding, *T. t. punctulorum* Roding and *T. t. delicatum* Kuroda and Kawamoto. Those species are mainly distinguished by color pattern. Jung and Abbott (1967) showed some differences of the shell morphology according to the growth (size of shell). In the immature stage, the aperture of the species is narrowly open and short. A complete list of synonymous species was make by Jung and Abbott (1967). The species ranges from the Miocene to Recent.

Locality; Loc. no. 88 (rare).

Genus *Strombus* Linnaeus, 1758
Subgenus *Labiostrombus* Oostingh, 1925
Strombus (*Labiostombus*) *japonicus* (Reeve, 1851)
Fig. 19-6a－8b.

1851, *Strombus japonicus* Reeve, pl. 17, fig. 42. (*fide* MacNeil, 1961)
1922b, *Strombus japonicus*, Yokoyama, 70, pl. 3, fig. 12.
1935, *Strombus taiwanicus* Nomura, 177-178, pl. 8, figs. 15a-b.
1935, *Strombus* (*Labiostrombus*) *japonicus*, Otuka, 866, pl. 54, fig. 99.
1936, *Strombus* (*Labiostrombus*) *japonicus*, Nomura and Zinbo, 259-260, pl. 11, figs. 27a-b.
1954, *Canarium* (*Labiostrombus*) *japonicus*, Taki and Oyama, pl. 23, fig. 12.
1961, *Canarium* (*Labiostombus*) *japonicum*, Hayasaka, 74, pl. 9, figs. 14-15b.
1961, *Strombus* (*Labiostrombus*) cf. *japonica*, MacNeil, 48, pl. 12, figs. 14-15, 22-23.
1981, *Canarium* (*Doxander*) *japonicus*, Ogasawara, pl. 2. figs. 3a-3b, 12.
1984, *Doaxander japonica*, Nohara and Miyagi, pl. 2, figs. 9a-b.
1994, *Strombus vittatus japonicus*, Nakao, pl. 1, fig. 23.

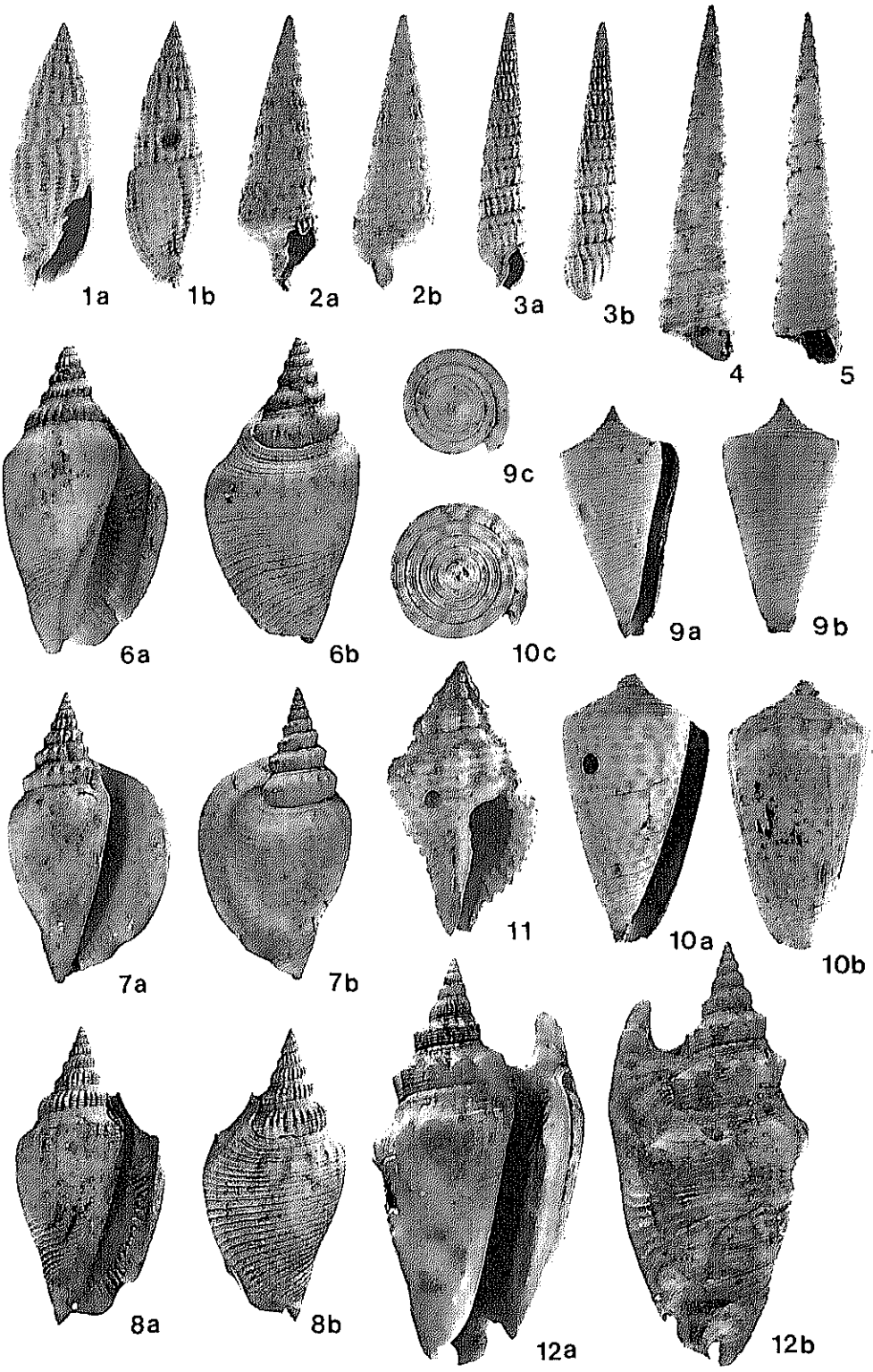
Remarks; *Strombus taiwanica* Nomura (1935, p. 125-126) is not distinguished from *S. japonicus* by similar external features. Among the specimens collected from the Nakoshi Sand, the small sized specimens are identical with *Strombus bivaricosus* Nomura (1935). Thencewhere, *Strombus taiwanica* and *S. bivaricosus* are identical with *S. japonicus*.

Locality; Loc. no. 81 (common), no. 84(rare), no. 87 (few), 88 (common).

Subgenus *Euprotomus* Gill, 1869
Strombus (*Euprotomus*) *aurisidianae* Linnaeus, 1758
Fig. 9-12a－b.

1936, *Strombus* (*Euprotomus*) *aurisidianae*, Nomura and Zinbo, 259, pl. 11, figs. 26a-b.
1941, *Strombus aurisidianae*, Hatai, 102, pl. 20, figs. 2-3, pl. 31, figs. 6-8.

←Fig. 18
1a-1b, *Hindsia* sp. .....p. 107
Loc.no. 81, x 3, IGUT coll. cat. no. 12416.
2. *Nassarius* (*Niotha*) *gemmalatus* (Lischke).....p. 108
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12417.
3a-3b. *Cymatium* (*Cymatriton*) *nicobaricum* (Broderlip).....p. 106
Loc. no. 84, x 1.5, IGUT coll. cat. no. 12418.
4a-4b, 8. *Pyrene flava* (Bruguière).....p. 108
4a-4b, Loc. no. 81, x 2, IGUT coll. cat. no. 12419; 5a-5b, Loc. no. 88, x 2, IGUT coll. cat. no. 12420.
5a-6b. *Semicassis* sp.
Loc. Miyagi-dam, x 2, IGUT coll. cat. no. 12453. (For comparison)
7. *Eunaticina papilla* (Gmelin).....p. 103
Loc. no. 109, x 2, IGUT coll. cat. no. 12421.
9a-10b, 13a-13b. *Gyrineum pusillum* (Broderlip).....p. 106
9a-10b, Loc. no. 84, x 1, IGUT coll. cat. no. 12422, 13a-13b, Loc. no. 81, x 1.5, IGUT coll. cat. no. 12423.
11a-11b. *Bursa* (*Bufenaria*) *rana* (Linnaeus).....p. 106
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12424.
12a-12b. *Cancellaria* (*Trigonostoma*) *taiwanensis* Nomura.....p. 109
Loc. no. 109, x 3, IGUT coll. cat. no. 12425.
14. *Nassarius* (*Zeuxis*) *caelatus* (Gould) .....p. 108
Loc. no. 109, x 5, IGUT coll. cat. no. 12426.
15. *Pollia martini* Shuto.....p. 107
Loc. no. 84, x 2, IGUT coll. cat. no. 12427.
16a-18. *Polinices sagamiensis* Pilsbry.....p. 103
16a-17b, Loc. no. 81, x 1, IGUT coll. cat. no. 12428; 18, Loc. no. 84, x 1, IGUT coll. cat. no. 12429.


1a
1b
2a
2b
3a
3b
4
5
6a
6b
9c
10c
9a
9b
7a
7b
11
10a
10b
8a
8b
12a
12b

1984, *Euprotomus vomer*, Nohara and Miyagi, pl. 12, figs. 10a-b.
1993, *Euprotomus* cf. *hirasei*, Katto and Masuda, 16, pl. 7, fig. 8.

Remarks; The present species is well identical with the Recent species, *Euprotomus vomer* Roeding in having fine crenulated sculpture at the immature whorls, a row of tubercles on near shoulder from middle to body whorls, pointed up outer lip, double siphonal canals on the anterior end with thick outer and inner lips. Nohara and Miyagi (1984) first illustrated the present species from the Nakoshi Formation. *Euprotomus aurisidianae* is vallied to the present species in having similar external sculptures and the size of outer lip but the present species has more slender shell and more distinct row of tubercles. *E. bulla* Roeding has more swollen shell.

Locality; Loc. no. 84 (rare)

Family Naticidae Forbes, 1838
Subfamily Polinicinae Grag, 1847
Genus *Polinices* Montfort, 1810
Polinices sagamiensis Pilsbry, 1904
Figs. 18-16a－18.

