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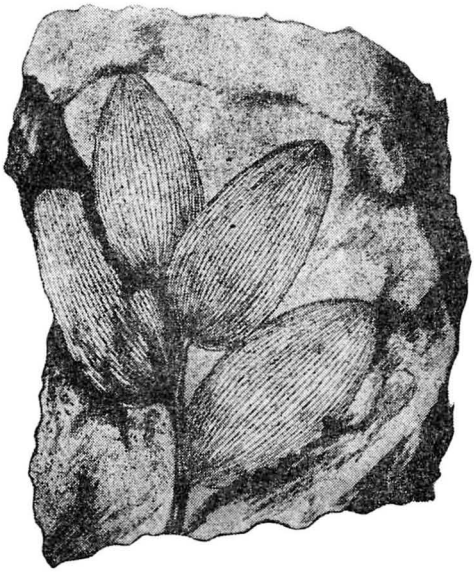

日本古生物学会

Palaeontological Society of Japan
December 30, 1978

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The fossil on the cover: Original figure of *Podozamites Reinii* GEYLER, 1877, from the Tetori group. GEYLER's description marked the onset of modern palaeontology in Japan.

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694. QUATERNARY OSTRACODA FROM KISARAZU NEAR TOKYO*

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Abstract. This paper gives a detailed account of the Quaternary ostracode fauna of Kisarazu area near Tokyo. Three fossil ostracode assemblages are discernible: i) a sand flat assemblage, ii) a shallow mud assemblage, and iii) a silty sand assemblage. In systematic paleontology, eight new species, *Pseudopsammocythere tokyoensis*, *Ambostracon ikeyai*, *Cornucoquimba ishizakii*, *Actinocythereis kisarazuensis*, *Lixouria nipponica*, *Buntonia hanaii*, *Paracytheridea bosoensis* and *Cytheroma? hanaii*, are described.

Introduction

Information about Quaternary ostracodes from Japan is scarce. In his pioneer work on the Japanese Cenozoic ostracodes, HANAI (1957a-c, 1959a, b, 1961a, b) described some Pleistocene species from the Sawane Formation and the Setana Formation of northeastern Japan, the Katase Formation and the Sakurai silty sand (Kisarazu) of central Japan. ISHIZAKI (1976) also described some Pleistocene ostracodes from the Furuya Mud, Shizuoka Prefecture.

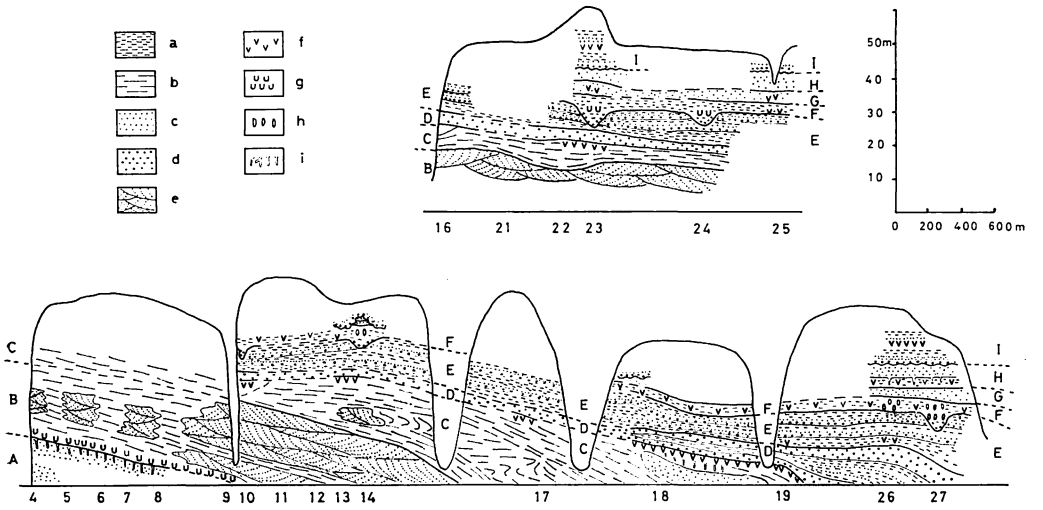
The purpose of this study was to obtain basic data for a systematic study on the marine ostracodes occurring in the Japanese Pleistocene. Fossiliferous marine deposits of Kisarazu near Tokyo were selected for field observation. In this area, marine Quaternary sediments, which contain abundant, well-preserved ostracodes and molluscs, are exposed in the cliffs along the coast of Tokyo Bay. In order to infer Pleistocene environments inhabited by the ostracodes, detailed field observations were made on the sediments and megafauna. Ostracodes were collected from the localities whose environmental conditions were analysed giving special attention to the occurrence of molluscs and the nature of burrows. Then the distribution of ostracodes was interpreted in light of the inferred environmental conditions.

* Received Dec. 27, 1977; read Jan. 22, 1977 at Koganei.

Field observation

The upper Pleistocene sediments of Kisarazu inclined slightly and homoclinally toward the northwest, represent the last stage of filling-up deposition of the Paleo-Tokyo Bay, which opens its mouth toward the east (YABE, 1914). They can be classified stratigraphically into nine members called A-I in upward sequence. Correlation between various stratigraphic units used by previous authors is presented in Table 1.

A Sand.—The A Sand, the lowest member exposed in the area, is distributed narrowly along the east coast of Tokyo Bay from Hitomi to Owada (Locs. 1-8). It consists of a lower 7 m of red-brownish, medium-grained sand, and an upper 5 m



Text-fig. 1. Geological cross sections. Upper, section along a road from Honnawa (16) to Katsudoyatsu (25); lower, section along the coastal road of Tokyo Bay from Hitomi (4) to Sakurai (26, 27). Numerals represent locality number. a, massive silt; b, thin laminated silt; c, sand; d, gravel; e, cross laminations; f, pumice tuff; g, oyster banks; h, *Dosinia angulosa*; i, type 1 burrow.

Table 1. Comparison of the stratigraphic units among various works.

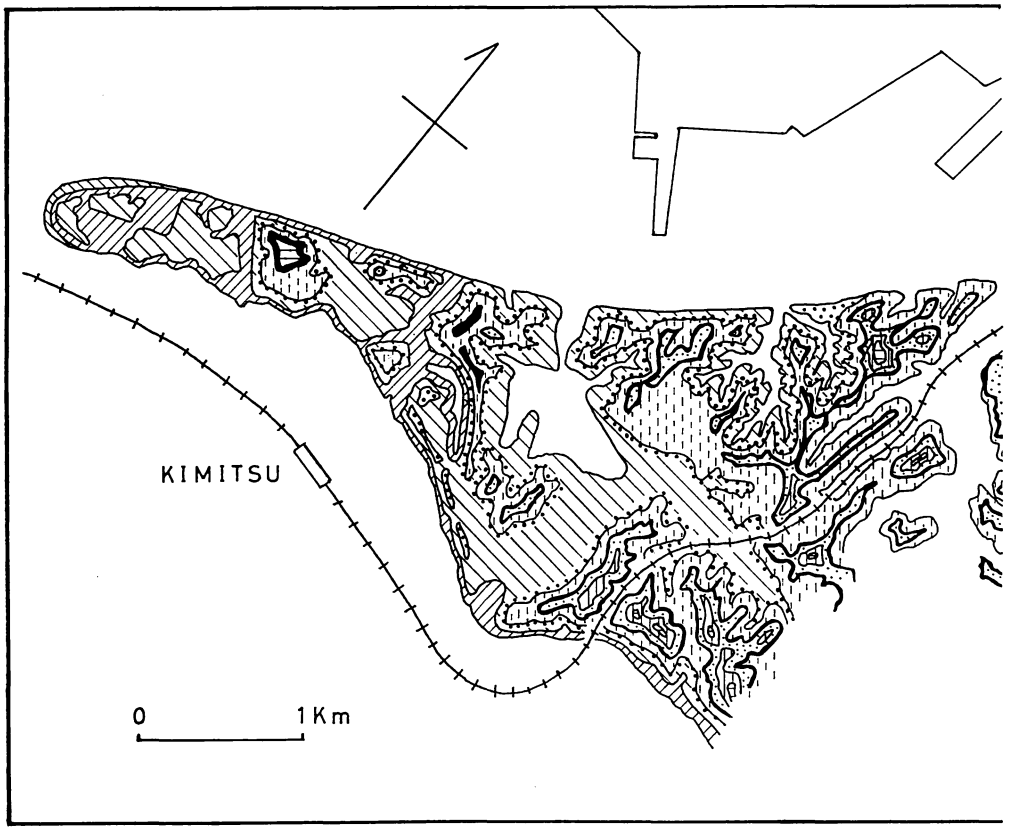
KOZIMA 1966a	KIKUCHI 1972b		AOKI and BABA 1973		YAJIMA 1977
"Se"	Narita F.	Kioroshi M.	Anegasaki F.		I Member
"Su"					
"Shi"		Kamiiwahashi M.	Narita F.	Kioroshi M.	H Sand
"Sa"				Kamiiwahashi M.	G Sand
"Ko"					F Silt
"Ke"		Kiyokawa M.		Kiyokawa M.	E Member
"Ku"					
"Ki"					D Gravel
			Kamiizumi F.		
"U"-"Ka"			Semata F.		C Silt
"I"			Jizodo F.		B Member
"A"			Naruto F.		A Sand

of yellowish brown or grey well-sorted medium- to coarse-grained sand with cross lamination.

White cylindrical aggregates of white sand grains which attain 1 to 2.5 cm in length and 3 to 4 mm in diameter are scattered in the upper part of the A Sand throughout the area, forming irregularly lenticular bodies of 2 to 3 m in diameter and 50 to 70 cm in thickness (Locs. 5, 6). Most of the cylindrical aggregates lie parallel to bedding, but some are oblique, forming cross lamination. This feature has been regarded as trace fossils made by isopods of the genus *Excilolana* (KIKUCHI, 1972a).

Simple tube-like burrows of about 6 cm in diameter and 50 to 100 cm in length are often branched and are disposed nearly vertically at intervals of about 20 cm in the uppermost horizon of the A Sand. Most of them terminate upward at the top of the A Sand. Some, however, seem to extend further upward to certain bedding planes in the lower part of the B Member. The wall of tube is made of mud, and the inside is filled with muddy sand of the B Member. It may be considered that the burrowers lived during a certain period of time which is represented by the lowermost several centimeters of the B Member, though the evidences are found mostly in the underlying A Sand. These burrows, described and illustrated by OHSHIMA (1967), and herein called Type 1, are quite similar in size and shape to those of *Upogebia major*, a decapod.

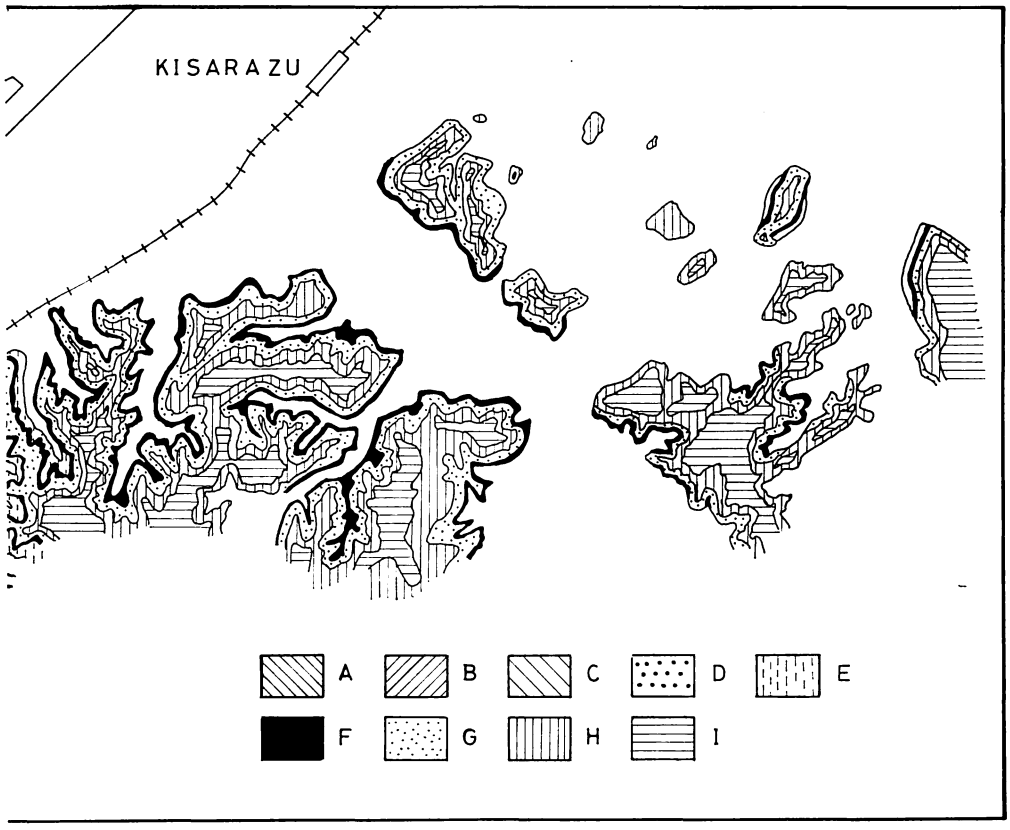
B Member.—Deposition of the B Member begins with the lowest mud which also fills the burrows in the A Sand. The B Member, about 20 m in thickness throughout the area, is chiefly composed of alternation of thin layered sand and silt. It outcrops along the coastal road of Tokyo Bay from Hitomi (Loc. 4) to Sakata through Owada (Locs. 9, 10), and the unconnected exposures are extended further inland to the Kita-Koyasu area (Loc. 24). Litho- and biofacies of this member are remarkably different between southern and northern areas. In the former (Hitomi to Owada), silty elements of alternation predominate and oyster banks are developed in the basal 3 m of silt. The lowest horizon of the B Member is characterized by 20 cm thick of muddy sand with abundant shell fragments which are generally too fragmentary to warrent species identification. Valves of some larger molluscs, *Glycymeris yessoensis* and *Crassostrea gigas*, however, lie with convex sides upwards, and form a substratum for growth of oysters. Individuals of an oyster species, *Crassostrea gigas*, attach their umbones to these valves and grow upward to form the first "generation" of oysters. The oysters of next "generation" attach themselves to the side of the valves of the first "generation" and grow again upward so as to form a spreading dendritic colony of oysters (cf. CHINZEI, 1971). Various growth stages of oyster colony are preserved in the mud. Together these colonies form a large oyster bank 10 m long and about 3 m thick. Mud surrounding the oyster colonies contains such fossils as *Balanus rostratus* and foraminifers, but ostracodes are rare. Oyster banks are covered by black to grey micaceous silt with thinly laminated sand or by a silt layer 10 m thick with pebbles, granules, and moulds of *Pecten albicans*, *Mytilus* sp. and barnacles. The silt is intercalated at some places with lenticular bodies of coarse-grained sand and granules, more than 15 m in length and about 7 m in maximum thickness. Many molluscan fossils such as *Tapes japonicus* and *Glycymeris yessoensis* occur from these lenses.