1904, *Polinices sagamiensis* Pilsbry, 23-24, pl. 4, figs. 37-37a. (*fide* Majima, 1989)
1922b, *Polinices powisianus* Yokoyama, 83-84, pl. 4, fig. 12.
1927a, *Polinices sagamiensis*, Makiyama, 74-75, pl. 3, figs. 1-2.
1928a, *Polinices sagamiensis*, Yokoyama, 63, pl. 6, fig. 2.
1935, *Polynices sagamiensis*, Otuka, 866, pl. 53, fig. 36.
1956, *Polinices sagamiensis*, Kawamoto, p. 27, pl. 10, fig. 95.
1961, *Polinices sagamiensis*, Azuma, pl. 21, fig. 2.
1961, *Polinices sagamiensis*, Shikama, text-fig. 191-6.
1969, *Polinices sagamiensis*, Oyama, text-fig. 4.
1970, *Polinices sagamiensis*, Habe and Kosuge,48, pl. 18, fig. 29.
1971, *Polinices sagamiensis*, Kuroda *et al.*, 182-183, 120, pl. 18, figs. 7-8.
1973, *Polinices sagamiensis*, Oyama, 31-32, pl. 7, figs. 7a-b.
1981, *Polinices sagamiensis*, Kira, 41, pl. 17, fig. 15.
1985, *Polinices sagamiensis*, Majima, pl. 17, Na-b.
1961, *Polinices*. cf. *albumen*, MacNeil., 45-46, pl. 4, figs. 23-27.
1981, *Polinices powisianum*, Kira, 41, pl. 17, fig. 16.
1989, *Polinices sagamiensis*, Majima, 45-46, pl. 4, figs. 23-27, text-figs. 4.2, 15.13, 15.14, 17.3.
1993, *Polinices sagamiensis*, Okumura and Takei, pl. 28, figs. 7a-c.

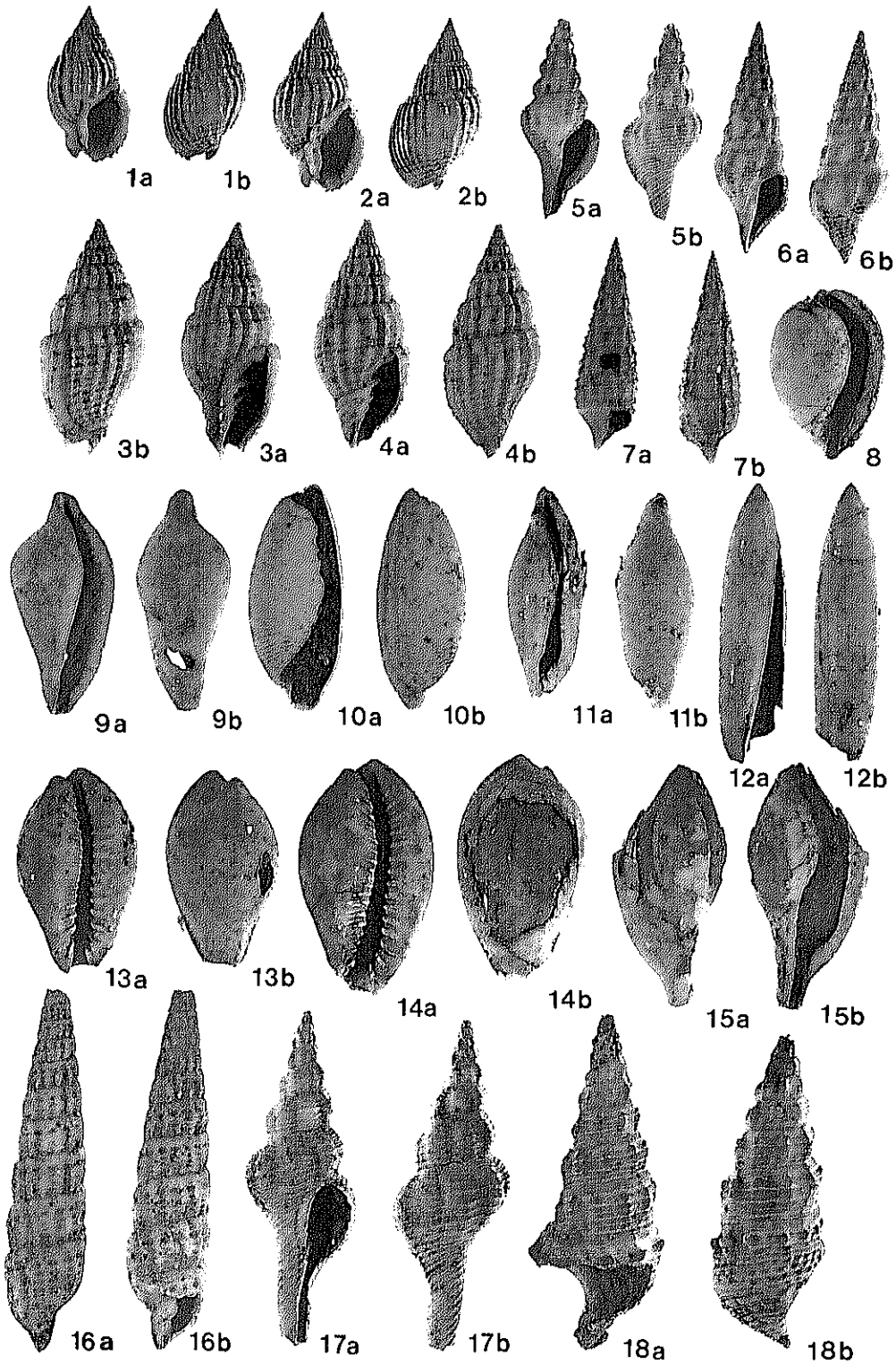
Remarks; The complete synonymous list was made by Majima (1989, p. 45-46). The species is characterized by ovately round to globosely elongated shell with thick and large umbilical callus, and deep groove. Up to date the species was recorded from the Pliocene to Pleistocene formations in the southwest Japan.

Locality; Loc. no. 81 (rare), no. 84 (rare).

Genus *Eunaticina* Fischer, 1885
Eunaticina papilla (Gmelin, 1791)
Fig. 18-7.

1791, *Nerita papilla* Gmelin, 3675. (*fide* Kuroda *et al.*, 1971)
1864, *Sigaretus papilla*, pl. 4, figs. 19a-b. (*fide* Kuroda *et al.* 1971)
1886, *Sigaretus* (*Eunaticina*) *papilla*, Tryon, 58, pl. 28, figs. 78-79, 87-88. (*fide* Majima, 1989)
1905, *Sigaretus papilla*, Martin, 269, pl. 40, figs. 647-648. (*fide* Majima, 1989)
1906, *Sigaretus papilla*, Tokunaga, 19, pl. 1, fig. 34.
1920, *Sigaretus papilla*, Tesch, 68, pl. 132, figs. 204a-b.
1922, *Sigaretus papilla*, Yokoyama, 84, pl. 5, fig. 8.
1954, *Eutaticina papilla*, Taki and Oyama, 17, pl. 25, fig. 8.

←Fig. 19
1a-1b, *Uromitra obeliscus* (Reeve).....p. 108
Loc. no. 81, x 2, IGUT coll. cat. no. 12430.
2a-2b, *Rhinoclavis* (*Proclava*) *kochi* Philippi.....p. 97
Loc. no. 88 (rare), x 1.5, IGUT coll.cat.no. 12431.
3a-3b, *Myurella* (*Clathroterebra*) *woodwardi* (Marten) .....p. 110
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12432.
4-5. *Turritella* (*Kurosioia*) *filiola* (Reeve).....p. 95
Loc. no. 81, x 2, IGUT coll. cat. no. 12433.
6a-8b. *Strombus* (*Labiostrombus*) *japonica* (Reeve)..... .....p. 101
Loc. no. 88, x 1, IGUT coll. cat. no. 12434.
9a-9c. *Conus quercinus* Lightfoot.....p. 110
Loc. no. 84, x 1, IGUT coll. cat. no. 12435.
10a-10c. *Conus tessellatus* Born.....p. 110
Loc. no. 88, x 1, IGUT coll. cat. no. 12436.
11. *Pollia martini* Shuto.....p. 107
Loc. no. 84, x 2, IGUT coll. cat. no. 12427.
12a-12b. *Strombus* (*Euprotombus*) *aurisdiana* Linnaeus .....p. 101
Loc. no. 84, x 1, IGUT coll. cat. no. 12437.


1a
1b
2a
2b
5a
5b
6a
6b
3b
3a
4a
4b
7a
7b
8
9a
9b
10a
10b
11a
11b
12a
12b
13a
13b
14a
14b
15a
15b
16a
16b
17a
17b
18a
18b

1961, *Eunaticina papilla*, Azuma, 199, pl. 13, fig. 7.
1961, *Eunaticina papilla*, Habe, 40, pl. 8, fig. 14.
1961, *Eunaticina papilla*, Hayasaka, 77-78, pl. 9, figs. 21a-b.
1964, *Eunaticina papilla*, Habe, 61, pl. 18, fig. 14.
1969, *Eunaticina papilla*, Oyama, 80, text-fig. 6.
1970, *Eunaticina papilla*, Habe and Kosuge, 45, pl. 18, fig. 3.
1971, *Eunaticina papilla*, Kuroda *et al.*, 188-189, 123, pl. 108, fig. 10.
1982, *Eunaticina papilla*, Kanno *et al.*, 104, pl. 17, figs. 11a-b.
1989, *Eunaticina papilla*, Majima, 68, pl. 9, fig. 16, text-figs. 15, 36, 23a-d, tab. 28.
1995, *Eunaticina papilla*, Nakao, pl.1, fig. 3.
1998, *Eunaticina papilla*, Ozawa *et al.*, 34-35, pl.4, figs. 3a－b.

Remarks; Majima (1989) made a complete synonymous list and he mentioned the type locality of the species is Tranquebar, India (*fide* Weinkauff, 1883). The species is recorded from the Pliocene to early Pleistocene (Dainichi Formation, Semata Formation, Shimoda Formation, Toshima Sand), but not from the formations before the Pleistocene. *Sinum neritoideum* was once recorded from the Nakoshi Sand by Nomura and Zinbo (1936, pl. 11, figs. 33a-b) and is quite similar to the present species.

Locality; Loc. no. 109 (rare).

Family Cypraeidae Rafinesque, 1815
Subfamily Nariinae Schilder, 1927
Genus *Erosaria* Troschel, 1863

Subgenus *Erosaria* s.s.
Erosaria (*Erosaria*) *erosa* cf. *phragedaina* Melvill, 1888
Figs. 20-13a－14b.

Compared with;
1935, *Cypraea miliaris* Gmelin, Nomura, 172, pl. 9, figs. 4a-b.
1961, *Erosaria* (*E.*) *erosa* cf. *phragedaina*, MacNeil, 51, pl. 19, figs. 9, 12.
1993, *Cypraea* sp., Okumura and Takei, 141, pl. 27, figs. 11a-c.

Remarks; The present species resembles *Cypraea carneola* Linnaeus described by Yokoyama (1928c) from the Upper Byoritsu Bed in Taiwan in shell form and apertural features (16 to 18 in number) but the latter has much more number of apertural crenulation.

Locality; Loc. no. 84 (rare)

Family Ovulidae Bruguière, 1792
Genus *Ovula* Bruguière, 1792
Ovula sp.
Fig. 20-8.

Remarks; The present unnamed species has smooth external surface in ovately elongated shell and narrow aperture as long as shell height with depressed apex. The siphonal canal is short but apparent. As the only one imperfect specimen especially the outer lip was missing, is at hand, the more collection is necessary to discuss

---

←Fig. 20
1a-4b. *Nassarius* (*Zeuxis*) *caelatus* (A.Adams)...p. 108
Loc. no. 81, 1a-2b, x 1, 3a-4b, x 3, IGUT coll. cat. no. 12438-12439.
5a-5b, *Rostellaria* cf. *spinifera* Marten. .....p. 107
Loc. no. 87, x 1.5, IGUT coll. cat. no. 12440.
6a-6b. *Crassispira pseudoprincipalis* (Yokoyama) .....p. 109
Loc. no. 81, x 1.5, IGUT coll. cat. no. 12441.
7a-7b. *Cerithium* (*Proclava*) *turritum* Sowerby .....p. 97
Loc. no. 81, x 2, IGUT coll. cat. no. 12442.
8. *Ovula* sp. .....p. 105
Loc. no. 87, x 2, IGUT coll. cat. no. 12443
9a-9b. *Cernavoluva* cf. *frumentum* Sowerby. .....p. 107
Loc. no. 84, x 3, IGUT coll. cat. no. 12444.
10a-10b. *Aliculsteum* cf. *cylindricum* Sowerby. .....p. 110
Loc. no. 87, x 5, IGUT coll. cat. no. 12445.
11a-11b. *Phenacovoluva macneili* Noda. .....p. 107
Loc. no. 87, x 3, IGUT coll. cat. no. 12446.
12a-12b. *Terebellum terebellum* (Linnaeus).....p. 99
Loc. no. 88, x 1.5, IGUT coll. cat. no. 12447.
13a-14b. *Erozaria* (s.s.) *erosa* cf. *phragedaina* Melville .....p. 105
Loc. no. 84, x 1, IGUT coll. cat. no. 12448.
15a-15b. *Volva* sp. .....p. 107
Loc. no. 84, x 1, IGUT coll. cat. no. 12449.
16a-16b. *Strioterebrum* sp. .....p. 108
Loc. no. 88, x 5, IGUT coll. cat. no. 12450.
17a-17b. *Fusinus perplexus* (A.Adams) .....p. 109
Loc. no. 88, x 1, IGUT coll. cat. no. 12451.
18a-18b. *Batillaria flectosiphonata* Ozawa .....p. 97
Loc. no. 109, x 1.5, IGUT coll. cat. no. 12452.

the species since it is referred to the genus *Ovula*.

Locality; Loc. no. 87 (rare).

Family Bursidae Thiele, 1925
Genus *Bursa* Roeding, 1798
Subgenus *Bufonaria* Schumacher, 1817
Bursa (*Bufonaria*) *rana* (Linnaeus, 1758)
Figs. 18-11a–b.

1758, *Murex rana* Linnaeus, 748.
1844, *Ranella albivaricosa* Reeve, pl. 1, fig. 2. (*non vidi*)
1881, *Ranella albivaricosa*, Tryon, pl. 18, fig. 6. (*non vidi*)
1915, *Ranella* (*Bursa*) *subgranosa*, Tesch, 70, pl. 82, fig. 152.
1920, *Ranella* (*Bursa*) *nobilis*, Tesch, 41, pl. 129, fig. 153.
1922, *Ranella* (*Bursa*) *subgranosa*, Dickerson, pl. 4, fig. 13b.
1928a, *Gyrineum scelestum* Yokoyama, 44-45, pl. 3, figs. 5-6.
1961, *Bursa* (*Bufonaria*) *rana*, MacNeil, 60, pl. 13, fig. 5.

Remarks; The present species is defined by having smooth mammilated protoconchs (3½ turns), primally and secondarly spiral cords crossed longitudinal ribs. Two longitudinal valixes are crossed with spiral ribs. At their crossings, the tubercles and nodes are developed. The longitudinal folds are on the both sides of aperture. About 11-12 inside teeth are developed on the outer lip. The inner side of outer lip.

Locality; Loc. no. 81 (rare)

Genus *Gyrineum* Link, 1807
Gyrineum pusillum (Broderlip, 1832)
Figs. 18-9a–10b, 13a–b.

1984, *Apollon cuspidatus*, Nohara and Miyagi, pl. 2, figs. 6a-b, 7.

Remarks; The present species is different from *Gyrineum cuspidatus* (Reeve) which recorded from the same formation by Nohara and Miyagi (1984) in having more finer reticulated sculptures due to the fine longitudinal ribs in comparison with the latter species.

Locality; Loc. no. 81 (rare), no. 84 (rare).

Genus *Cymatium* Roeding, 1798
Subgenus *Cymatriton* s.s.
Cymatium (*Cymatriton*) *nicobaricum* (Roeding, 1798)
Figs. 18-3a–b.

Remarks; The present species at hand is an immature form of the species. The external sculptures as the longitudinal folds, longitudinal ribs crossed with the spiral ribs, thick outer lip, teeth on inner side of aperture, slightly anteriorly curved siphonal canal are referred to the species named.

Locality; Loc. no. 84 (rare).

Family Cassididae Latereille, 1825
Genus *Mario* Montfort, 1810
Mario pamotanensis Martin, 1899
Fig. 17-10.

1899, *Mario pamotanensis* Martin, 157, pl. 24, figs. 365-365a.

Remarks; The present species is characterized by narrowly elevated spiral ribs and subsutural flat part at near suture line as shoulder. The shell is moderate in size (shell length 42.1 mm, width 27.9 mm). The protoconch was missing but 5 whorls are remained. The body whorl is moderaly swollen and sculptured with spiral ribs and its intermediates. The subsutural flat area is also sculptured with two main rows of spiral ribs and its intermediates. The siphonal canal is narrow and slightly inclined forward. The present species is imcomplete in preservation but the species is comparable to *Mario pamotanensis*. But the Javan species has two to three spiral ribs and more smooth spiral ribs. As the present species is distinguished from the Javan species, the Okinawan species should be more examined in future.

Locality; Loc. no. 109 (rare).

Genus *Semicassis* Moerch, 1852
Semicassis sp. indet.
Fig. 17-13.

Remarks; Only one immature specimen is at

hand. The external surface is sculptured with roundly elevated spiral ribs. The body whorl is almost 80% of shell height.

Locality; Loc. no. 81 (rare).

Family Ovulidae Bruguière, 1792
Genus *Phenacovolva* Iredale, 1930
Phenacovolva macneili Noda, 1980
Figs. 20-11a-11b.

1961, *Volva* (? *Pellasimnia*) sp., MacNeil, 53, pl. 13, fig. 8.
1980, *Phenacovolva macneili* Noda, 15, pl. 7, figs. 12a-b.

Remarks; The present species is probably same with *Volva* (? *Pellasimnia*) sp. of MacNeil (1961, p. 53, pl. 13, fig. 8) described from the Chinen Formation. The external surface is sculptured by fine spiral grooves being distinct on the both sides but not on middle part of the shell.

Locality; Loc. no. 87 rare.

Genus Volva Bruguière, 1792
Volva sp.
Figs. 20-15a－15b.

Remarks; The imperfect specimen is at hand. The shell is moderate in size since the apical part was missing. The outer inner lip is stoutly thick with faint teeth like sculpture. As the aperture and main part of the shell was missing, the present species is remained unnamed. However, this unnamed species resembles with *Volva volva* (Linnaeus) and *V. v. habei* Oyama.

Locality; Loc. no. 84 (rare).

Genus *Crenavolva* Sowerby, 1823
Crenavolva cf. *frumentum* (Sowerby, 1823)
Figs. 20-9a－9b.

Remarks; The shell is ovately elongated with very fine spiral grooves on the both upper and lower sides of shell, since the main part of body whorl is rather smooth. The upper most part of aperture is erected to the upper margin of shell and higher as shell height. The elongated apex beyonds the shell height. The inside of the outer lip tightly teethed. The present species is comparable with *Diminovula sinem* (Sowerby) but the present species has somewhat swollen at shoulder. The present species is referred to *Crenovolva frumentum* (Sowerby) as illustrated by Habe (1974, pl. 19, fig. 5).

Locality; Loc. no. 84 (rare).

Family Buccinidae Rafinesque, 1815
Genus *Pollia* Sowerby, 1834
Pollia martini Shuto, 1969
Figs. 18-15, 19-11.

1969, *Pollia martini* Shuto, 11, pl. 12, fig. 33.

Remarks; The present species is characterized by thick and solid shell with 9 longitudinal folds crossed by spiral ribs, 9 horizontal teeth at inner margin of the aperture, and slightly inclined siphonal canal. The present species is identical with *Pollia martini* described from the late Miocene Dingle Formation by Shuto (1969). The species is distinguished from *Coralliophila hataii* described from the Pleistocene in Aichi Prefecture (Hayasaka, 1961).

Locality; Loc. no. 84 (rare).

Genus *Hindsia* H. and A. Adams, 1850
Hindsia sp.
Figs. 18-1a－1b.

Remarks; Only one small specimen is at hand. The species has small and pointed 1.5 coiled protoconch with smooth surface, and 12 longitudinal folds crossed with narrowly elevated 5 radial ribs.

Locality; Loc. no. 81 (rare).

Genus *Rostellaria* Lamarck, 1799
Rostellaria cf. *spinifera* Martens, 1899
Figs. 20-5a－5b.

Remarks; Only small specimen is at hand. The specimen has 14 longitudinal folds crossed with concentric fine spiral ribs.

Locality; Loc. no. 87 (rare).

Family Nassariidae Iredale, 1916

Subfamily Nassariinae Iredale, 1916
Genus *Nassarius* Dumeril, 1806
Subgenus *Zeuxis* H. and A. Adams, 1853
Nassarius (*Zeuixs*) *caelatus* (Gould, 1850)
Figs. 20-1a－4b.