Text-fig. 2. Geological map. A, A Sand; B, B Member; C, C Silt;

In the northern area (Owada to Sakata and Kita-Koyasu area), the B Member is composed of alternation of thin silt layers (6 cm) and medium-grained sand layers about 15 cm thick. Sand layers yield abundant molluscs whose specific names are listed in Table 2. The abundance of cold "Oyashio" type species, i. e. *Glycymeris yessoensis* and *Spisula sachalinensis*, characterizes the fossil assemblage of this horizon (KOZIMA, 1966b). They are mostly disarticulated, abrased and broken. In addition to mechanical destruction, shells often show evidence of attack by boring sponges and annelids. Two kinds of tube-like burrows, both of which are vertical to the bedding plane but different in size, are also found in sand layers. One is about 8 mm in diameter and 5 cm in length, and another about 2 to 3 mm in diameter and 5 cm in length. The wall of tube is made up of silt, and the inside is filled with mediumgrained sand. In general, shape of these burrows resembles those of the isopods, *Tylos* and *Talorchestia*, and the decapod *Scopimera*, all common inhabitants of the intertidal zone (OHSHIMA, 1967). This type of burrow is different from Type 1 bur- row in size and thickness of wall, and is here called Type 2 burrow.

C Silt.—The C Silt is widely distributed from Hitomi to Obama and conformably overlies the B Member. It is about 10



D, D Gravel; E, E Member; F, F Silt; G, G Sand; H, H Sand; I, I Member.

to 15 m thick and is composed of thinly laminated silt. The *Tapes japonicus*-bearing middle part of the C Silt, which reaches 5 m in thickness, shows slumping fold structure (Loc. 17) accompanied by lenticular bodies of medium- to coarse-grained sand (Loc. 14). Sand lens contains allochthonous shells of the molluscan species listed in Table 3. The upper part of the C Silt is composed of thin layered silt. In the southern area at Owada it changes into sand with pebbles and cobbles (Loc. 10). In the northern area from Hatazawa to Obama (Locs. 18 to 19), the upper laminated silt contains shell moulds in the sandy layer, and is intercalated with sand lenses which contain the molluscan species listed in Table 3. *Tapes japonicus*, *Glycymeris yessoensis* and *Suchium costatum* are dominant and articulated shells of *Pecten* (*Mizuhopecten*) *tokyoensis*, a large pectinid having shell length of more than 20 cm, are found in life position with the flat left valve upward. However, *Suchium costatum* is represented by many water-worn specimens, and thus the fossil assemblage of the C Silt may be the result of mixture of various sources of supply. Type 1 burrows and bivalve moulds occur in the uppermost part of sand lense.

An upper white fine acidic tuff and a lower acidic tuff, each about 15 cm thick, are found two-in-set in the uppermost

Table 2. Fossils of molluscs and barnacles from the B Member.

Molluscs \ Locality number	10	22	24
Collisella (Conoidacmea) heroldi (DUNKER)			C
Turcica coreensis PEASE			R
Suchium giganteum (LESSON)		R	
S. costatum (KIENER)	R		A
Homalopoma sangarense (SCHRENCK)		R	
Batillaria cumingii (CROSSE)			R
Neverita (Glossaulax) didyma (RÖDING)			C
Tectonatica severa GOULD		R	R
Tonna luteostoma (KÜSTER)			R
Neptunea (Barbitonia) arthritica (BERNARDI)			C
Siphonalia cassidariaeformis (REEVE)			C
Tritia (Tritonella) fuscolineata (E.A. SMITH)			R
Olivella japonica STERNS			C
Noditerebra (Noditerebra) reticostata (YOKOYAMA)		R	
Fulgoraria prevostiana (CROSSE)		R	
Ringicula doliaris GOULD	R	R	
Dentalium (Paradentalium) octangulatum hexagonum GOULD			R
Nucula (Lamellinucula) tokyoensis YOKOYAMA	R		
Glycymeris (Glycymeris) yessoensis (SOWERBY)	C	C	R
Arca boucardi miyatensis OYAMA		R	C
Anadara (Scapharca) broughtoni (SCHRENCK)	R		
Striarca (Galactella) interplicata (GRABAU & KING)	R		C
Chlamys (Chlamys) farreri (JONES & PRESTON)		A	
Pecten (Mizuhopecten) tokyoensis TOKUNAGA		R	R
Crassostrea gigas (THUNBERG)			R
Venericardia (Megacardita) ferruginosa (ADAMS & REEVE)		C	R
Carditella (Carditellopsis) toneana (YOKOYAMA)	R	R	
Callista chinensis (HOLTEN)	R		R
Dosinia (Phacosoma) japonica (REEVE)		R	
Gomphina (Macridiscus) veneriformis (LAMARCK)	R		R
Tapes (Ruditapes) japonicus (DESHAYES)	A	A	A
Mactra (Mactra) sulcataria REEVE	R		
Spisula (Pseudocardium) sachalinensis (SCHRENCK)	R	R	
Gari (Gobraeus) kazusensis (YOKOYAMA)			R
Macoma tokyoensis MAKIYAMA			R
Solen grandis DUNKER		R	R
Myadora japonica HABE			R
Barnacles			
Solidobalanus (Solidobalanus) socialis (HOEK)	R		
S. (Hesperibalanus) hesperius (PILSBRY)		C	
Balanus rostratus HOEK	R	C	

A, abundant; C, commen; R, rare.

Table 3. Fossils of molluscs and barnacles from the C Silt.

Molluscs \ Locality number	14	16	18
Suchium giganteum (LESSON)		R	
S. costatum (KIENER)	R	R	C
Homalopoma sangarense (SCHRENCK)	R		
Daronia yokoyamai OYAMA		R	R
Batillaria cumingii (CROSSE)	R	R	R
Neptunea (Barbitonia) arthritica (BERNARDI)	R	R	
Ringicula doliaris GOULD	R	R	
Glycymeris (Glycymeris) yessoensis (SOWERBY)	C	A	C
Anadara (Scapharca) broughtoni (SCHRENCK)		R	C
Chlamys (Chlamys) farreri (JONES & PRESTON)			R
Pecten (Notovola) albicans albicans (SCHRÖTER)	R		
P. (Mizuhopecten) tokyoensis TOKUNAGA		R	A
Anomia sp.	R		
Crassostrea gigas (THUNBERG)		R	
Ostrea sp.		R	
Clinocardium (Clinocardium) californiense (DESHAYES)			R
Sunetta (Cyclosunetta) concinna DUNKER	R		
Tapes (Ruditapes) japonicus (DESHAYES)	C	A	A
Spisula (Pseudocardium) sachalinensis (SCHRENCK)	A	A	R
Gari (Gobraeus) kazusensis (YOKOAYMA)			R
Barnacles			
Balanus rostratus HOEK	R		
Megabalanus rosa (PILSBRY)	R		

horizon of the C Silt throughout the area. The lower tuff contains appreciable amount of mafic minerals.

D Gravel.—The boundary between the C Silt and the overlying D Gravel may correspond to the basal unconformity of the Narita Formation of previous authors (KIKUCHI, 1972b; AOKI et al., 1973a). Although the uneven, possibly erosional surface can be observed between the two members at Loc. 10, the D Gravel always rests upon the uppermost tuff of the C Silt throughout the area. Thus, the writer failed to find convincing evidence that of appreciable discontinuity of deposition between the C Silt and the D Gravel. It is quite likely that the gravel is not a basal conglomerate but merely the base of the deltaic deposits.

The D Gravel is distributed from Owada to Sakurai. In the southern area from Owada to Hatazawa, it is 3 to 5 m thick and is composed of pebbles and granules with a matrix of coarse-grained sand. Rare shell fragments were unidentifiable.

The D Gravel thickens toward the north by intercalation of massive silt layers. The silt layers thicken and the gravel gradually becomes coarse sand to-

ward north forming alternating layers reaching 1 m in thickness near Obama. Further, silt predominates toward north and the intercalated coarse-grained sand layers become 10 to 20 cm thick near Sakurai. There, the D Gravel is about 10 m thick with an intercalation of silt, 6 m thick. The silt is typically a dusty yellow-green when wet, and greenish-grey when dry. Wood fragments and pumice particles are found commonly in the silt. Thus the gravel bed is confined to the uppermost and lowermost parts of the D Gravel at Sakurai.

Subrounded to flattened pebbles of siltstone are characteristic of the gravel bed. A mould of *Palliolum* (*Delectopecten*) *peckhami* which occurs in one of the siltstone pebbles suggests they were derived from the Kazusa Group (Pliocene and Pleistocene) immediately to the south. Irregular bodies of coarse-grained sand in the gravel often show varieties of cross-laminations.

E Member.—The E Member, about 6 to 8 m thick, conformably overlies the D Gravel and is exposed extensively over the area from Hitomi to Kazusa-Kiyokawa (Loc. 42). It is composed of sand and silt beds, characterized by graded bedding. The each bed is 1 to 2 m thick and has a textural gradation from coarse-grained sand at the base and fine silt at the top. A number of Type 1 burrows, about 5 cm in diameter and 20 cm or more in length, with fillings of pumiceous sand and granules, are found in a bed of 1 m in thickness. The upper surface of this bed lies about 3 m below the top of the E Member. The silty part contains abundant wood fragments and pumice particles. The uppermost 1 m of silt again contains Type 1 burrows which attain 3 to 4 cm in diameter.

In the vicinity of Kazusa-Kiyokawa, the lithofacies characterized by graded bedding change laterally into the well-sorted, grey, medium-grained sand containing molluscan fossils. Current-strewn valves of *Spisula sachalinensis*, lying convex side upward, form several layers in the sand.

F Silt.—In some localities (Locs. 10, 14, 23, 24 and 27), the F Silt is separated from the E Member by some notable stratigraphic breaks. V-shaped channels of various size are eroded into the E Member lying below. These channels have a maximum width of about 20 m and depth of 6 to 7 m, and are filled with bluish grey silt containing abundant granules of black sandstone and chert, and considerable amount of wood fragments. Thus it may be concluded that the depositional break and time gap exist between the E Member and the F Silt.

The F Silt is exposed along the east coast of Tokyo Bay from Owada to Kazusa-Kiyokawa through Sakurai and further inland-ward along the route from Kita-Koyasu to Katsudoyatsu. It is only 2 to 4 m thick and is composed mainly of bluish-grey silt with abundant pumice particles and Type 1 burrows. The bed contains many species of fossil molluscs including *Dosinia angulosa*, *Crassostrea gigas*, *Anadara broughtoni*, and *Panopea japonica*. Dates by fission tracks of the pumice particles fall between 147,000± 9,000 and 143,000±11,000 years B. P. for these shell bed (SUZUKI, 1976).