1928a, *Nassa* (*Hinia*) *verbeeki*, Yokoyama, 40, pl. 2, figs. 9, 13.
1935, *Nassarius* (*Zeuxis*) *caelatus*, Otuka, 871, pl. 53, fig. 44.
1936, *Nassarius* (*Alechtrion*) *caelatus*, Nomura and Zinbo, 256, pl. 11, fig. 24.
1961, *Nassarius* (*Niotha*) *caelatus*, MacNeil, 79, pl. 13, fig. 30.
1971, *Nassarius* (*Zeuxis*) *caelatus*, Noda, 46-47, pl. 7, figs. 1a-b.
1982, *Nassarius caelatus verbeeki*, Kanno *et al.*, 113, pl. 19, figs. 9a-b.
1993, *Nassarius* (*Hinia*) *caelatus dainichiensis*, Okumura and Takei, 146, pl. 30, fig. 1.

Remarks; Complete synonymous list of the present species was mentioned by Cernohorsky (1984). The species mentioned above were considered to be synonymous with *Nassarius caelatus* Gould. The species is widely distributed in the sea of the Red Sea, Perusian Gulf, South Africa, Philippines, China, Fiji and Java at the subtidal at a depth of 150 m (Cernohorsky, 1984). The species ranges from Miocene to Recent. The Okinawan species is well identical with the species whose holotype specimen was illustrated by Cernohorsky (1984, pl. 24, fig. 7, USNM no. 5724).

Locality; Loc. no. 81 (few).

Subgenus *Niotha* H. and A. Adams, 1853
Nassarius (*Niotha*) *gemmulatus* (Lamarck, 1822)
Fig. 18-2.

According to Cernohorsky (1984, p. 78-79), the following species are included as the synonymous species of the species.

1844, *Buccinum gemmulatum*, Deshayes, 169 (*fide* MacNeil, 1961)
1928a, *Nassa* (*Niotha*) *gemmulata*, Yokoyama, 40, pl. 2, fig. 8.
1936, *Nassarius gemmulatus*, Nomura and Zinbo, pl. 106, fig. 9.
1961, *Nassarius* (*Niotha*) *gemmulatus*, MacNeil, 79, pl. 13, fig. 29.
1969, *Nassarius* (*Niotha*) *gemmulatus*, Shuto, 144, pl. 12, figs. 14, 15, 17.

Remarks; Only one imperfect specimen was collected from sandstone of the Nakoshi Formation. The external fine but distinct reticulated sculpture made by 5 rows of spiral and 22 longitudinal ribs are identical with the present species. The present species is distinguished from *Nassarius* (*Niotha*) *fulleri* MacNeil (1961) in having no distinct outer lip and reticulated external sculptures.

Locality; Loc. no. 81 (rare).

Family Mitridae Swainson, 1831
Genus *Uromitra* Bellardi, 1887
Uromitra obeliscus (Reeve, 1844)
Figs. 19-1a－1b.

1844, *Mitra obeliscus* Reeve, 107.
1961, *Uromitra* aff. *obeliscus*, MacNeil, 90, pl. 4, fig. 17, pl. 14, figs. 5, 7-8.

Remarks; The present species is referred to *Uromitra obeliscus* which was collected from the Yonabaru Formation by MacNeil (1961, p. 90, pl. 4, fig. 17). The species is characterized by reticulated sculpture made of crossing of 19 longitudinal ribs and 6-7 fine spiral riblets. The upper two of columner folds are stout and the lowest one is weak but clear.

Locality; Loc. no. 81 (rare).

Family Terebridae Moerch, 1852
Genus *Strioterebrum* Sacco, 1891
Strioterebrum sp.
Figs. 20-16a－16b.

Small turreted shell with longitudinal ribs crossed spiral riabs. The specimen at hand is small and apical part is missing. It is hard to identify the species.

Locality; Loc. no. 88 (rare).

Family Columbellidae Swainson, 1840
Genus *Pyrene* Roeding, 1798
Pyrene flava (Bruguière)

Figs. 18-4a－4b, 8.

1961, *Pyrene* aff. *flava*, MacNeil, 66, pl. 13, figs. 12, 18.

Remarks; As mentioned by MacNeil (1961, p. 66), the present species is difficult to identify in the species level. The specimens collected from the Nakoshi Formation (Loc. nos. 81 and 88) are defined by swollen body whorl with smooth external surface and spiral grooves at the siphonal part. *Pyrene* aff. *ligula* recorded from the Naha Limestone by MacNeil (1961) is distinguished from the present species in having more slender shell and narrow aperture. The species has inner teeth at inner surface of aperture, well swollen body whorl and step-like suture lines and small protoconch volution.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Family Fasciolariidae Montfort, 1810
Genus *Fusinus* Rafinesque, 1815
Fusinus perplexus (A.Adams, 1864)
Figs. 20-17a－17b.

1864, *Fusus perplexus* A.Adams, 106 (*non vidi*).
1869, *Fusus inconstans*, Lischke, 34, pl. 2, figs. 1-2.
1871, *Fusus inconstans*, Lischke, 26, pl. 3, figs. 1-5.
1903, *Fusus perplexus*, Cossman, 125, pl. 4, figs. 17-18. (*fide* Baba, 1990)
1936, *Fusinus perplexus*, Nomura and Hatai, 39.
1961, *Fusinus perplexus*, MacNeil, 84, pl. 13, fig. 22.
1971, *Fusinus perplexus*, Kuroda *et al.*, 280-281, 183, pl. 49, fig. 3
1984, *Fusinus perplexus*, Nohara and Miyagi, pl. 2, figs. 11a-b.
1989, *Fusinus perplexus*, Ito, 49, pl. 8, fig.11.
1990, *Fusinus perplexus*, Baba pl. 33, fig. 33.
1993, *Fusinus perplexus*, Okumura and Takei, 146-147, pl. 30, fig. 5.

Remarks; The specimen at hand is moderate in size as the species. Eight longitudinal folds on body whorl are crossed with spiral ribs. These ribs disappeared to upper and lower sides of each suture lines. The apical part was missing but long siphonal canal. The inner surface of aperture is crenulated horizontally.

Locality; Loc. no. 88 (rare).

Family Cancellaridae Gray, 1853
Genus *Cancellaria* Lamarck, 1799
Subgenus *Trigonostoma* Blainville, 1826
Cancellaria (*Trigonostoma*) *taiwanensis* Nomura, 1935
Figs. 18-12a－12b.

1935, *Cancellaria* (*Trigonostoma*) *taiwanensis* Nomura, 212-213, pl. 13, fig. 14.

Remarks; The present species is defined by 9 distinct longitudinal folds on the body whorl and obsolete spiral threads between the folds, and two oblique columellar folds. The protoconch volution is round and swollen with smooth surface. The present species is of immature form (shell height 10.8 mm, shell diameter 6.5 mm) but is identical with *Cancellaria taiwanensis* by the same sculptures on the external surface. *Cancellaria chinenensis* MacNeil (1961, p. 99, pl. 14, fig. 12) is distinguished from the present species in having distinct columellar folds and more than ten longitudinal folds on the external surface.

Cancellaria scalariformis Lamarck (Tesch, 1915, p. 35, pl. 79, figs. 81a-b) is another allied species.

Locality; Loc. no. 109 (rare).

Family Turridae Swainson, 1815
Subfamily Crassispirinae Morrison, 1966
Genus *Crassispira* Swainson, 1840
Crassispira pseudoprincipalis (Yokoyama, 1920)
Figs. 20-6a－6b.

1920, *Pleurotoma* (*Drillia*) *pseudoprincipalis* Yokoyama, 37-38, pl. 1, fig. 21.
1928a, *Drillia pseudoprincipalis*, Yokoyama, 32, pl. 32, fig. 15.
1960, *Clathrodrillia* (*Pseudoinquisitor*) *pseudoprincipalis*, Makiyama, pl. 87, fig. 15.
1965, *Pleurotoma* sp., Shuto, 168, pl. 30, figs. 4, 6, 12.
1973, *Crassispira pseudoprincipalis*, Oyama, 151, pl. 15, fig. 12.
1984, *Crassispira pseudoprincipalis*, sic. Nohara and Miyagi, pl. 2, fig. 8.
1990. *Crassispira pseudoprincipalis*, Baba, 193, pl. 16, fig. 11.

Remarks; The present species was originally described from the Pleistocene Formation in

Naganuma, Kanagawa Prefecture by Yokoyama (1920) with some allied species. The species illustrated from the Nakoshi Formation by Nohara and Miyagi (1984) is referred to the present species. The species has 12 longitudinal folds crossed with fine spiral ribs and 6-7 subsutural threads.

Locality; Loc. no. 81 (rare).

Family Conidae Rafinesque, 1815
Genus *Conus* Linnaeus,1758
Conus tesselatus Born, 1778
Figs. 19-10a－10c.

1843, *Conus tesselatus*, Reeve, pl. 28, figs. 163. (*non vidi*)
1936, *Conus tesselatus*, Nomura and Zinbo, 250, pl. 11, fig. 18.
1970, *Lithoconus tesselatus*, Habe and Kosuge, 91, pl. 36, fig. 6.

Remarks; The present species is moderate in size with brown to orange colored dotted pattern and spiral fine 8-10 grooves on the lower part of the body whorl, and bluntly elevated apical fold. The shoulder is rather distinctly sharp. The apical part is sculptured with 10-11 spirals, and distinct and concentric grooves. The apical part is narrowly erected.

Localities; Loc. no. 81 (rare), no. 88 (rare).

Conus quercinus Lightfoot, 1786
Figs. 19-9a－9c.

Remarks; The present species is characterized by obsconical shell with concentric shell with brown color band with fine concentric ribs on the basal part. The protoconch is high and 5 volutions and 10 spiral whorls are sculptured with small dotted shoulder. The base is sculptured with fine concentric grooves.

Locality; Loc. no. 84 (few), no. 88 (rare).

Family Terebridae Moerch, 1852
Genus *Myurella* Hinds, 1844
Subgenus *Clathroterebra* Oyama, 1961
Myurella (*Clathroterebra*) *woodwardiana* (Martin, 1887)
Figs. 19-3a－3b.

1883-1887, *Terebra woodwardiana* Martin, 73, pl. 5, fig. 76.
1915, *Terebra woodwardiana*, Tesch, 38, pl. 79, figs. 79a-b.
1927, *Terebra* (*Myurella*) *woodwardiana*, Fischer, 90, pl. 214, fig. 68.
1938, *Terebra* (*Myurella*) *bomasenis*, Ostingh, 54, pl. 4, fig. 83.
1969, *Myurella* (*Clathroterebra*) *woodwardiana*, Shuto, 230-231, pl. 23, figs. 8-9, 11-12, 14, 16-17, 23, text-figs. 41, 43.