Complete valves of *Dosinia angulosa* are embedded vertically to the bedding plane. The inside of shells is mostly empty, but some are partly filled with laminated sediments. The sediments fallen into the cavities through the small opening along the contact margin of two valves are much finer than those of the surrounding sediments. The mode of occurrence strongly suggests that *Dosinia*

angulosa was buried while in living position. *Panopea japonica* also occurs rarely and in life position. Oyster banks of the small scale develop at Kita-Koyasu (Locs. 23, 24). The upper part of the F Silt contains moulds of molluscs such as *Macoma* sp.

G Sand.—The G Sand conformably overlies the F Silt and is distributed near Sakurai. It is about 2 to 5 m thick and is composed mainly of grey fine-grained well-sorted pumiceous sand. The sand, containing numerous molluscan species listed in Table 4, echinoderms, bryozoans and solitary corals, has been called "Sakurai Shell Bed" by KOZIMA (1966a, b) and OYAMA (1967). Fossils occur as scattered masses of irregularly packed shells. Among the molluscan species, *Pecten albicans, Limopsis forskalii* and several others which dominate the assemblage, are shallow bottom inhabitants (about 20 to 50 m in depth) of the "Kuroshio" type warm sea of the present Japanese coast. Valves of *Pecten albicans* are usually articulated. Unidentified tube-like burrows are rare.

H Sand.—The H Sand lies conformably on the G Sand and is distributed in the northern part of the area. It is composed of the lower greyish muddy sand about 3 m thick, and the upper well-sorted medium-grained pumiceous sand about 3 m thick. It gradually thickens northward. In the fossil bed of the lower muddy sand the following taxa predominate:

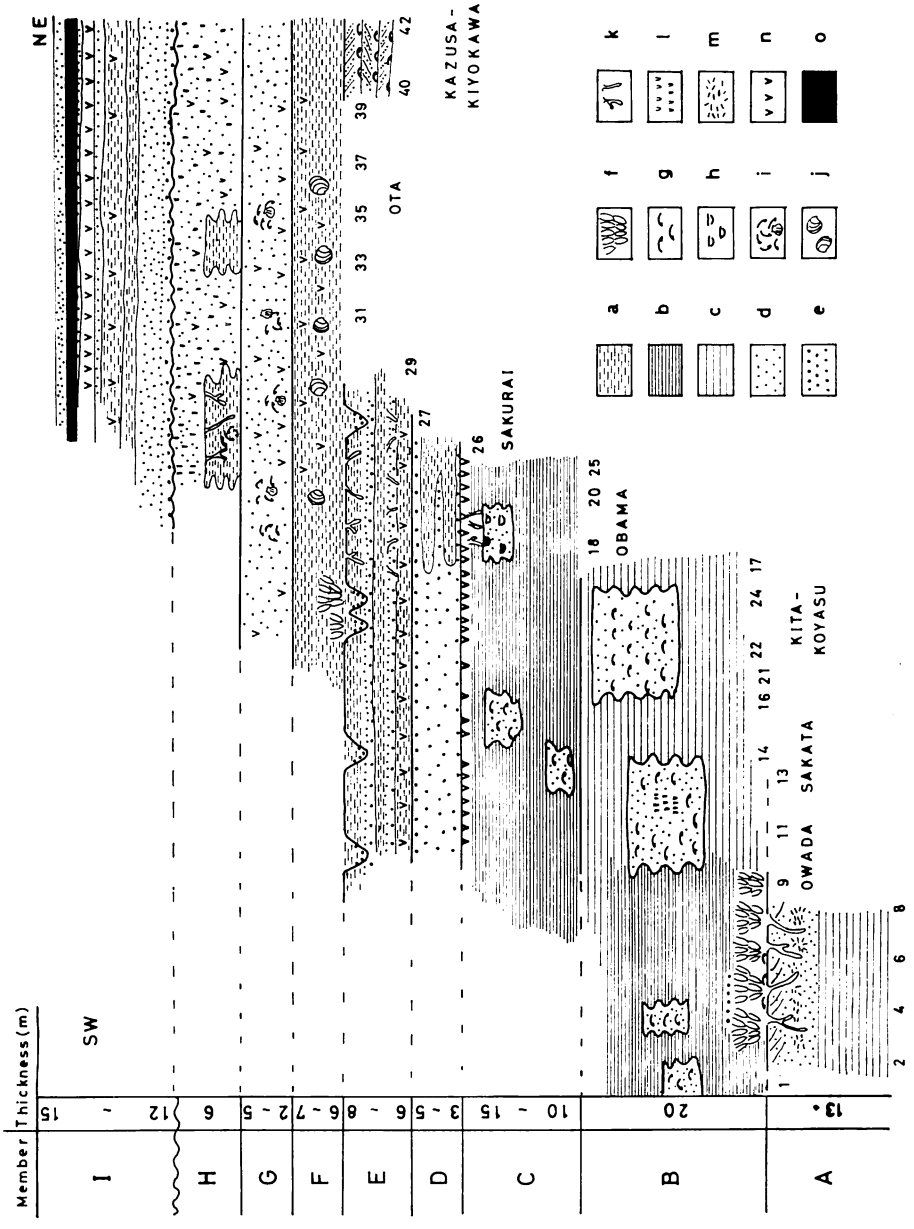
Table 4. Fossils of molluscs and barnacles from the G Sand

Molluscs \ Locality number	26	27	29	33	36
Calliostoma (Tristichotrochus) consors (LISCHKE)	C	C		C	
Homalopoma sangarense (SCHRENCK)			C		
Sinum javanicum (GRIFFITH & PIDGEON)	R				
Neverita (Glossaulax) reiniana (DUNKER)	R				
N. (G.) didyma (RÖDING)			C		
Tectonatica severa (GOULD)			R		
Eunaticina papilla (GMELIN)	R				
Cymatium (Reticutriton) tenuiliratum (LISCHKE)				C	
Morum (Onimusiro) grande (A. ADAMS)	R				
Tonna luteostoma (KÜSTER)		R			
Ceratostoma (Ocenebra) modesta FULTON	R				
Coralliophilla costularis (LAMARCK)			R		
Siphonalia fusoides (REEVE)	A	A	A	C	
Nassarius (Zeuxis) caelatus (A. ADAMS)	R			C	
Ficus subintermedius (d'ORBIGNY)	R				
Fusinus perplexus (A. ADAMS)	R	C	A	C	
Cancellaria (Sydaphera) spengleriana DESHAYES	C		C	C	
Inquisitor jeffreysii (E. A. SMITH)	C		C		
I. cosibensis (YOKOYAMA)	R	C		C	
Lophiotoma (Lophioturris) leucotropis (ADAMS & REEVE)	R			C	

Molluscs \ Locality number	26	27	29	33	36
Terebra serotina ADAMS & REEVE	C		C		
Strioterebrum (*Cinguloterebra*) *naumanni* (YOKOYAMA)	C			C	
Punctotereba (*Granuliterebra*) *bathyrhaphe* (E. A. SMITH)			C		
Eocylichna braunsi (YOKOYAMA)					C
Dentalium sp.	A	A	A	A	A
Nuculana (*Nuculana*) *yokoyamai* KURODA					C
Saccella gordonis (YOKOYAMA)		A			
S. confusa (HANLEY)			C		
Acila (*Acila*) *divaricata* (HINDS)	R		A	C	
Limopsis (*Oblimopa*) *forskalii* A. ADAMS	A	A	A	A	A
Glycymeris (*Glycymeris*) *vestita* (DUNKER)	C				
Arca boucardi miyatensis OYAMA			C		
Anadara (*Scapharca*) *broughtoni* (SCHRENCK)	R				
Striarca (*Galactella*) *interplicata* (GRABAU & KING)				R	
Chlamys (*Chlamys*) *farreri* (JONES & PRESTON)				R	
Pecten (*Notovola*) *albicans albicans* (SCHRÖTER)	A	A	A	A	A
Anomia cytaeum GRAY			C	C	
Crassostrea gigas (THUNBERG)	R	C	C		
Cycladicama cumingi (HANLEY)				C	
Lucinoma concentricum (YOKOYAMA)		A			
Pillucina (*Wallucina*) *striata* (TOKUNAGA)			R		
Fulvia mutica (REEVE)	A	A	A	A	A
Callista chinensis (HOLTEN)	C				
Clausinella (*Placamen*) *tiara* (DILLWYN)	A		A	A	C
Paphia (*Paphia*) *naganumana* OTUKA	A	A	C	A	A
Lutraria sieboldi REEVE	C	C	C	C	
Arcopagia (*Merisca*) *diaphana* (DESHAYES)	C	C	A	C	
Sinonovacula constricta (LAMARCK)			C		
Panopea japonica ADAMS			C		
Barnacles					
Balanus poecilotheca KRÜGER	R	R	R		
B. rostratus HOEK	R	R	R	R	R
Chirona (*Striatobalanus*) *tennuis* (HOEK)					R
Megabalanus rosa (PILSBRY)	R	R			
Solidobalanus (*Solidobalanus*) *socialis* (HOEK)	R	R			
Boscia oulastreae (UTINOMI)			R		

pelecypods (i. e. *Pecten* (*Mizuhopecten*) *tokyoensis, Chlamys farreri, Clausinella* (*Placamen*) *tiara, Limopsis* (*Oblimopa*) *forskalii, Lucinoma concentricum, Puncturella nobilis,* and *Arca boucardi*), cirripeds (*Balanus rostratus*), brachiopods and echinoderms.

Type 1 burrows about 3 cm in diameter and 80 to 100 cm in length are bored downward from the top of the muddy sand. The wall of these tubes is made of fine-grained silt and the inside is filled with coarse-grained sand of the upper



Text-fig. 3. Schematic stratigraphic succession. a, massive silt; b, thin laminated silt; c, alternation of thin layered sand and silt; d, sand; e, gravel; f-j, fossil occurrences (f, *Crassostrea gigas*; g, *Tapes japonicus, Glycymeris yessoensis* and *Spisula sachalinensis*; h, *Pecten* (*Mizuhopecten*) *tokyoensis*; i, *Pecten albicans* and *Limopsis* (*Oblimopa*) *forskalii*; j, *Dosinia angulosa*); k, type 1 burrow; l, type 2 burrow; m, trace fossils made possibly by isopods of genus *Excirolana*; n, pumice tuff; o, peat. Numerals represent locality number.

pumiceous sand. Moulds of articulated *Gomphina* (*Macridiscus*) *melanaegis* are found embeded vertically to the bedding plane.

Two kinds of Type 2 burrows are excavated into the pumiceous sand of the upper H Sand. One has a diameter of about 5 mm and an average length of 10 cm. The other is about 2 mm in diameter and 4 cm in length. The burrowers may have been isopods or decapods similar to those found in sand layers of the B Member in the northern area.

I Member.—The I Member is almost horizontal and forms the basal deposits of the wide terrace standing about 60 m above the sea level. It is distributed in the northeastern region and unconformably overlaps the gently tilted lower beds. In northern exposures it is disconformable with the underlying H Sand, while it rests unconformably upon the uneven surface of the C Silt in the southern area. It is about 12 to 15 m thick, and consists of a lower conglomeratic sand with siltstone at the base, and upper alternating beds of ill-sorted sand and silt. A considerable number of pumiceous tuff layers of varying thickness and a peat layer are intercalated in the I Member. No marine fossils have been found from the I Member.

The I Member is regarded, at least in part, as non-marine deposits by the existence of a peat layer at the middle horizon, and may be correlated with the Anegasaki Formation (AOKI, 1968) known from the north of this area.

Ostracode assemblages

76 species of ostracodes were found in 54 samples from 23 localities. A complete list of ostracodes from all samples can be found in Table 5. Text-fig. 5 shows the stratigraphic and geographic distributions of ostracodes.

No ostracodes were found in the A Sand. Ostracodes are extremely rare in the oyster banks of the B Member, represented by only 3 separate valves in 80 g of the sediment. They are also poorly represented in the upper sand layers of the B Member, ranging from 1 to 42 individuals per 80 g. In the sand lenses of the C Silt, ostracodes occur rather commonly, attaining an average of 76 individuals per 80 g. No ostracodes were found in the entire D Gravel and the E Member, except for the fossiliferous sand of the E Member in the vicinity of Kazusa-Kiyokawa, where the sand contains 44-90 individuals per 80 g. In general, the F Silt includes moderate number of ostracodes ranging from 93 to 828 individuals per 80 g, except for a sample from the oyster bank (Sample no. 57, from Loc. 23) which contains only 3 specimens in 320 g, and a sample from the eastern area (Sample no. 7, from Loc. 34) which attains 1904 individuals per 80 g. A small number, 15 individuals per 320 g in Sample no. 105 from Loc. 32, may be explained by ill-preservation which is suggested by dissolved surface of the carapace. Ostracodes are extremely abundant in the G Sand, reaching about 7328 individuals per 80 g. In the H Sand ostracodes occur in moderate number, averaging 788 individuals per 80 g, but only in the lower muddy beds.

Three factors seem to affect the ostracode abundance, i. e. original abundance of animals, transportation after death of animals and the preservation through diagenetic and weathering processes. Among these, the effect of weathering may be inferable from field observations of sediments. No ostracodes were found in the localities where molluscs and other megafossils were dissolved from the.

moulds. Examples may be seen in the following samples: Sample no. 27 from Loc. 17 (C Silt), Sample no. 106 from Loc. 25, Sample no. 47 from Loc. 27, Sample no. 108 from Loc. 38, Sample no. 117 from Loc. 42 (F Silt), Sample no. 58 from Loc. 31 (G Sand). The distribution of these samples in the sediments is extremely localized and is found usually at the margin of the fossiliferous beds.

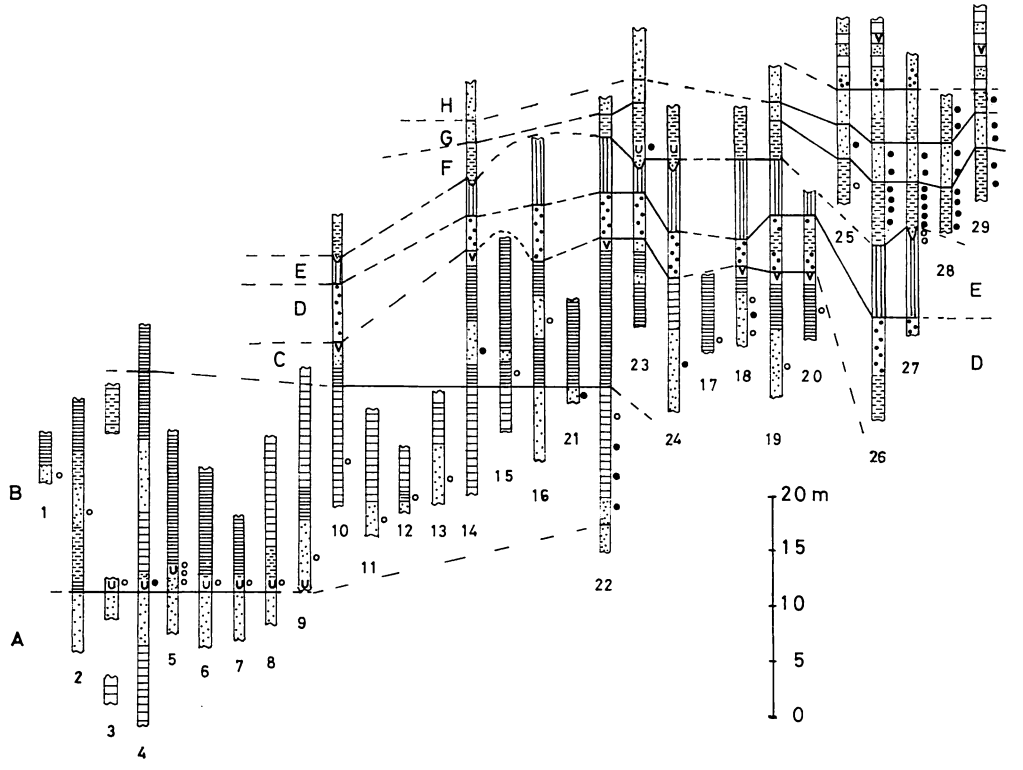
For further information on original abundance of animals and the effects of the transportation, analyses of the species composition was performed and is presented below.

A Sand.—Ostracodes are totally absent.

B Member.—Three specimens, *Howeina camptocytheroidea, Cythere lutea omotenipponica* and *Munseyella japonica*, are rare in the silty matrix of oyster banks (Sample no. 120 from Loc. 4). However, none of them are brackish water inhabitants in modern waters.

The ostracodes from the medium sand layers of the B Member are listed in Table 5 (Sample no. 23 from Loc. 9, Sample no. 54 from Loc. 21, Sample nos. 42, 52, 53 from Loc. 22, Sample no. 61 from Loc. 24). The assemblage is characterized by abundant or common occurrence of *Aurila munechikai, Loxoconcha* (*Loxoconcha*) *laeta, Pontocythere miurensis, Ruggieria* (*Keijella*) *bisanensis, Xestoleberis hanaii*, and *Loxoconcha* (*Loxoconcha*) *optima*. Among these six species, the first two inhabit the leaves of *Zostera* on shallow sand bottoms; the last two species are found commonly in tide pools, and *Ruggieria* (*Keijella*) *bisanensis* crawls just below the sediment-water intersurface of shallow mud bottoms. These five species are represented in the B Member mostly by thick, adult valves which are seemingly resistant to destruction. The carapace of the five species are nearly of the same size. The sorting index of the sand of the B Member is as small as 1.4, suggesting long term drifting of the sand which contain valves of these species. Conversely, *Pontocythere miurensis* is found in sand flats in the well-sorted sand off the present open coast. The sand is similar to that of the B Member. It may not be merely chance, therefore, that, in the B Member, this species is represented by both adults and instars. In conclusion the ostracode assemblage of the B Member seems to be a mixture of the B Member itself. It is also noteworthy that occurrence of genus *Howeina* is restricted to the B Member, suggesting a colder climate at that time, since the known occurrence of *Howeina leptocytheroidea* in modern seas is limited to the area north of Tsugaru Strait along the Pacific coast.

C Silt.—The species composition and abundance of ostracodes from two sand lenses of the C Silt are shown in Table 5 (Sample no. 25 from Loc. 14, Sample no. 55 from Loc. 18). Species of the *Zostera* habitat i. e. *Aurila munechikai* and *Loxoconcha* (*Loxoconcha*) *laeta* are abundant. Shallow sand flat species, *Pontocythere miurensis, P. japonica*; deeper silty sand species, *Callistocythere subjaponica, Schizocythere kishinouyei, Coquimba ishizakii* n. sp., *Proteoconcha tomokoae*; tide pool species, *Xestoleberis hanaii, Mutilus assimilis*; and shallow silt species *Spinileberis quadriaculeata* are characteristic of this assemblage. The assemblage is similar to those of the B Member. Certainly they represent a mixture of species from various habitats of the shallow sand and mud bottoms. In addition to the above species assemblage, a sample from the upper horizon of the C Silt (Loc. 18) contains abundant *Paracytheridea bosoensis* n. sp. This species is represented in this sample by abundant adults with several instars, suggesting an environment of the C Silt relatively deeper than that of the



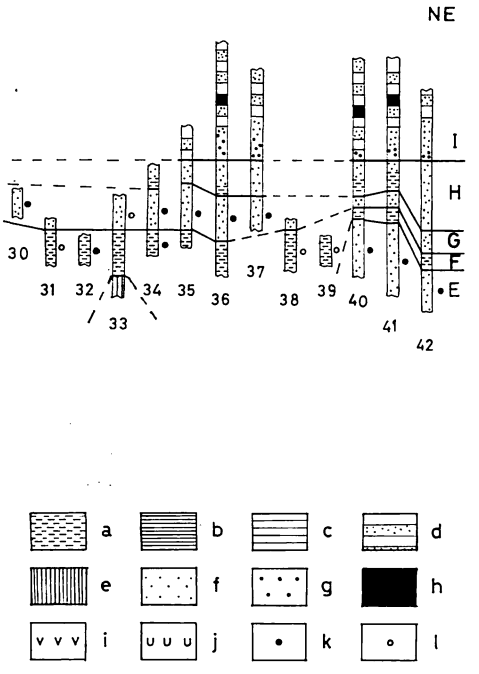
Text-fig. 4. Columnar sections. a, massive silt; b, thin laminated silt; c, alternation of thin layered sand and silt; d, alternating beds of ill-sorted sand and silt; e, alternation of sand and silt characterized by graded bedding; f, sand; g, gravel; h, peat; i, pumice tuff; j, oyster banks; k, sampling horizons where ostracodes were found; l, sampling horizons where ostracodes could not be found.

B Member. It is interesting to note that from this locality articulated valves of *Pecten* (*Mizuhopecten*) *tokyoensis* occur abundantly, in life position. This is the latest probable autochthonous occurrence of this species before the extinction of this lineage.

D Gravel.—Ostracodes are totally absent.

E Member.—The species composition of the ostracode assemblage of the E Member is shown in Table 5 (Sample no. 119 from Loc. 40, Sample no. 2 from Loc. 41, Sample no. 36 from Loc. 42). *Pontocythere miurensis, Schizocythere kishinouyei,* and *Aurila munechikai* are abundant. *Munseyella japonica, Hemicytherura cuneata, Loxoconcha* (*Loxoconcha*) *hattorii* and *Callistocythere subjaponica* are common. The assemblage seems to be closely similar to those of the B Member and of sand lenses in the C Silt.

F Silt.—One sample from the oyster bank of the F Silt (Sample no. 57 from Loc. 23) contains 3 specimens of ostracodes in 320 g represented by 2 species (*Spini-*

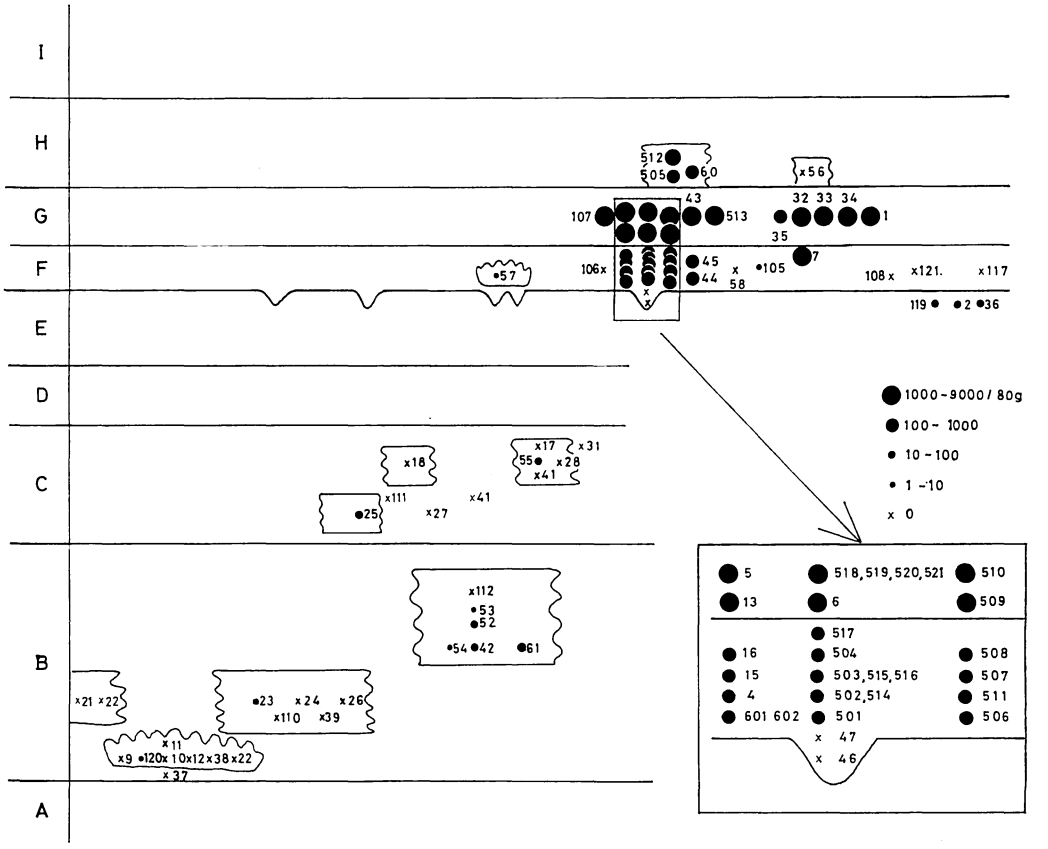


leberis quadriaculeata, Loxoconcha (Loxoconcha) laeta). The species composition of the ostracode assemblage of the F Silt shown in Table 5 (Sample nos. 601, 602, 4, 15, 16 from Loc. 26, Sample nos. 501, 502, 503, 504, 514, 515, 516, 517 from Loc. 27, Sample nos. 506, 511, 507, 508 from Loc. 28, Sample nos. 44, 45, from Loc. 29, Sample no. 105 from Loc. 32, Sample no. 7 from Loc. 34) is dominated especially in its lower half, by crawlers that live just below the water-sediment interface of shallow mud bottoms of bays. The species include: *Ruggieria (Keijella) bisanensis, Spinileberis quadriaculeata, Cytheromorpha acupunctata, Neomonoceratina microreticulate,* and *Nipponocythere bicarinata.* Together these species comprise more than 90% of total number of individuals. Abundant juveniles characterize this assemblage as well. Grain size analysis suggests very low level water energy of the depositional environment. The reconnaissance sampling of living representatives of these five species indicates that the microhabitat of each species does not always overlap much, a fact reflecting the slight differences in their salinity preferences. It is still difficult to determine whether the assemblage is influenced by post-morten transportation or by environmental fluctuations over long periods of time. In either case, the transported distance seems short and is restricted within the area of the silt bottom.