Remarks; The present species is defined by having 4 high protoconch volutions with one distinct subsutural groove, about 20 longitudinal ribs, and 5 spiral ribs. The aperture is narrowly elongated. The inner lip smooth with two folds. The siphonal canal is slightly wide and short.

Locality; Loc. no. 81 (rare).

Family Haminoidae Pilsbry, 1815
Genus *Aliculastrum* Pilsbry, 1896
Aliculastrum cf. *cylindricum* (Helbling, 1779)
Fig. 20-10
Compared with;
1961 *Aliculastrum cylindricum*, Hayasaka, 95, pl. 10, fig. 8.

Remarks; Only one immature shell was collected and is characterized by cylindrical thin shell with spiral grooves on the upper and lower external surface of the shell and long aperture. *Aliculastrum cylindricum* from the Yontan Limestone (MacNeil, 1961, pl. 19, fig. 24) has more cylindrical shell than that of the present species.

Locality; Loc. no. 87 (rare).

References Cited

Adams, H. and Adams, A, 1853-1858, The genera of Recent mollusca. vols. 1-3, pls. 1-138.
—— and ——, 1861, On some new genera and species of mollusca. *Ann. Mag. Nat. Hist., Ser. 3*, 8, 239-246.
Akiyama, M., 1957, *Amussiopecten iitomiensis* (Otuka) and its allies from Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (25), 31-39, pls. 6-7.
Akutsu, J., 1964. The geology and paleontology of Shiobara and its vicinity, Tochigi Prefecture. *Sci. Rep., Tohoku Univ., 2nd Ser., Geol.*, 35 (3), 211-293, pls. 57-66.

Altena, C.O. van R., 1938, The marine Mollusca of the Kendeng Beds (East Java), Gastropoda, Part 1 (Families, Fissurellidae-Vermetidae inclusive). *Leid. Geol. Medel.*, **19**, 241-320.

——, 1941, The marine mollusca of the Kendeng Beds (East Java), Gastropoda, Part 2 (Family Pianaxidae-Naticidae inclusive). *Ibid.*, **12**, 1-86.

Amano, K., Kanno, S., Ichikawa, A. and Yanagisawa, Y., 1987, Molluscan fauna from the Tanihama Formation in the western part of Joetsu City -Studies on the molluscan fossils from the western part of the Joetsu district, Niigata Prefecture (Part 2) -. *Bull. Joetsu Univ. Educ.*, **6**, Sec. 3, 157-170, pls. 1-2.

Aoki, N., 1960, Molluscan fossils from the Nakazato Formation in Yokohama, Japan. *Trans. Proc. Palaeont. Soc. Jap., N. S.*, (39), 301-304, pl. 34.

——, 1966, Molluscan fossils from the Nobori Formation, Shikoku, Japan. *Ibid.*, (62), 251-259, pl. 31.

—— and Baba, K., 1980, Pleistocene molluscan assemblages of the Boso Peninsula, Central Japan. *Sci. Rep., Inst. Geosci., Univ. Tsukuba, Sec. B*, **1**, 107-148.

—— and ——, 1983, Some rare species of mollusks in the Pleistocene Shimosa Group, central Japan. *Ann. Rep., Inst. Geosci., Univ. Tsukuba*, (9), 49-55.

—— and ——, 1984a, Additions to the molluscan fossils from the Nobori Formation, Shikoku. *Ann. Rep., Inst. Geosci., Univ. Tsukuba*, (10), 73-79.

—— and ——, 1984b, Additions to the rare species of mollusks in the Pleistocene Shimosa Group, Central Japan. *Ibid.*, (10), 80-82.

—— and Espiritu, E.A., 1977, Canguinsa and Vigo Formations, Bondoc Peninsula, Central Philippines. *Geol. Paleont. South East Asia*, **18**, 149-160.

Baba, K., 1990, Molluscan fossil assemblages of the Kazusa Group, South Kwanto, Central Japan. Keio Gijyuku Yochisha, 1-445, pls. 1-40. (*in Japanese*)

Brauns, D., 1881, Geology of the environs of Tokio. *Mem. Sci. Rep., Tokio Daigaku*, (4), 1-82, pls. 1-8.

Cernohorsky, W.O., 1984, Systematic of the Family Nassariidae (Mollusca; Gastropoda). *Bull. Auckland Inst. Mus.*, (14), 1-356, pls. 1-51.

Cheng, H-W., Wu, L-C., Huang, C-Y. and Masuda, K. (1991); Late Pleistocene molluscan paleoecology of Lagoon Deposits of the Szekou Formation, Hengchun Peninsula, southern Taiwan. *Proc. Geol. Soc. China*, **34** (1), 57- 87, pls. 1-3.

Cossmann, M., 1923, Faune Pliocenique de Karikal. *Jour. Conchyliol., Ser. 4*, **68** (22), 85-150, pls. 1-8.

Cox, L.R., 1948, Neogene Mollusca from the Dent Peninsula, British North Borneo. *Schweiz. Palaeont. Abhand.*, **66**, 1-70, pls. 1-5.

Dance, S.P., 1988, The encyclopedia of shells. 288pp., Blandford Press.

Dickerson, R. E., 1922, Review of the Philippine paleontology. *Philipp. Journ. Acad. Sci.*, **20**, 195-220.

Dunker, G., 1822, Index Molluscorum Maris Japonici, Cassellis Cattorum, 1-301, pls. 1-16.

Fisher, P. J., 1927, Beitrage zur Kenntnis der Pliozaen fauna der Moluskkeninseln Seran und Obi. *Paleont. von Timor*, **15**, 1-184, pls. 212-217.

Flint, D.E., Saplis, R.A. and Corwin, G., 1959, Military geology of Okinawa-jima, Ryukyu Retto (5). Geol Surv., Branch of Intl. Div., Off. Eng., Hq. U.S. Army Forces, Far East, Personel of U.S. Geol. Surv.

Fukuta, O. *et al.* 1970, Natural gas resources of the Ryukyu Islands —Prelininary report by the 5th phase survey Team of G.S.J.— *Bull. Geol. Surv.*, **21** (11) 627-672. (*in Japanese with English abstract*)

Habe, T., 1951-1953, *Genera of Japanese Shells, Pelecypoda and Scaphopoda, (1-4)*. Kyoto Bunken Kankoukai, 1-326.

—— 1958, Report on the mollusca chiefly collected by the S. S. Soyo-maru of the Imperial Fischeries experimental station on the continental shelf bordering Japan during the years 1922-1930, pt. 3. *Bull. Seto Mar. Biol. Lab.* 6 (3), 241-280, pls. 11-13.

—— 1960, Fauna of Shell bearing mollusks of the sea around Shirikishinai, Hokkaido, 1, Pelecypoda, Fauna Flora Shirikishinai Mar. Stat., **2**, 1-10.

—— 1964, Notes on strange ark shell, *Trisidos* Roeding. *Bull. Nat. Sci. Mus.*, 7 (3), 255-257, pl. 1.

—— 1965, Shells of the Western Pacific in Colour, vol. 2, 233 pp., 66 pls., Hoikusha, Tokyo.

—— 1966, The arcid subfamily Anadarinae in Japan and its adjacent areas (Mollusca). *Bull. Nat. Sci. Mus.*, **8** (1), 71-85, pls.1-3.

—— 1977, Systematics of molluscs in Japan. Bivalvia and Scaphopoda. 372 pp., Hokuryukan, Tokyo. (*in Japanese*)

——1982, Coloured illustrations of the shells of Japan. (II), 183 pp., 66 pls., Hoikusha. (*in Japanese*)

—— and Ito, K., 1965, Shells of World in Col. Hoikusha Publ., **1**, 1-176, pls.1-56. (*in Japanese*)

—— and Kosuge, S., 1966, Shells of the World in colour, vol 2, Hoikusha, 1-193, pls. 1-68.

—— and ——, 1970, The standard book of Japanese shells in colour, vol. 2, 223 pp., 84 pls., Hoikusha.

Hatai, K., 1941, Recent marine shell-bearing mollusca of the south islands. (Parts 1-2), *Trop. Indust. Inst. Palau, South Sea Islands, Japan*, **7-A, B**, 1-160, pls. 1-79.

Hayami, I., 1984, Natural history and evolution of *Cryptopecten* (a Cenozoic Recent pectinid genus). *Univ. Mus., Univ. Tokkyo, Bull.*, (24), 1-149, pls. 1-13.

—— 1989, Outlook on the Paleozoic historical biogeography of pectinids in the western Pacific region. *Univ. Mus., Univ. Tokyo, Nat. Cult.*, **(1)**, 1-25.

Hayasaka, S., 1961, The geology and paleontology of the Atsumi Peninsula, Aichi Prefecture, Japan. *Sci. Rep., Tohoku Univ., 2nd Ser., Geol.*, **33** (1), 1-103, pls. 1-12.

——, 1971, Note on the marine molluscan fauna from the Pleistocene Kogashira Formation in Kagoshima City, South Kyushu, Japan. *Rep. Fac. Sci., Kagoshima Univ., (Earth Sci.)*, (3), 1-13, pl. 1.

——, 1973, Pliocene marine fauna from Tane-ga-shima, South Kyushu, Japan. *Sci. Rep., Tohoku Univ., 2nd Ser., Spec. Vol.*, (*3*), (*Hatai Memorial Vol.*), 97-108, pls. 6-7.

—— and Hashimoto, S., 1970, Discovery of marine fossils from immediately below the Ata Pyroclastic Flow Deposits, Onejima-cho, Osumi Peninsula, Kagoshioma Prefecture. *Rep. Fac. Sci., Kagoshima Univ.*, (*Earth Sci. B*), (3), 17-22, pl. 1.

Ida, K., 1952, A study of fossil *Turritella* in Japan. *Rep. Geol. Surv. Japan*, (150), 1-64, pls. 1-7.

Ito, K., 1985, Distribution of the molluscan shells in the surrounding areas of Sado and Awa Isls, Niigata Prefecture. *Bull. Japan Sea Region. Fish. Res. Lab.*, (35), 23-127, pls. 1-16. (*in Japanese with English abstract*)

——, 1989, Distribution of molluscan shells in the coastal areas of Chuetsu, Kaetsu and Sado Island, Niigata Prefecture, Japan. *Ibid.*, (39), 37-133, pls. 1-28. (*in Japanese with English abstract*)

——, 1990, Distribution of molluscan shells in Wakasa Bay, Japan Sea. *Ibid.*, (40), 79-211, pls. 1-34. (*in Japanese with English abstract*)

Iwai, 1965, The geological and paleontological studies in the marginal area of Tsugaru Basin, Aomori Prefecture, Japan. *Bull. Fac. Educ., Hirosaki Univ.*, (15), 19-68, pls. 12-20.