The species composition of the upper part of the F Silt shown in Table 5 (Sample no. 517 from Loc. 27, Sample no. 508 from Loc. 28, Sample no. 7 from Loc. 34), is different from that of the lower half. The number of species increases and the number of mud dwellers diminishes to 45-60% of total number. Common species other than mud dwellers include those associated with the sand bottom and *Zostera* habitats.

G Sand.—Species composition and abundance of ostracodes in the G Sand are shown in Table 5. Samples were collected from upper horizon at 8 localities (Sample no. 107 from Loc. 25, Sample no. 43 from Loc. 29, Sample no. 513 from Loc. 30, Sample no. 35 from Loc. 33, Sample no. 32 from Loc. 34, Sample no. 33 from Loc. 35, Sample no. 34 from Loc. 36, Sample no. 1 from Loc. 37) and from upper and lower horizons at Loc. 26, 27 and 28 (Sample nos. 13 (upper), 5 (lower) from Loc. 26, Sample nos. 521, 519, 518, 520 (upper), 6 (lower) from Loc. 27, Sample nos. 509 (upper), 510 (lower) from Loc. 28).

Mast of the species making up the assemblage of the upper part of the F Silt also occur in the G Sand. In the G Sand, however, the assemblage becomes completely dominated by *Loxoconcha (Loxoconcha) laeta, Aurila munechikai, Hemicytherura cuneata,* and *Xestoleberis hanaii,* i. e. species found in *Zostera* or on sand



Text-fig. 5. Ostracode abundance. Numerals represent sample number, whose exact horizons are shown in text-fig. 4.

to silty sand bottoms on which *Zostera* thrives. The assemblage is no doubt heterogeneous mixture of ostracodes winnowed from several different habitats. However, the G Sand assemblage is definitely different from that of the upper part of the F Silt, because it includes *Kobayashiina hyalinosa* and *Paracytheridea bosoensis*, species which are considered characteristic of the silty sand bottom, suggesting somewhat deeper water than that of the *Zostera* sand. Moreover this conclusion agrees quite well with that based on the megafossils, discussed in the preceding chapter.

H Sand.—Ruggieria (*Keijella*) *bisanensis* is the most important species of the lower silt part of the H Sand. This species makes up 20% of the assemblage in the Sample 60 from Loc. 29, 23% in the Sample 505 from Loc. 28, and 22% in the Sample 512 from Loc. 28. *Loxoconcha* (*Loxoconcha*) *laeta* and *Aurila munechikai* probably from *Zostera* beds, *Pontocythere miurensis* from sand flat and *Buntonia hanaii* n. sp. and *Cornucoquimba tosaensis*

Table 5. List of Pleistocene ostracode species from Kisarazu near Tokyo. Number of individual specimens including both adults and juveniles is shown in roman type. Number of juveniles is shown in italics. Number of separate valves is included.

Member	B							C		E		
Locality number	4	9	21		22		24	14	18	40	41	42
Sample number	120	23	54	42	52	53	61	25	55	119	2	36
1 *Neonesidea oligodentata* (KAJIYAMA)			2 *1*	5 *2*	6 *2*		7	1				2
2 *Propontocypris (Propontocypris) attenuata* (BRADY)											1	3 *1*
3 *Clithrocytheridea? japonica* (ISHIZAKI)												1
4 *Pontocythere japonica* (HANAI)			1	2				2	4		1	
5 *P. miurensis* (HANAI)			4	6 *3*	17 *6*	3		1 *1*	26 *4*			23 *2*
6 *P. subjaponica* (HANAI)			4		4		7 *2*		10 *2*	10 *4*	7 *5*	14 *2*
7 *Krithe japonica* ISHIZAKI				1								
8 *Parakrithella pseudadonta* (HANAI)												
9 *Pseudopsammocythere tokyoensis* n. sp.												
10 *Munseyell japonica* (HANAI)	1			4	8					3	1 *1*	2
11 *Callistocythere alata* HANAI											2 *1*	1
12 *C. hayamensis* HANAI									1			
13 *C. reticulata* HANAI									2			4
14 *C. rugosa* HANAI							1		1			
15 *C. undata* HANAI											2	3
16 *C. undulatifacialis* HANAI											2	
17 *C. japonica* HANAI							4		4		3	
18 *C. pumila* HANAI												
19 *C. subjaponica* HANAI				1				1	16	1	1	7
20 *C.* sp.					1 *1*						1 *1*	
21 *Cythere lutea omotenipponica* HANAI	1			5 *5*			4 *1*				2	
22 *Schizocythere kishinouyei* (KAJIYAMA)				2 *1*	1 *1*		7 *6*	1	5 *4*	8 *5*	17*13*	10 *9*
23 *Paijenborchella triangularis* HANAI				3	8 *2*				3 *1*	1		
24 *Neomonoceratina microreticulate* KINGMA												
25 *Spinileberis quadriaculeata* (BRADY)								1	4			
26 *Hemicythere? miii* (ISHIZAKI)					1							
27 *Ambostracon ikeyai* n. sp.				1 *1*			2		1		5 *1*	6 *5*
28 *Aurila munechikai* ISHIZAKI		1		4 *1*	8 *3*		13 *2*	13	9 *3*	5 *3*	9 *5*	12*12*
29 *A. punctata* (MUNSTER)				9 *2*	10 *7*		7 *3*	2	4 *1*		11 *1*	6 *2*
30 *Mutilus assimilis* (KAJIYAMA)			5	1	1		4	4	4 *1*	1	11 *3*	6 *1*
31 *Bradleya? sendaiensis* ISHIZAKI				1	1							
32 *Cornucoquimba tosaensis* (ISHIZAKI)				1			1					
33 *Coquimba ishizakii* n. sp.				1 *1*	1		1	1	14 *5*			2 *2*
34 *Proteoconcha tomokoae* (ISHIZAKI)				1	1		1	5	1 *1*		2	14*10*
35 *Trachyleberis scabrocuneata* (BRADY)				1	2		1					
36 *T.* sp.				2 *2*								
37 *Acanthocythereis? mutsuensis* ISHIZAKI				1								
38 *A.? niitsumai* (ISHIZAKI)												
39 *Actinocythereis kisarazuensis* n. sp.												
40 *Echinocythereis? bradyformis* ISHIZAKI							1			1		1
41 *E.? bradyi* ISHIZAKI												
42 *Ruggieria (Keijella) bisanensis* (OKUBO)		1 *1*	1 *1*		9 *6*		1	4 *1*				
43 *Lixouria nipponica* n. sp.												1
44 *Buntonia hanaii* n. sp.				15 *2*	11 *3*							
45 *B.? japonica* ISHIZAKI							1					
46 *Ambocythere japonica* ISHIZAKI										1	2	
47 *Basslerites obai* ISHIZAKI												
48 *Bythoceratina hanaii* ISHIZAKI				7 *1*					1 *1*			5 *3*
49 *Hemicytherura cuneata* HANAI			1	5 *3*	5 *3*				2 *2*	3	1	9 *7*
50 *H. tricarinata* HANAI										1 *1*		
51 *Howeina camptocytheroidea* HANAI	1											
52 *H. leptocytheroidea* (HANAI)							1					
53 *Semicytherura henryhowei* HANAI & IKEYA									1			
54 *S.? miurensis* (HANAI)				2 *2*	1 *1*	1 *1*	1 *1*		4 *3*			7 *1*
55 *S. skippa* (HANAI)												
56 *Cytheropteron miurense* HANAI			2	8	7 *2*	1 *1*						1 *1*
57 *C. uchioi* HANAI											1	
58 *Kobayashiina hyalinosa* HANAI												
59 *Paracytheridea bosoensis* n. sp.				1 *1*	5 *4*		6 *1*	1	4235	2 *2*		5 *3*
60 *Loxoconcha (Loxoconcha) bispinosa* KAJIYAMA												
61 *L. (L.) hattorii* ISHIZAKI			2		2			1	1	5 *3*	5	1
62 *L. (L.) japonica* ISHIZAKI												1
63 *L. (L.) laeta* ISHIZAKI			1	2 *1*	3 *3*	2	4	3 *2*	24 *4*			5 *3*
64 *L. (L.) optima* ISHIZAKI		1		3	1		10					2
65 *L. (L.) uranouchiensis* ISHIZAKI				7 *4*	6 *3*	1						
66 *L. (L.) viva* ISHIZAKI				1								
67 *Cytheromorpha acupunctata* (BRADY)				2	1				9 *5*			3
68 *Nipponocythere bicarinata* (BRADY)												
69 *Xestoleberis dentata* SCHORNIKOV										1		
70 *X. hanaii* ISHIZAKI			2 *1*	2 *1*		2	2 *1*	2	4	1	3	7 *1*
71 *X. sagamiensis* KAJIYAMA				1	4 *1*				1			
72 *Paradoxostoma oblongum* KAJIYAMA												
73 *P. triangulum* KAJIYAMA												
74 *Cytherois asamushiensis* ISHIZAKI				1								1
75 *Paracytherois tosaensis* ISHIZAKI				5								
76 *Cytheroma? hanaii* n. sp.					1							
total number of individuals	3	3	25	114	126	10	87	43	198	44	90	165
total number of juveniles		*1*	*3*	*34*	*48*	*2*	*17*	*4*	*72*	*18*	*30*	*65*
total number of species	3	3	11	35	28	6	23	16	27	15	22	31
weight of sample (in gram)	80	240	240	240	240	480	480	40	240	80	80	160

	F																							
	23	26					27								28				29		32	34		
species	57	601	602	4	15	16	501	502	514	515	503	516	504	517	506	511	507	508	44	45	105	7		
1																								
2																								
3																								
4						1							1									1		
5		1	1	9 6	6 5	12 8	3 1						2	7 5	1 1	1		1312	1210	4 3		1411		
6						2		3 1	3 1		1	3 2		2 1						1		2		
7																								
8																								
9				1														1				1		
10				1		2																1		
11						1												1 1		3 2		2		
12																								
13														1										
14																						1		
15						1																		
16																								
17																								
18																								
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20																								
21				1 1		3 3	1 1							3 3								1 1		
22				1 1		1 1							1	1 1										
23									1															
24		5 2	7 2	13 4	7 6	6	19 7	10 3		23 5				2			3723	3 2	3018	4 2	1 1	33 5		
25	1	36 1	36	33	15	6	16 4	56	49 3	55 9	26 7	30 8	12 3	33 4	65 6	23 6	38 2	18 2	24 4	7 2	8 1	42 8		
26																								
27																		1 1						
28				1	3 2	6 4			1 1						2 2	1 1		2315		3 3		3 2		
29				1 1									1				1 1	4 3						
30						1813													7 6	7 7		1513		
31																								
32																			1 1					
33				1 1														1 1				1		
34																								
35				5 4	12 9	26 9				2				2112				2622	3 3	10 9		2216		
36				1 1	2 2	1 1					1 1			1 1				7 7	2 2	3 3				
37																								
38						1																		
39																								
40		2	4 3	5 5	4 4	3 3	5 4	2 1			1			10 8			2 1	2 1	6 5			10 8		
41						1 1																		
42		2520	3935	5436	4130	5339	5042	6439	2515	6016	3018	4023	2715	6658	4833	7148	5648	6852	3629	41 8	2 1	2419		
43						1														2 1				
44			1	3	5 2	9 1		1 1		6		1						7 1	1 1	4		3		
45																								
46																								
47																								
48																								
49																		2 1	1 1			1 1		
50					1											1 1		1	1			1		
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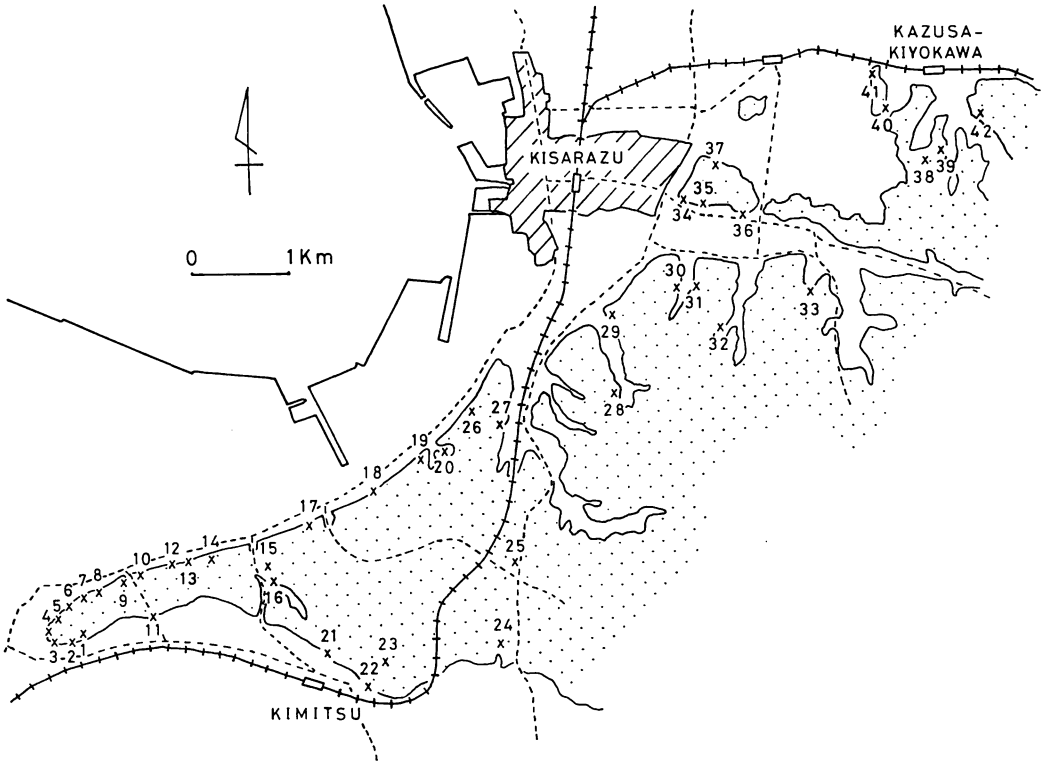
61																								
62																								
63	2	9 2	12 4	13 2	13 7	8 2	4 1	13 3	2	5	5	4	4 1	12	2 1		8 7	11 7	3	10 4	4	15 5		
64														1										
65																	2 2		1 1			2 1		
66																								
67		38	71	13	20		41	86	22	9	29	47	17	10	30	56	54	19	43	9		25		
68		9	7	9	16	8	7	3		3		1	1	2		3	9	1	6	4		14		
69																								
70																		1 1	2 1			2		
71																								
72																								
73																								
74																								
75																								
76					1 1	1																		
	3	125	178	165	146	171	146	238	103	163	93	126	66	172	148	156	207	210	180	112	15	238		
		23	44	62	68	85	60	48	20	30	26	33	19	93	43	56	84	125	82	43	3	91		
	2	8	9	18	14	23	9	9	7	8	7	7	9	15	6	7	9	20	18	15	4	26		
	320	40	40	20	20	40	40	80	80	40	80	40	40	40	80	20	20	40	20	20	320	10		

	G																	H		
	25	26		27					28		29	30	33	34	35	36	37	28		29
species	107	13	5	6	518	519	520	521	509	510	43	513	35	32	33	34	1	505	512	60
1		1	2 1	1 1			1		1 1			7 4	2 1		4 2			1 1		5
2			1	1													3	2	1	
3																				
4	29 4	3 2	6 3	6 3	3	4 4	5 3	7 4	6 3	3	4 4				6 6		5 4			
5	7	6 4	4 1	17 9	2	5 5	2925	2 2	9 7	2121	1717	7	1210	12 8	1414	7 7	1616	2724	1919	1010
6	12 2	7 6	6 1	3 1	6	6	8 1	6 6	1512	14					4	1	9 8			
7																				
8	1	1	2		1			1	1			1	2	2 1	1			10	4	
9		5		2			1	1				1	3	1	3	1	4	1	7	
10	5		4	1	6	4	4	1	3	3	2		3	4	9	6	15	5 3	2	2
11	30	10 3	4 1	2	6	6	4 2	6	2 1	1	1				6 2	4	16			2
12												3	3							
13		1								1										
14																				
15																				
16																				
17				4			1	1 1												
18												1								
19	2	2 1	1			1	1		1	3	1					1	2			
20												1 1	2 2	3 3					2 2	2 2
21												2 2	1 1		1 1			1 1		
22							1				1 1									
23	1	3 1	4 3	2 1	3 1	2 1	2 2		2 1		3 1		1 1		3 1		6 2	1	1 1	3 3
24	2														2 1		4			
25			1					1		1		2	2				5	2 1	1	
26																				
27											1 1	6 4	1010	11 8			1 1	7 6	3 3	5 5
28		1510	9 9	7 7	4	1111	9 9	3 3	6 6	4 4	6 6	12 6	1717		1111	3 3	1413	5 4	2 2	3 3
29		6 4	8 3	6 1	3 1	4	6	1 1	5 5			2 1	6 5	3 3	5 5		1313	6 5	3 2	1 1
30	23 6	10 7	9 7	3 1	6	8 8	1010	9 8	2322	1210	6 5	15 8	1311	1412	13 9	8 7	2725	8 7	8 8	6 5
31																				
32	3 2			1	1 1			2			1 1	9 6	1414	1111	1 1		3 3	3	4 4	7 5
33	1		2 2	1 1	1	1 1	1		2 2	1 1	2 1			1 1	2 1	2 1	3 3	1 1	2 2	2 2
34																				
35	3620	1	4 3	5 1	11 3	19 8	7 1	6 5	1612	2211	1110	2112	6 6	3 2	6 2	1611	5623	4 3		4 3
36	6 6	6 6	4 4	9 9	2 2	8 8	1010	2 2	4 4	1717	8 8		7 7	4 4	2626	2020	4242	3 3	2 2	4 4
37																				
38					1 1			1	1 1		1 1		2 2				11		1 1	
39		1 1		1						3 1					3 2	2 1	2			
40	7 3		6 5	3 3	8 6	12 8	14 4	7 6	1511	1715	8 7			3 1	7 7	9 9	2925	1 1	1 1	4 3
41			1 1				1 1	1 1	2 2	2 2	1 1				2 2	1 1	2			
42	1		2 2		2 1	1	2 1	1 1		2 2	1615	2413	1111	1716	3 3	5 4	14 9	4742	3332	4540
43					1	1			2	1	1	1	1	2	1	2		1	2	2
44											1	6	2	18 8	4 1		7	6 3	8 3	2011
45																				
46																				
47																				1
48						1 1	1													
49	2	24 1	30 8	23 5	15 3	3710	3612	15 7	21 7	14 5	21 8		8 3	1615	1110	5	6513	8 6	4 4	12 8
50																				
51																				
52																				
53		2 2	4 1	6	1	1	3		2	1		3 1	7 2	8 7	1	2	7 2	9 4	7 5	4 1
54		5	7 6	1310	1	3 2	11 8	4	7 7	1	2 1	1 1	2		2	1 1	12 5	8 3	7 5	6 5
55		1			1															
56		3 2			1			1						2	1		2			1
57			1		2			2	3		1 1									
58			1		1				2	1	1 1		1		2 1	2 1	2			1
59	6 2	5 2	9 4	5 4	3	6 5	3 2	10 8	4 4	6 5	1 1				6 4	3 2	11 6		1	
60	4	3		3	12	2	3	14	7	3							19 3			
61																				
62																				
63	34 2	1917	1814	17 8	1811	10 6	1410	1816	5017	23 7	2620	9 4	2612	2218	6858	4016	12139	2019	1511	2712
64										1 1										
65	3	10 8	5 1	11 5	4 1	12 4	1814	1613	1810	10 4	3 2		10 5			5 4	2821	3 3		2213
66																				
67									1		1	4			2	1	3	2	1	
68					3	3			5	3	5		2		4	3	14	1		7
69	1		1											1 1						
70		16	21 6	9 5		19 4	2311	13 8	10 6	8 6	2018		7 5	3 3	10 4	5 2	4835	1615	11 7	1615
71						1 1			2											
72														9				3		
73								1												
74																				
75			1										3	1						
76												1	7	8			1		1	2
	216	166	178	162	129	188	229	153	248	199	173	139	193	174	246	155	642	212	153	226
	47	77	86	75	21	87	126	92	141	112	131	63	125	122	175	90	311	155	113	151
	23	26	31	27	30	27	29	29	32	29	30	23	31	25	34	26	38	29	28	30
	5	5	2.5	5	5	2.5	2.5	2.5	5	5	5	20	10	5	10	5	40	20	20	20



Text-fig. 6. Sampling localities. Main roads are shown by broken lines.

from deeper silty sand are characteristic of this assemblage. Except for the abundance of *Ruggieria* (*Keijella*) *bisanensis*, no essencial difference can be ascertianed between ostracode assemblages found in the G Sand and H Sand.

Conclusions

A number of conclusions emerge from this study and are summarized below.

1. The Upper Pleistocene sediments of Kisarazu near Tokyo represent the last stage of filling-up deposition of so-called Paleo-Tokyo Bay. The sediments can be classified stratigraphically into nine members, A to I members in upward sequence. Each member overlies the lower member conformably, except for a diastem between the E Member and the F Silt, and an unconformity between the H Sand and the I Member. There is no evidence throughout the area suggesting the existence of the so-called basal unconformity of the Narita Formation at the base of the D Gravel.

2. Detailed field observations have been made by paying special attention to the occurrence of molluscs and burrows. Oyster banks in the B Member and the F Silt, *Pecten tokyoensis* in the C Silt, *Dosinia angulosa* in the F Silt, and *Gomphina* (*Macridiscus*) *melanaegis* in the H Sand show autochthonous occurrences. Burrows occur in almost all members except for the D Gravel and the I Member. They are classified into two types. The bur-

rowers were probably decapods or isopods. The assemblage which is dominated by "Oyashio" type molluscan species occurs in the B, C and E members and that including the abundant "Kuroshio" type molluscan species occurs in the F, G and H members. All members were deposited in the shallow waters of embayments, mostly in the subtidal zone. A cyclic tendency in sedimentary deposition has been observed in this area. One cycle begins with shallow brackish water facies of the B Member, attains its maximum depth at the upper part of the C Silt and ends up with shallow marine E Member, while the second cycle starts with shallow brackish water facies of the F Silt, the water deepened to 20-50 m in the G Sand. The cycle ends with the shallow water marine H Sand. This inundated phase of the second cycle is probably correlated with the Shimosueyoshi transgression. The D Gravel and the lower part of the E Member which is characterized by the graded bedding may be deltaic insertion of the sediment supplied by the nearby river. The I Member is a non-marine deposit and unconformably overlies the gently tilted lower members.

3. Ostracodes are found from the B, C, E, F, G and H members. The ostracode fauna can be classified into three assemblages: i) a sand flat assemblage, which is found from well-sorted sand of B, C and E members. It is composed of a mixture of species from various habitats of the bottoms of shallow embayments, including tide pools, *Zostera* leaves, and bottoms and sand flats, ii) a shallow mud assemblage which occurs in bluish grey silt represented by the F Silt. Species diversity is very low. The crawlers comprise 90% of the total assemblage. They live on and in mud bottoms of shallow embayment but are slightly different in their salinity preferences. iii) a silty sand assemblage, which is found in the upper sand lens of the C Silt and the G Sand and H Member. Ostracodes are abundant and species diversity is high, because of allochthonous species from various shallow water environments, in addition to the deeper water silty sand species.

Systematic paleontology

All types and illustrated specimens are deposited in the collection of the Univeristy Museum, University of Tokyo (UMUT). Specimen numbers are prefixed CA for Cenozoic Arthropoda.

The following abbreviations are used in the systematic section:

S: Specimen measured (L, R, C for left valve, right valve, carapace)
Loc: Sampling locality (see lists of sampling localities)
Me: Measurement (L for length, H for height, W for width)
N: Number of observations
$\bar{X}$: Arithmetric mean (mm)
s: Standard deviation (mm)
V: Coefficient of variability
OR: Observed range (mm)

Systematic description

Subclass Ostracoda LATREILLE, 1806

Order Podocopida SARS, 1866

Superfamily Cytheracea BAIRD, 1850

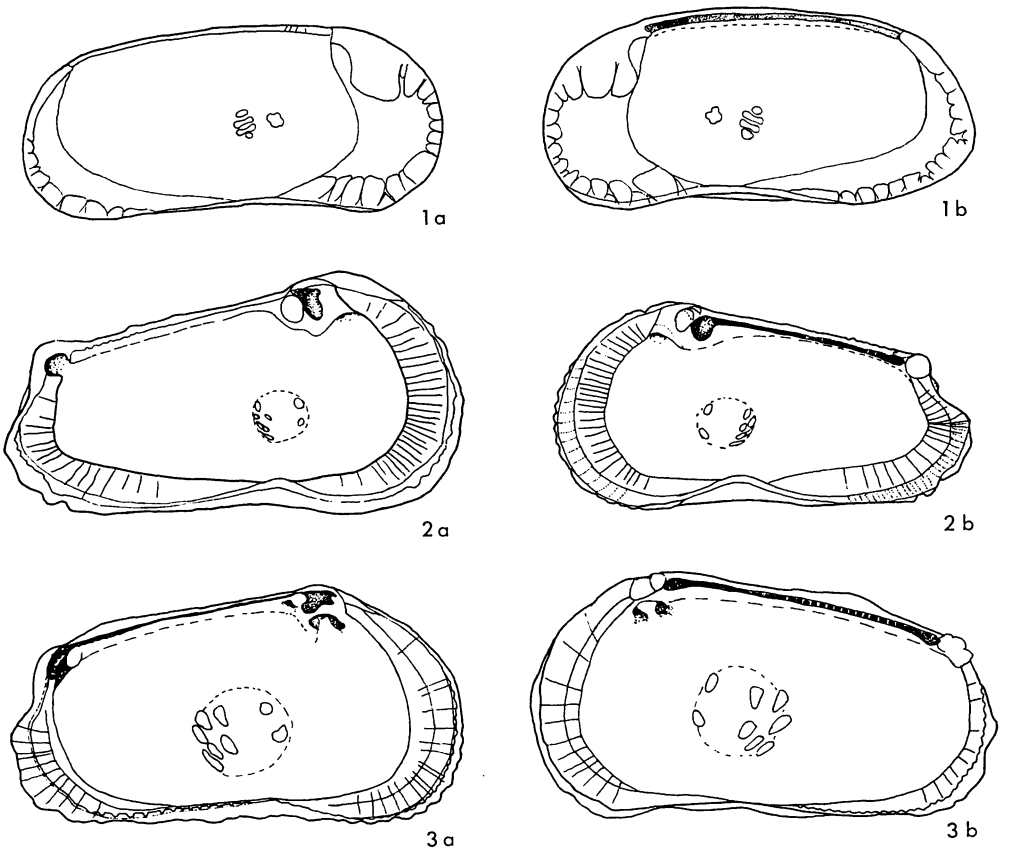
Family Cytherideidae SARS, 1925

Subfamily Krithinae MANDELSTAM, 1958

Genus *Pseudopsammocythere* CARBONNEL, 1966

Pseudopsammocythere tokyoensis n. sp.