—— and Siobara, T., 1969, Pleistocene mollusca from Kamikita-gun, Aomori Prefecture, Japan. *Bull. Educ. Fac. Hirosaki Univ.*, (20), 1-7, pls. 1-3.

Johnson, R. I., 1964, The Recent Mollusca of Augustus Addison Gould. *Bull. U. S. Nat. Mus., Smithon. Inst.*, (239), 1-182, pls. 1-45.

Jung, P. and Abbott, R. T., 1967, The genus *Terebellum* (Gastropoda; Strombidae). *Indo-Pacific Moll.*, 1 (7), 801-814.

Kaneko, S., 1966, Undersurface molluscan fossils in Osaka. Osaka City, Natural Museum *ed.*, Osaka Naturtal Science Research Group, 1-6, pls. 1-21. (*in Japanese*)

Kanno, S., 1962, Molluscan fauna from the so-called Setana Formation, South-western Hokkaido, Japan. *Sci. Rep., Tokyo Kyoiku Daigaku, Sec. C*, 8 (73), 46-62, pls. 1-5.

—— and Chang, L-S, 1973, *Amussiopecten* and its associated fauna from northern Taiwan. *Geol. Palaeont. Southeast Asia*, 12, 189-206, pls. 30-31.

——, Masuda, F., Amano, K., and Ito, M., 1978, Molluscan fossils from Hanamuro River sides, Tsukuba Scientific City, Ibaraki Prefecture, Japan. *Tsukuba Environm. Res.*, (3), 169-180, pls. 1-4. (*in Japanese*)

——, O'Hara, S. and Caagusan, N, L., 1982, Molluscan fauna from the Tartaro Formation (Upper Miocene) of Central Luzon, Philippines. *Geol. Paleont. Southeast Asia*, 24, 51-128, pls. 14-19.

Kaseno, Y. and Matsuura, N., 1965, Pliocene shells from the Omma Formation around Kanazawa City, Japan. *Sci. Rep., Kanazawa Univ.*, 10, 27-62, pls. 1-20.

Katto, J. and Masuda, K. 1993, Molluscan fossils from the Tonohama Group. *Rep. Sakawa Geol. Mus. and Inst.*, (1), 1-26, pls. 1-12. (*in Japanese, title translated*)

Kinoshita, T. and Isahaya, T., 1934, Catalogue of marine mollusca from Hokkaido. *Hokkaido Fish. Exp. Stat. Rep. Fish. Surv.*, (33), 1-19, pls. 1-15. (*in Japanese*)

Kira, T., 1981, Coloured illustrations of the shells of Japan. Hoikusha, 1-240, pls. 1-71. (*in Japanese*)

Koenen, A., 1894, Norddeutsche Unter-Oligocene Mollusken-Fauna. *Abhand. Geol. Special. Preus. Thuering. Staat.*, 10 (5), 1005-1248, pls. 63-86.

Koizumi, A. and Matsushima, Y., 1992, Deep sea molluscs, crustaceans, soft bone fishes from the Pleistocene Ofuna Formation in Kamakura City. *Mem. Kanagawa Prefectural Natural Science Museum*, (21), 37-43. (*in Japanese*)

Kotaka, T., 1959, The Cenozoic Turritellidae of Japan. *Sci. Rep., Tohoku Univ., 2nd Ser.*, 31 (2), 1-135, pls. 1-15.

——, 1973, Faunal analysis of the Upper Miaoli Group in the Tunghisao area, Miaoli Province, Formosa, China. *Sci. Rep., Tohoku Univ., Spec. Vol.*, (*6*), (*Prof. Kotora Hatai Memorial Vol.*), 81-96.

—— and Hasibuan, F. 1983, Molluscan fossils from the Sangiran Dome, Central Jawa. *Kaseki, Palaeont. Soc. Japan*, (33), 1-11, pls. 1-2.

Kuroda, T., 1929-1945, An illustrated catalogue of the Japanese Shells, (1)-(6). *Japan. Jour. Malac.*, Append. (1)-(6), 77-82, 1-4, 314-318, 1-4, 237-239, 29-42. (*in Japanese*)

——, Habe, T. and Oyama, K., The sea shells of Sagami Bay. Maruzen Book Co., 1-741 (*in Japanese*), 1-487 (*in English*), index 1-51, pls. 1-121.

Linnaeus, C. von, 1758, *Systema Naturae*. 824 pp. British Mus., Nat. Hist., London.

Lischke, 1869-1874, *Kenntniss der Mollusken Japanisch mit besonderer Rueckssicht auf die Geographische Verbreitung Derselle, Japanische Meeres-Conchylien*, 1, 1-192, pls. 1-14 (1869), 2, 1-184, pls. 1-14 (1871), 3, 1-123, pls. 1-9 (1874).

MacNeil, F. S., 1961, The Tertiary and Quaternary Gastropoda of Okinawa. *Prof. Pap., U.S. Geol. Surv.*, 339, 1-148, pls. 1-21.

Majima, R., 1985, Intraspecific variation in three species of *Glossaulax* (Gastropoda; Naticidae) from the late Cenozoic strata in central and southwest Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (138), 111-137, pls. 17-19.

——, 1989, Cenozoic fossil Naticidae (Mollusca; Gastropoda) in Japan. *Bull. Amer. Paleont.*, 96 (331), 1-159, pls. 1-14.

—— and Hanme, T., 1993, Molluscan shell beds of the Dainichi Formation of the Kakegawa Group, in Shizuoka Prefecture. *Jour. Geol. Soc. Japan*, 99 (11), 659-674. (*in Japanese*)

Makiyama, J., 1927a, Molluscan fauna of the Lower part

of the Kakegawa Series in the province of Totomi, Japan. *Mem. Coll. Sci., Kyoto Imp. Univ., Se. B*, 3, 1-147, pls. 1-6.

——, 1927b, Stratigraphy of the Kakegewa Pliocene in Totomi. *Ibid.*, 7 (1), 1-53, pls. 1-3.

——, 1957-1960, Matajiro Yokoyama's Tertiary fossils from various localities in Japan. Parts. 1-4, *Spec. Pap., Palaeont. Soc. Japan*, (1-4), pls. 1-119, Index 1-15.

Martin, K., 1879-80, Palaeontologische Engebnisse von Tief bohrungen auf Java, nebst allgemeinen studien uber das Tertiar von Java, Timor und einigen anderer Inseln. *Samml. Geol. Reichs. Mus., Leiden, Ser.* 3 (1-6), 1-381, pls. 1-15.

Masuda, K., 1962, Tertiary Pectinidae of Japan. *Sci. Rep., Tohoku Univ., 2nd Ser., Geol.*, 33 (2), 117-238, pls. 18-27.

——, 1980, Pliocene biostratigraphy in Japan based on pectinids. *Saito Ho-on Kai Mus., Res. Bull.*, (48), 9-19, pls. 2-3.

—— 1986a, Notes on origin and migration of Cenozoic pectinids in the Northern Pacific. *Palaeont. Soc. Japan, Spec. Pap.*, (29), 95-110, pls. 7-10.

——, 1986b, Historical change of the Neogene molluscan fauna of Japan with special reference to pectinids. *Monogr. Mizunami Fossil Mus.*, (6), 1-21. (*in Japanese*)

—— and Huang, C-Y. (1990a); Miocene Pelecypoda in the western foothills of northern Taiwan (Part II; Systematic description). *Bull. Nat. Mus. Nat. Sci.*, (2), 141-189, pls. 1-11.

—— and —— (1990b); Check list of Tertiary and Quaternary Mollusca in Taiwan. *Acta Geol. Taiwanica*, (28), 31-76.

—— and —— (1993a); Miocene gastropoda and scaphopoda in the western foothills of northern Taiwan. *Proc. Geol. Soc. China*, 36 (1), 11-138, pls. 1-3.

—— and —— (1993b); Additional Miocene Pelecypods in the western foothills of northern Taiwan. *Jour. Geol. Soc. China*, 36 (3), 259-290, pls. 1-5.

—— and —— (1994a); Pliocene shallow marine mollusks of the Chinsui and Choulan Formations in the Miaoli area, Northern Taiwa. *Jour. Geol. Soc. China*, 37 (3), 385-405, pls. 1-2.

—— and —— (1994b); Tertiary and Quaternary Pectinidae from Northern Taiwan. *Jour. Geol. Soc. Taiwan*, 37 (4), 497-548, pls. 1-10.

—— and Ogasawara, K., 1981, On the Omma-Manganzi Fauna and Tatsunokuchi Fauna. *Prof. M. Omori, Mem. Vol.*, 223-249, pls. 1-3.

Matsukuma, A., 1984, Intertidal bivalved molluscs collected from the Eastern Caroline and Marshall Islands, Western Pacific. *Proc. Japan. Soc. System. Zool.*, (27), 1-34, pls. 1-5.

——, 1986, Cenozoic glycymeridid bivalves of Japan. *Spec. Pap., Palaeont. Soc. Japan*, (29), 77-94, pls. 5-6.

—— and Yoosukh, W., 1988, Living *Bassina* and *Placamen* (Bivalvia; Veneridae) from the Australasia and the Indo-West Pacific (Studies on the Kawamura Collection (Mollusca) stored in the National Science Museum, Tokyo-V). *Saito Ho-on Kai, Spec. Publ. (Prof. T. Kotaka Commem. Vol.*), 567-582, pls. 1-2.

—— and Okamoto, K. 1986, New Cenozoic glycymeridid bivalves (Mollusca) from Japan. *Mem. Natn. Sci. Mus. Tokyo.*, (19), 91-100.

Matsuura, N., 1977, Molluscan fossils from the Late Pleistocene marine terrace deposit of Hokuriku region, Japan sea side of central Japan. *Sci. Rep., Kanazawa Univ.*, 22 (1), 117-162, pls. 1-20.

——, 1985, Successive change of the marine molluscan faunas from Pliocene to Holocene in Hokuriku region, central Japan. *Mem. Mizumai Fossil Mus.*, 12, 71-158, pls. 32-42.

Mimoto, K., 1992, Pliocene molluscan fossils from Iwado and Narashi, Muroto City, Kochi Prefecture. *Chigakukenkyu*, 41 (1), 47-51. (*in Japanese*)

Minoura, K., 1978, Growth and morphological change in *Anadara kogachiensis* Noda. *Earth Sci.*, 32 (1), 1-8. (*in Japanese with English abstract*)

Mizuno, T. and Amano, K. 1988, Molluscan fauna from the Kota Formation in the Joetsu City. *Bull. Mizunami City Fossil Mus.*, (14), 73-88, pls. 14-18. (*in Japanese with English abstract*).