Pl. 50, figs. 3a, b. Text-fig. 7, figs. 1a, b.



Text-fig. 7. Internal views. a, left valve; b, right valve. ×110.
Figs. 1a, b. *Pseudopsammocythere tokyoensis* YAJIMA, n. sp.
1a. Paratype, CA 8411; Sample no. 512, Loc. 28, H Sand.
1b. Holotype, CA 8410; Sample no. 512, Loc. 28, H Sand.
Figs. 2a, b. *Ambostracon ikeyai* YAJIMA, n. sp.
2a. Paratype, CA 8434; Sample no. 2, Loc. 41, E Member.
2b. Paratype, CA 8435; Sample no. 2, Loc. 41, E Member.
Figs. 3a, b. *Coquimba ishizakii* YAJIMA, n. sp.
3a. Paratype, CA 8431; Sample no. 55, Loc. 18, C Silt.
3b. Paratype, CA 8432; Sample no. 55, Loc. 18, C Silt.

Diagnosis.—A species of the genus *Pseudopsammocythere*, characterized by a vertical row of four ovate adductor scars in which the median two are slightly oblong.

Description.—Carapace elongate subrectangular in lateral view. Highest at slightly posterior to middle. Anterior margin equally rounded, dorsal margin nearly straight, ventral margin slightly sinuated at middle, dorsal and ventral margins nearly parallel, posterior margin obliquely rounded. In dorsal view, carapace slender, sides slightly inflated, thickest at posterior third.

Surface smooth and pelucid. Eye tubercle

obscure. Normal pore canals simple open type, moderate in number, evenly scattered. Radial pore canals straight and radiate, often bifurcate, 15 to 20 in number, along anterior, ventral and posterior margins.

Marginal infold extremely broad anteriorly, narrow posteriorly. Inner margin not parallel to outer margin, sinuate anteriorly and nearly straight along posterior margin. Anterior vestibule well develped, deep in lower two-thirds. Posterior vestibule shallow, nearly parallel to posteroventral margin. No selvage or list on marginal infold.

Hinge pseudadont. Long groove of right valve with extremely faint crenulation in its anterior half. Muscle scar field slightly anterior to middle. Adductor muscle scars consisting of a vertical row of four ovate scars, whose median two slightly oblong, and together forming a vertically oval outline. Single frontal scar large and quadrilobate. Two dorsal scars long and slender.

Dimensions.—Measurements of specimens from Sample no. 512 of the H Sand (Loc. 28).

S	*Me*	*N*	$\bar{X}$	*s*	*V*	*OR*
L	L	4	0.533	0.005	0.94	0.50-0.54
	H	4	0.238	0.015	6.30	0.22-0.25
R	L	1				0.50
	H	1				0.23

Types.—Holotype, UMUT-CA 8410, a right valve (Pl. 50, fig. 3a. Text-fig. 7, fig. 1b); Figured paratype, UMUT-CA 8411, a left valve (Pl. 50, fig. 3b. Text-fig. 7, fig. 1a).

Type-locality.—Loc. 28 (Sample no. 512, H Sand).

Remarks.—This species is closely similar to *Pseudopsammocythere similis* (MÜLLER, 1894) described by SISSINGH, 1972, from the Pliocene sediments of the Crete and the Rhodos Islands, southern Greece, in lateral outline and form of vestibule, but different in the shape and distribution pattern of muscle scars.

Occurrence.—This species occurs commonly from the G Sand, and rarely from the F Silt.

Family Cytheridae BAIRD, 1850

Subfamily Leptocytherinae HANAI, 1957

Genus *Callistocythere* RUGGIERI, 1953

Callistocythere sp.

Pl. 49, figs. 6a, b.

Description.—Description is based on juvenile valves. Adult has not been found yet.

Carapace subquadriangular, highest at anterior cardinal angle. Anterior margin smooth, broadly and obliquely rounded. Dorsal contact margin straight, partly hidden by a swelling of posterodorsal surface, giving slightly concave posterodorsal outline in lateral view. Posterior cardinal angle prominent. Ventral margin sinuate near middle. Posterior margin gently turning to broadly rounded posteroventral margin. Color yellow.

Surface sculptured by small, irregular, incomplete reticulations. Three swellings in anterocentral, posterodorsal and posteroventral areas of carapace surface. Three or four rows relatively large latices along anterior margin. A prominent ridge starting from eye region downward bordering anterior margin of dorsoanterior sulcus. Dorsoanterior sulcus deep, running downward along anterior margin of anterocentral swelling. Anterodorsal swelling ornamented with four to five small reticulations. Two ventral rows of dorsomedian sulci just behind anterocentral swelling. Posterodorsal and posteroventral

swellings with reticulations. Posterior marginal ridge arising from hinge margin, making an arch convex posteriorly and ending in posteroventral margin.

Eye tubercle obscure. Normal pore canals moderate in number, open in muri. Radial pore canals simple. Marginal infold narrow. Hinge desmodont of juvenile stage. Muscle scars not seen.

Dimensions.—Measurements of pooled specimens are given below:

S	*Loc*	*Me*	*OR*
L	22 B	L	0.47
		H	0.26
C	41 E	L	0.40
		H	0.23
		W	0.17
R	34 G	L	0.52
		H	0.29
L	34 G	L	0.48
		H	0.27
R	33 G	L	0.48
		H	0.27
R	30 G	L	0.39
		H	0.22
R	28 H	L	0.31
		H	0.19
C	28 H	L	0.34
		H	0.20
		W	0.16
L	29 H	L	0.52
		H	0.30

Illustrated specimens.—UMUT-CA 8439, a right valve (Pl. 49, fig. 6a) UMUT-CA 8437, a left valve (Pl. 49, fig. 6b).

Remarks.—Desmodont hingement and narrow marginal infold suggest that the specimens described herein all represent juveniles. Unfortunately information on the juvenile carapace of Japanese *Callistocythere* is very scarce. Characteristic lateral outline, three prominent swellings, and dorsoanterior and dorsocentral sulci all suggest that this juvenile form belongs to a species which has not yet been described from Japan and its adjacent seas.

Occurrence.—This species occur very rarely from the B, E, G and H members.

Family Hemicytheridae PURI, 1953

Subfamily Hemicytherinae PURI, 1953

Genus *Ambostracon* HAZEL, 1962

Ambostracon ikeyai n. sp.

Pl. 49, figs. 5a-c. Pl. 50, figs. 1, 2.
Text-fig. 7, figs. 2a, b.

Diagnosis.—A species tentatively assigned to the genus *Ambostracon*, characterized by elongate lateral view, and low subcentral tubercle. Median and ventral ridges are parallel and ventral ridge does not project posterolaterally.

Description.—Carapace elongate subtrapezoidal in lateral outline, highest at anterior cardinal angle. Anterior margin obliquely rounded with about 20 spines. Dorsal and ventral margins straight, subparallel and slightly tapering toward posterior. Posterior margin truncated obliquely in dorsal half, and obliquely rounded with 6 spines in ventral half. In dorsal view, carapace oblong ovate, broadest at subcentral tubercle.

Surface reticulate. A ridge along dorsal margin running from eye tubercle to posterior cardinal angle, weak in anterior half and strong in posterior half. From middle of dorsal ridge, a weak ridge branches off running straight anteriorly. A ridge arising from posterior cardinal angle running down dorsal one-fourth of posterior height and turning toward subcentral tubercle. Ventral ridge parallel to ventral margin arising from anteroventral corner terminating in posterior one-fourth of ventral margin. Subcentral tubercle low but prominent. From subcentral tubercle about 15 weak ridges run radially toward

marginal area. Among them, a prominent median one runs from subcentral tubercle longitudinally toward anterior area of carapace. These radial ridges and several weak concentric ridges form rather regular reticulations.

Eye tubercle large and prominent. Normal pore canals, sieve type, moderate in number, and evenly scattered. Pore opening with a large sunken sieve plate and a large central opening. Radial pore canals with bulbous enlargement and dense along anterior and posterior margins.

Marginal infold moderately broad. Selvage distinct. Inner margin parallel to outer margin. No vestibule.

Hinge holamphidont. Median bar of left valve crenulate in posterior half. Anterior tooth of right valve with slight trace of crenulation. Muscle scar field in area of subcentral tubercle. Muscle scars consisting of two vertically arranged eliptic frontal scars and four elongate adductor muscle scars. Adductor scars arranged side by side on the posterior wall of subcentral depression, median two devided.

Dimensions.—Measurements of specimens from Sample no. 2 of the E Member (Loc. 41).

S	*Me*	*N*	*OR*
C	L	2	0.54-0.55
	H	2	0.30
	W	2	0.23
L	L	1	0.57
	H	1	0.33
R	L	1	0.57
	H	1	0.28
L (Adult-1)	L	1	0.42
	H	1	0.23

Type specimens.—Holotype, UMUT-CA 8433, a complete carapace (Pl. 49, fig. 5c); figured paratypes, UMUT-CA 8434, a left valve (Pl. 49, fig. 5b. Pl. 50, figs. 1, 2. Text-fig. 7, fig. 2a); UMUT-CA 8435, a right valve (Pl. 49, fig. 5a. Text-fig. 7, fig. 2b).

Type-locality.—Loc. 41 (Sample no. 2, E Member).

Remarks.—This species resembles both *Bradleya saitoi* ISHIZAKI, 1963, from the Miocene of the Yatsuo Formation of Ishikawa Prefecture and *Urocythereis miii* ISHIZAKI, 1969, from Recent sediments of Nakanoumi, Shimane Prefecture in its outline and surface ornamentation. Actually, however, no known genus can accomodate this species. Since this species occurs living in tide pools, study of the appendage structure will be desirable before the description of a new genus.

Occurrence.—Several specimens were obtained from the B, C, E, F, G and H members.

Subfamily Thaerocytherinae HAZEI, 1967

Genus *Cornucoquimba* OHMERT, 1968

Cornucoquimba tosaensis (ISHIZAKI, 1968)

Pl. 49, figs. 2a-c. Text-fig. 8.

Hermanites tosaensis ISHIZAKI, 1968, p. 41, Pl. 2, fig. 4, Pl. 8, figs. 13, 14.

—— ——: ISHIZAKI, 1969, p. 222, Pl. 26, fig. 19.

—— ——: ISHIZAKI, 1971, p. 94, 95, Pl. 4, fig. 3.

Cornucoquimba tosaensis (ISHIZAKI, 1968) : HANAI et al., 1977, p. 48.

Diagnosis.—A species of the genus *Cornucoquimba* characterized by a prominent subcentral tubercle, an oblique pos-

Text-fig. 8. Muscle scar pattern of *Cornucoquimba tosaensis* (ISHIZAKI, 1968), left valve, CA 8441; Sample no. 60, Loc. 29, H Sand. ×180.

terior transverse ridge, and a ventrolateral alate ridge.

Description.—Carapace subrectangular in lateral view. Anterior margin broadly and obliquely rounded and with 20-25 small spines. Dorsal and ventral margins straight. Ventral contact margin sinuate at middle. Posterior margin subtriangular, dorsal half concave, ventral half narrowly rounded with six to eight large spines. In dorsal view, anterior and posterior areas compressed sides with two strong projections owing to subcentral tubercle and posterior part of ventrolateral ridge.