Mori, S. and Nagata, T., 1979, Fossil assemblages from the Ninomiya Group. *Data of the Hiratsuka City Museum*, (19), 1-73, pls. 1-15. (*in Japanese title translated*).

Nakamura, Y., Ozawa, T. and Nobuhara, T., 1999, Stratigraphy and molluscan fauna of the Upper Miocene to lower Pliocene Miyazaki Group in the Aoshima area, Miyazaki Prefecture, southwest Japan. *Jour. Geol. Soc. Japan*, 105 (1), 45-60, pls. 1-2. (*in Japanese with English abstract*)

Nakao, K., 1995, Holocene molluscan fossils and their radiocarbon ages in the Nakagawa Plain in eastern Shikoku, Southwest Japan. *Bull. Tokushima Pref. Mus.*, (5), 11-43, pls. 1-5. (*in Japanese with English abstract*).

——, 2001, Holocene molluscan fossils from Nishizuka, southern Tokushima Plain, Southwest Japan. *Bull. Tokushima Pref. Mus.*, (11), 105-121, pls. 1-6. (*in Japanese with English abstract*).

Natori, H., Fukuta, O. and Ishida, M., 1972, Late Cenozoic planktonic foraminiferal biostratigraphy of Okinawa-jima and Miyazaki-ken. A preliminary report. *Jour. Japan. Assoc. Tech.*, 37 (7), 48-53.

Nemoto, N. and Akimoto, Y., 1990, Marine molluscan fauna of Joban coast, Fukushima Prefecture, Pacific coast, northern Honshu. *Taira Chigaku Dokokai*, (18), 3-21, pls. 1-15. (*in Japanese*)

Nishida, S., 1973, Preliminary study of the Upper Cenozoic calcareous nanno-plankton assemblages from the Nansei Island. *Mem. Geol. Soc. Japan*, 8, 65-75, 2 pls. (*in Japanese with English abstract*)

Nobuhara, T., 1993, The relationship between bathymetric depth and climate change and its effect on molluscan faunas of the Kakegeawa Group, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (170), 159-185.

—— and Tanaka, T., 1999, A new subspecies of *Rhizoconus hyaena* (Caenogastropoda; Conidae) from the Upper Pliocene Dainichi Formation, Shizuoka Prefecture, central Japan. *Venus, Japan. Jour. Malac.*, 58 (3), 129-143, pls. 1-2.

Noda, H., 1965, Some fossil *Anadara* from southwest Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (59), 92-109, pls. 10-11.

——, 1966, Cenozoic Arcidae of Japan. *Sci. Rep., Tohoku Univ., 2nd Ser., Geol.*, 38 (1), 1-161, pls. 1-14.

——, 1971, New anadarids and associated molluscan fauna from the Haneji Formation, Okinawa-jima, Ryukyu Islands. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (81), 27-51, pls. 6-7.

——, 1972, Geological significance of *Saxidomus purpuratus* (Sowerby) from the Pliocene Haneji Formation in Okinawajima. *Prof. Iwai, J. Mem. Vol.*, 683-690, pl. 4.

——, 1980, Molluscan fossils from the Ryukyu Islands, Southwestern Japan. *Sci. Rep., Inst. Geosci. Univ. Tsukuba, Sec. B, Geol. Sci.*, (1), 1-95, pls. 1-12.

——, 1988a, Molluscan fossils from the Ryukyu Islands, Southwest Japan. Part 2, Gastropoda and Pelecypoda from the Shinzato Formation in the middle part of Okinawa-jima. *Ibid.*, 9, 29-85, pls. 5-19.

——, 1988b, Neogene arcoids (Mollusca; Bivalvia) from the Ryukyu Islands, Southwest Japan. *Saito Ho-on Kai Spec. Publ. (Prof. T. Kotaka Commem. Vol.)*, 107-127, pls. 1-4.

——, 1991, Molluscan fossils from the Ryukyu Islands, Southwest Japan, Part 3, Gastropoda and Pelecypoda from the Yonabaru Formation in the southwestern part of Okinawa-jima, *Sci. Rep., Inst. Geosci., Univ. Tsukuba, Sec. B, Geol. Sci.*, 12, 1-63.

——, Kikuchi, Y. and Nikaido, A., 1993, Molluscan fossils from the Pliocene Kume Formation in Ibaraki Prefecture, Northeastern Kanto, Japan. *Sci. Rep., Inst. Geosci., Univ. Tsukuba, Sec. B*, 14, 115-204.

——, Watanabe, R. and Kikuchi, Y., 1995, Pliocene marine molluscan fauna from the Hitachi Formation in the northeastern part of Ibaraki Prefecture, Japan. *Ibid.*, 16, 39-93.

Nohara, T. and Miyagi, T., 1984, Notes on Nakoshi Sand of Northern Okinawa-jima. *Bull. Coll. Educ., Univ. Ryukyus*, 27 (2), 149-165, pls. 1-2. (*in Japanese with English abstract*)

Nomura, S, 1933, Catalogue of the Tertiary and Quaternary Mollusca from the Island of Taiwan (Formosa) in the Institute of Geology and Paleontology, Tohoku Imperial University, Sendai, Japan. *Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Geol.*, 16 (1), 1-108, pls. 1-4.

——, 1935, Catalogue of the Tertiary and Quaternary Mollusca from the Island of Taiwan (Formosa) in the Institute of Geology and Paleontology, Tohoku Imperial University, Sendai, Japan. Part 1, Pelecypoda. *Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Geol.*, 18 (2), 53-228, pls. 6-10.

——, 1937, The molluscan fauna from the Pliocene of Tosa. *Jour. Geol. Geogr.*, 14 (3-4), 67-90.

—— and Hatai, K., 1935, Pliocene mollusca from the Daishaka shell bed in the vicinity of Daishaka, Aomori-ken, Northeast Honshu, Japan. *Saito Ho-on Kai Mus., Res. Rep.*, (6), 83-142, pls. 9-13.

—— and ——, 1936, A note on the fossil marine fauna from Okinawa-zima, Ryukyu Group. *Jour. Geol. Soc. Japan*, 43 (512), 336-339.

—— and Zinbo, N, 1934a, Molluscan fossils from the Shimajiri Group, Ryukyus. *Jour. Geol. Soc. Japan*, 41 (489), 382-384. (*in Japanese*)

—— and ——, 1934b, Marine Mollusca from the "Ryukyu Limestone" of Kikai-zima, Ryukyu Group. *Sci. Rep., Tohoku Imp. Univ., Ser. 2, Geol.*, 16 (2), 109-164, pl. 5.

—— and ——, 1936, Molluscan fossils from the Simaziri Beds of Okinawa-zima, Ryukyu Islands. *Ibid.*, 18 (2), 229-266, pl. 11.

Ogasawara, K., 1977, Paleontological analysis of the Omma Fauna from Toyama-Ishikawa area, Hokuriku Province, Japan. *Sci. Rep., Tohoku Univ., 2nd Ser., Geol.*, 47 (2), 43-156, pls. 3-22.

——, 1981, Paleogeographic significance of the Omma-Manganzian Fauna of the Japan Sea Borderland. *Saito Ho-on Kai Mus., Res. Bull.*, (49), 1-17, pls. 1-2.

——, 1986, Notes on origin and migration of the Omma-Manganzian Fauna, Japan. *Spec. Pap., Palaeont. Soc. Japan*, (29), 227-244.

——, 1988, Neogene bio-events in terms of warm-and cold-water molluscs in Northeast Honshu, Japan. Osaka Nat. Hist. Mus., 49-70.

——, 1994a, Paleogeography and paleoceanic climate at the Japan Sea opening based on the shallow marine molluscan faunas. *Monthly Chikyu*, 16 (3), 174-180. (*in Japanese title translated*)

——, 1994b, Neogene paleogeography and marine climate of the Japanese Island based on shallow marine molluscs. *Paleogeogr. Palaeoclim. Palaeoecol.*, 108, 335-351.

——, 1995, Notes on adaptational process of cold-water molluscs on the basis of Japanese Cenozoic molluscan records. *Rep. Shallow Tethys 4, Ann. Mus. Civ. Roverto, Sez. Aech., St. Sc. nat. Suppl.*, 11, 277-286.

—— and Masuda, K., 1983, Notes on the paleoenvironments based upon the Cenozoic molluscs in the Ryukyu Islands. *Mem. Geol. Soc. Japan*, (22), 95-105. (*in Japanese with English abstract*)

O'Hara, S., 1968, Illustration book of the geoscience of Chiba Prefecture. *Ser. 5*, Pelecypods. *Research Comm. Geosci. Chiba Pref.*, 1-91, pls. 1-17. (*in Japanese, title*

translated)

—— and Ito, M., 1980, Molluscan fossils from the Senhata Formation in the Boso Peninsula. *Prof. S. Kanno Mem. Vol.*, 121-136, pls. 14-17.

—— and Nemoto, N., 1988, Pectinids from Taga Group of the Joban Coalfield. *Saito Ho-on Kai, Spec. Publ. (Prof. T. Kotaka Commem. Vol.)*, 481-496, pls. 1-4.

Okamoto, K., 1978, Paleontological note of mega fossils. *Geol. Surv. Japan Cruies Rep.*, (10), 55-58.

—— and Honza, E., 1978, The "Pliocene" fossil molluscan assemblages including *Amussiopecten* collected by GH77-2 Cruise in the Southwestern Japan Sea. *Jour. Geol. Soc. Japan*, 84 (10), 625-628. (*in Japanese*)

—— and Ibaraki, M., 1988, Early Pleistocene fossil mollusca from the sea of Japan off Yamaguchi Prefecture, southwest Japan. *Saito Ho-on Kai, Spec. Pub. (Prof. Kotaka, T. Commem. Vol.)*, (3), 523-532, pls. 1-2.

Okumura, K., 1988, Molluscan fossils from the Pleistocene Ninomiya Group in the Oiso Hills, Kanagawa Prefecture, Central Japan. *Culture Properties Res. Rep., Ninomiya Kyoiku Iinkai*, (16), 1-99, pls. 1-18.

Okumura, K. and Koyanagi, T., 1989, Molluscan fossils from the Ashigara Group, southwestern part of the Kanto Region, central Japan. *Bull. Mizunami Fossil Museum*, (16), 65-83, pls. 8-9.

—— and Takei, T., 1993, Molluscan assemblage from the Late Pliocene Ananai Formation, Kochi Prefecture, Southwest Japan. *Bull. Mizunami Fossil Museum*, (20), 133-183, pls. 27-40.

—— and Ueda, T., 1998, Molluscan fossils from the Upper Pliocene Nakatsu Formation in the middle part of Sagami River, Kanagawa Prefecture, Japan. *Ibid.*, (25), 53-87, pls. 5-15.

—— and Yamaguchi, Y., 1992, Molluscan fauna from the Late Miocene Hatsuse Formation in the Miura Peninsula, Kanagawa Prefecture, Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (165), 1009-1023.

Omori, M.,1977, Molluscan fosssils from the so-called Sawane Formation, Sado Island, with special description of Pectinidae. *Res. Rep., Sado Mus.*, (7), 63-76, pls. 1-5. (*in Japanese*)

Otuka, Y., 1935, The Oti Graben in southern Noto Peninsula, Japan. (Part 3). *Bull. Inst. Earthq. Res., Tokyo Imp. Univ.*, 13 (3), 846-909, pls. 53-57.

Oyama, K., 1951, Classification of Cenozoic taxodont shells of Japan. *Mineral and Geology*, 4 (5-6), 146-157, pl. 6. (*in Japanese*)

——, 1954, Matajiro Yokoyama's the Pliocene and later fauna from Kwanto region in Japan. *Palaeont. Soc. Japan, Spec. Pap.*, (2), 1-68, pls. 1-49.

——, 1973, Revision of Matajiro Yokoyama's type mollusca from the Tertiary and Quaternary of the Kanto area. *Palaeont. Soc. Japan, Spec. Pap.*, (17), 1-148, pls. 1-57.

Ozawa, T., 1996, A new species of *Batillaria* (Gastropoda; Batillariidae) from Japan. *Venus, Japan. Jour. Malac.*, 55 (3), 189-197, pl. 1.

——, Tanaka, T. and Tomida, S., 1998, Pliocene to early Pleistocene warm water molluscan fauna from the Kakegawa Group, central Japan. *Nagoya Univ., Furukawa Mus., Spec. Pap.*, (7), 1-204, pls. 1-31.

Sato, Y., Masuda, K. and Shuto, T., 1986, Pelecypod fauna of the Shimajiri Group in Miyako-jima, Okinawa Prefecture, Japan. *Mem. Fac. Sci., Kyushu Univ., Ser D.*, 26 (1), 1-49, pls. 1-5.

Sawada, Y. 1962, The geology and paleontology of the Setana and Kuromatsunai areas in southwest Hokkaido, Japan. *Mem. Muroran Inst. Tech*, 4 (1), 1-110, pls. 1-5.

Sakagami, S. *et al.*, 1966, Fossils from the Tomikawa Formation of Kamiiso, Ohshima Peninsula, Hokkaido, I, Mollusca etc. *Jour. Hokkaido Univ. Educ., Ser. 2*, 2B, 17 (1), 78-93, pls. 1-9.

Shuto, T., 1960, On some pectinids and venerids from the Miyazaki Group (Paleontological study of the Miyazaki Group 7). *Mem. Fac. Sci., Kyushu Univ., Ser. D*, 9 (3), 119-149, pls. 12-14.

——, 1961, Palaeontological study of the Miyazaki Group-A general account of the faunas. *Mem. Fac. Sci. Kyushu Univ., Ser. D*, 10 (2), 73-206, pls. 11-13.

——, 1969, Neogene Gastropods from Panay Island, the Philippines. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, 19 (1), 1-250, pls. 1-24.

——, 1986, Origin and development of the Kakegawa Fauna. *Spec. Pap., Palaeont. Soc. Japan*, (29), 199-210.

Takahashi, H., 1986, Molluscan fossils from the Pliocene Kume Formation in the Hitachi-Ota area, Ibaraki Prefecture, Japan. *Bull. Mizunami Fossil Mus.*, (6), 91-103, pls. 12-14.

Takayasu, K., 1976a, The Quaternary Limestones in the northern part of the Motobu Peninsula, Okinawa Islands. *Jour. Geol. Soc. Japan*, 82, 153-162. (*in Japanese with English abstract*)

——, 1976b, Re-examination on the Quaternary System of Okinawa-jima, Ryukyu Islands. *Geol. Stud. Ryukyu Islands*, 1, 79-96. (*in Japanese*)

——, 1978, "Ryukyu Limestone" of Okinawa-jima, South Japan —A stratigraphical and sedimentological study—. *Mem. Fac. Sci., Kyoto Univ., Ser. Geol. Mineral.*, 45 (1), 133-175, pls. 14-16.

Takayasu, T., Ogasawara, K., Masuda, K. and Matoba, Y., 1986, Neogene and Quetemary molluscs from the Akita Oil-field, Japan. Commem. Assoc. Prof. T. Takayasu, Mineral. Indust. Mus., Minin. Coll., Akita Univ., 1-310, pls.1-45. (*in Japanese*)

Taki, I. and Oyama, K., 1954, The Pliocene and later faunas from the Kanto region in Japan. *Spec. Pap., Palaeont. Soc. Japan*, (2), 1-68. pls. 1-49.

—— and ——, 1960, The Pliocene and later faunas from the Kwanto region in Japan. *Spec. Pap., Palaeont. Soc. Japan*, (2), 1-68. pls. 1-49.

Tesch, P., 1915, Jungtertiaere und Quartaere Mollusken von Timor. *Palaeont. Timor*, **5**, 73-82, pls. 73-82.

——, 1920, Jungtertiaere und Quartaere Mollusken von Timor. *Palaeont. Timor*, **8**, 41-121, pls. 129-140.

Tokunaga, Y., 1906, Fossils from the environs of Tokio. *Jour. Coll. Sci., Tokyo Imp. Univ.*, **21** (2), 1-96, pls. 1-6.

Tsuchi, R., 1955, The paleo-ecological significance of the later Pliocene molluscan fauna from the Kakegawa district, the Pacific Coast of Central Japan. *Rep. Lib. Arts Fac. Shizuoka Univ.*, (8), 45-58, pl. 1.

——, 1961, On the Late Neogene sediments and molluscs in the Tokai region, with notes on the geologic histroy of the Pacific Coast of Southwest Japan. *Jour. Geol. Geogr.*, **32** (3-4), 437-456.

—— and Ibaraki, M., 1978, Late Neogene succession of molluscan fauna on the Pacific coast of Southwestern Japan, with reference to planktonic foraminiferal sequence. *Veliger*, **21** (2), 216-224.

Ujiie, H. and Oki, K., 1974, Uppermost Miocene-Lower Pleistocene planktonic foraminifera from the Shimajiri Group in Miyakojima, Ryukyu Islands. *Mem. Natn. Sci. Mus.*, **7**, 31-52.

Woodring, W. P., 1973, Geology and paleontology of the central zone and adjoining parts of Panama, Description of Tertiary mollusks additions to Gastropods, Scaphopods, Pelecypods; Nuculidae et Malletidae). *Geol. Surv. Prof. Pap.*, **306-E**, 453-539, pls. 67-82.

Yabe, H. and Hatai, K., 1937, On the stratigraphical significance of *Pecten naganumanus* Yokoyama, and its bearing on the Japanese Neogene. *Jour. Geol. Soc. Japan*, **44** (530), 1013-1024, pl. 32.

——, and ——, 1941a, A supplementary note on the fossil marine fauna from Okinawa-zima, Ryukyu Islands. *Trans. Palaeont. Soc. Japan*, (133), 464-468, pl. 11.

—— and ——, 1941b, Additional fossils from the Shimaziri Beds of Okinawa-zime, Ryukyu Islands, Japan. *Japan. Jour. Geol. Geogr.*, **18** (1-2), 71-78, pl. 7.

Yamada, J., 1963, Remarks on the significance of the Pleistocene Mollusca from the Shima Peninsula, Mie Prefecture, Japan. *Bull. Dep. Lib. Arts, Mie Univ.*, (27), 96-103, 1 pl.

Yamashita, Y., Yuge, K. and Matsukuma, A., 1998, Molluscan fossils of the Pleistocene Ryukyu Limestone of Kikaijima Island, Southwestern Japan- 1. Bivalvia. *Sci. Rept., Dept. Earth and Planet. Sci., Kyushu Univ.*, **29** (1), 1-15, pls.1-9.

Yokoyama, M., 1920, Fossils from the Miura Peninsula and its immediate north. *Jour. Coll. Sci., Imp. Univ. Tokyo*, **39** (6), 1-193, pls. 1-20.

——, 1922a, On a new species of *Pecten* from the Neogene of Japan. *Jour. Geol. Soc. Tokyo*, **29** (350), 1-2, pl. 5.

——, 1922b, Fossils from the Upper Musashino of Kazusa and Shimosa. *Jour. Coll. Sci., Imp. Univ. Tokyo*, **44** (1), 1-200, pls. 1-17.

——, 1923, Tertiary mollusca from Dainichi in Totomi. *Jour. Coll. Sci., Imp. Univ. Tokyo*, **45** (2), 1-18, pls. 1-12.

——, 1924, Mollusca from the Coral Bed of Awa. *Jour. Coll. Sci., Imp. Univ. Tokyo*, **45** (1), 1-62, pls.1-5.

——, 1926a, Tertiary Mollusca from Southern Totomi. *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, **1** (9), 313-364, pls. 38-41.

——, 1926b, Tertiary shells from Tosa. *Ibid.*, **1** (9), 365-368, pl. 42.

——, 1927, Mollusca from the upper Musashino of Tokyo and its suburb. *Ibid.*, **1** (10), 291-437, pls. 46-50.

——, 1928a, Mollusca from the oil-field of the islands of Taiwan. *Rep. Imp. Geol. Surv. Japan*, (101), 1-112, pls. 1-18.

——, 1928b, Pliocene shells from Hyuga. *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, **2** (7) , 331-356, pls. 66-67.

——, 1929, Pliocene shells from Tonohama, Tosa. *Rep. Imp. Geol. Surv. Japan*, (104), 9-17, pls. 7-8.

Yoon, S., 1988, The Seoguipo molluscan fauna of Jeju Island, Korea. *Saito Ho-on Kai, Spec. Publ. (Prof. Kotaka, T. Commem. Vol.)*, 539-545, pls. 1-5.

Yoshida, H., 1980, Molluscan fossil assemblages from the Kakegawa Group in the Kakegawa district, Shizuoka Prefecture. Study of Molluscan Paleobiology (Prof. M. Omori Mem. Vol.), 327-340.