Surface reticulate with posterodorsal and alate ventral ridges. Both ridges connected obliquely by a transverse ridge in the posterior part of the carapace. Transverse ridge slightly concave toward posterior and with posteriorly directed three tubercles. Posterodorsal ridge running along dorsal margin, and culminating in a short oblique ridge at the middle of dorsal margin. Three ridges running more or less radially from subcentral tubercle toward anterior part of carapace. One connecting subcentral tubercle to eye tubercle, one running longitudinally and one connecting subcentral tubercle to anterior part of ventral ridge. Subcentral tubercle surrounded by reticulations between ridges. Anterior and posterior rims distinct.

Eye tubercle round and distinct. Normal pore canals sieve type with central opening, numerous, and evenly scattered. Radial pore canals straight and dense, with bulbous enlargement.

Duplicature moderately broad. Selvage distinct. Anterior vestibule narrow.

Hinge holamphidont with crenulate posteromedian element. Muscle scars in area of subcentral tubercle, consisting of two frontal scars and a vertical row of four adductor muscle scars. Upper three adductor scars obliquely arranged on the posterior wall of subcentral depression lower one on edge of depression in inside view. Division of median two scars distinct.

Dimensions.—Measurements of specimens from Sample no. 60 of the H Sand (Loc. 29).

S		*Me*	*N*	*OR*
R		L	1	0.67
		H	1	0.35
L		L	1	0.67
		H	1	0.36
C		L	1	0.65
		H	1	0.35
		W	1	0.33
L	(Adult-1)	L	1	0.54
		H	1	0.30
R	(Adult-1)	L	2	0.54
		H	2	0.30
R	(Adult-2)	L	1	0.43
		H	1	0.24

Illustrated specimens.—UMUT-CA 8440, a right valve (Pl. 49, fig. 2a); UMUT-CA 8441, a left valve (Pl. 49, fig. 2b. Text-fig. 8); UMUT-CA 8442, a complete carapace (Pl. 49, fig. 2c).

Remarks.—This species was originally described by ISHIZAKI (1968) based on the Recent specimens from the bottom sediments of Uranouchi Bay, Kochi Prefecture. In his treatment he only compared it with *Bradleya saitoi*, by its dimensions, occurrence and figures. Since then no description has been made on this species, and it may therefore be of use to redescribe the species in detail.

The muscle scar pattern of this species is identical with that described by OHMERT (1968) for his genus *Cornucoquimba*. This species is similar to *Hermanites* sp. described by HOLDEN, 1967 from Holocene of the Hawaiian Islands, in outline as well as general surface ornamentation. It is highly possible that Hawaiian *Hermanites* is conspecific with this species.

Occurrence.—This species occurs commonly from the G Sand and the H Sand, and rarely from the B Member and the F Silt.

Subfamily Coquimbinae OHMERT, 1968

Genus *Coquimba* OHMERT, 1968

Coquimba ishizakii n. sp.

Pl. 49, figs. 4a-c. Text-fig. 7, figs. 3a, b.

"Hermanites" sp. A, ISHIZAKI, 1968, p. 41, Pl. 6, fig. 13.

Coquimba sp. HANAI, ISHIZAKI and IKEYA, HANAI et al., 1977, p. 48.

Diagnosis.—A small species of the genus *Coquimba* characterized by uneven surface, deep and narrow groove around very large subcentral tubercle, and absence of tubercles along posterior margin.

Description.—Carapace small, subquadrate in lateral view. Anterior margin obliquely and broadly rounded with crenulations along anterodorsal margin. Dorsal margin nearly straight. Ventral margin concave at anterior one-third in lateral view. Ventral contact margin sinuate at middle. Posterior margin truncated obliquely at posterior cardinal angle and narrowly rounded in ventral half. In dorsal view, carapace oblong ovate with posterior and compressed, and ovate in anterior and posterior views.

Surface uneven, anterior rim distinct and high. Deep depression developing narrowly along anterior rim. Subcentral tubercle large, round and circumscribed by a narrow groove. Posterodorsal swelling small but distinct. Sinuate blunt ridge arising from anteroventral area of carapace, running just below subcentral tubercle and terminating at posteroventral tubercle, having a large pit opening ventrally. Ridge strong in immature stage.

Eye tubercle obscure but eye depression distinct in inside view. Normal pore canals sieve type, large, moderate in number and commonly scattered. Radial pore canals straight, 10-15 along anteroventral and 10-13 along posteroventral margins, often pairing off along anteroventral margin.

Marginal infold narrow. Selvage distinct. Inner margin coincides with line of concrescence. No vestibule. Hinge holamphidont with crenulate median element. Muscle scar field in subcentral tubercle. Muscle scars composed of two frontal scars and four adductor muscle scars. Upper frontal scar circular and lower frontal scar stout, j-shaped. Adductor scars arranged side by side obliquely. Both dorsomedian and ventromedian scars divided into two distinct parts.

Dimensions.—Measurements of specimens from Sample no. 55 of the C Silt (Loc. 18).

S	*Me*	*N*	$\bar{X}$	*s*	*V*	*OR*
C	L	1				0.56
	H	1				0.29
	W	1				0.30
L	L	4	0.553	0.007	1.27	0.55-0.56
	H	4	0.287	0.010	3.48	0.28-0.30
R	L	1				0.56
	H	1				0.29

Types.—Holotype, UMUT-CA 8430, a complete carapace (Pl. 49, fig. 4c); figured paratypes, UMUT-CA 8431, a left valve (Pl. 49, fig. 4b. Text-fig. 7, fig. 3a); UMUT-CA 8432, a right valve (Pl. 49, fig. 4a. Text-fig. 7, fig. 3b).

Type-locality.—Loc. 18 (Sample no. 55, C Silt).

Remarks.—This species is similar to *Coquimba piscicula* OHMERT, 1968, from the Pliocene of Chile, but the species is distinguishable easily from *C. piscicula* by the absence of tubercles along posterior

margin, the indistinct eye tubercle and the presence of a large pit on the posteroventral ridge.

Occurrence.—The species commonly occurs in sand lenses of the C Silt. A few specimens also occur in the B, E, F, G and H members.

Family Trachyleberididae
SYLVESTER-BRADLEY, 1948

Subfamily Trachyleberidinae
SYLVESTER-BRADLEY, 1948

Genus *Trachyleberis* BRADY, 1898

Trachyleberis sp.

Pl. 49, figs. 1a, b.

Description.—Description is based on juvenile valves. Adult has not been found yet.

Carapace elongate subtrapezoidal and tapering toward posterior in lateral view. Highest at anterior cardinal angle. Anterior margin broadly and evenly rounded with denticulations along its ventral half. Dorsal margin straight. Ventral margin slightly sinuate at middle. Posterior margin truncated its dorsal half. Ventral half of posterior margin denticulate. Denticulation thickest at posterior end. In dorsal view, carapace oblong. Anterior cardinal angle protrudent, having slight concavity behind it. Posterior cardinal angle obtuse. Left valve overreaching right valve at anterior cardinal angle and in region of posterodorsal slope.

Surface coarsely reticulate, dominated by an anterior marginal ridge and four longitudinal ridges. Anterior marginal ridge prominent, arising from area behind anterior cardinal angle, running parallel to anterior margin, and connecting to fourth longitudinal ridge. First longitudinal ridge starting from anterodorsal area behind anterior marginal ridge running posterodorsally to dorsal margin and then posteriorly along dorsal margin, and terminating before reaching posterior cardinal angle. Median longitudinal ridge arising from middle area just behind anterior marginal ridge, running obliquely backward, and terminating at posterodorsal angle. Third longitudinal ridge starting from lower part of anterior margin, running parallel to second longitudinal ridge, and terminating in posteroventral area. Fourth and most ventral ridge weak, running close and parallel to third ridge. Weak, short ridges run parallel between the third and fourth ridges, and the fourth ridge and ventral contact margin. Regular reticulation between longitudinal ridges. Fossae between anterior margin and anterior maginal ridges large. Anterior and posterior rims low and indistinct. Subcentral tubercle not prominent. Reticulation irregular in area of subcentral tubercle.

Eye tubercle obscure in outside view but eye depression clear in inside view. Normal pore canals sieve type, sparsely scattered. Radial pore canals numerous, with bulbous enlargement and terminat-

S	*N*	*Me*	$\bar{X}$	*s*	*V*	*OR*
L (Adult-1)	6	L	0.774	0.011	1.42	0.77-0.79
		H	0.414	0.010	2.42	0.40-0.43
R (Adult-1)	1	L				0.76
		H				0.40
L (Adult-2)	2	L				0.71
		H				0.37
R (Adult-2)	6	L	0.714	0.008	1.12	0.71-0.73
		H	0.378	0.010	2.65	0.37-0.40
L (Adult-3)	2	L				0.54-0.55
		H				0.31-0.32
R (Adult-3)	7	L	0.565	0.023	4.07	0.53-0.60
		H	0.310	0.014	4.52	0.30-0.33
R (Adult-4)	1	L				0.43
		H				0.26
L (Adult-5)	1	L				0.34
		H				0.20

ing at each marginal denticulation.

Marginal infold narrow. Line of concrescence coincides with inner margin. No vestibule.

Hinge modified merodont of juvenile form. Muscle scars situated in subcentral depression and composed of a v-shaped frontal scar and vertical row of four horizontally elongated adductor muscle scars.

Dimensions.—Measurements of specimens from Sample no. 1 of the G Sand (Loc. 37).

Illustrated specimens.—UMUT-CA 8422, a left valve (Pl. 49, fig. 1b); UMUT-CA 8423, a right valve (Pl. 49, fig. 1a).

Remarks.—This form is closely similar to the immature form of *Trachyleberis niitsumai* ISHIZAKI, 1971 (p. 93, Pl. 4, fig. 15; not Pl. 1, fig. 5, Pl. 4, fig. 18, Pl. 5, fig. 3, Pl. 6, fig. 10, Pl. 7, fig. 9). It is interesting to note that this juvenile form has some resemblance to the adult form of the genus *Costa* NEVIANI, 1928 (e.g., *Costa* sp. of SISSINGH, 1972, from late Pliocene of Karpathos, South Aegean Islands, and *Costa* (*Paracosta*) *disintegra* SIDDIQUI, 1971 from Middle Eocene of Pakistan).

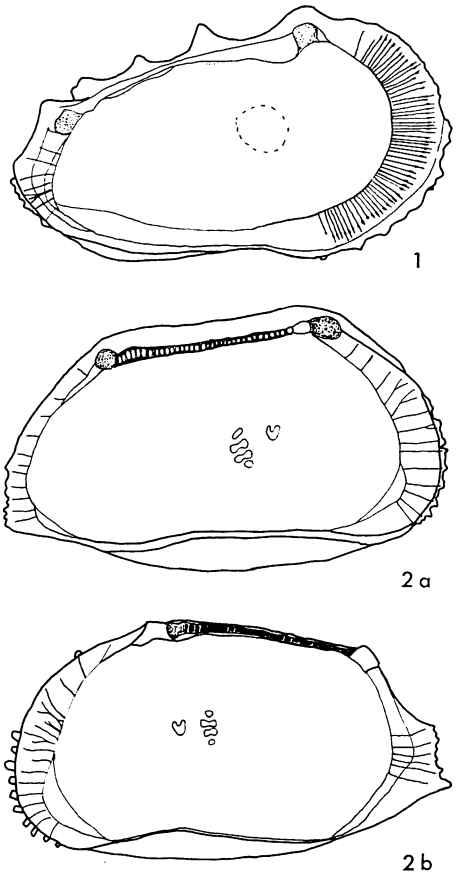
Occurrence.—All ilustrated specimens are obtained from the G Sand where they are common. This species occurs from the F Silt and the H Sand but rarely. Two specimens also obtained from the B Member.

Genus *Actinocythereis* PURI, 1953

Actinocythereis kisarazuensis n. sp.

Pl. 49, figs. 3a, b. Text-fig. 9, fig. 1.

Diagnosis.—A species of the genus *Actinocythereis* characterized by smooth surface with spinous nodes often bifurcating at top. Ten to 15 small tubercles arranged along anterior and posterior margins.



Text-fig. 9. Internal views. a, left valve; b, right valve.

Fig. 1. *Actinocythereis kisarazuensis* YAJIMA, n. sp.

Holotype, left valve, CA 8420; Sample no. 1, Loc. 37, G Sand. ×70.

Figs. 2a, b. *Lixouria nipponica* YAJIMA, n. sp.

2a. Paratype, CA 8419; Sample no. 513, Loc. 30, G Sand. ×90.

2b. Paratype, CA 8425; Sample no. 45, Loc. 29, F Silt. ×90.

Description.—Carapace subtriangular in lateral view. Highest at anterior cardinal angle. Anterior margin broadly rounded. Dorsal margin straight with five spinous nodes in lateral view, anterior one on eye

tubercle and posterior one at posterior cardinal angle. Dorsal contact margin straight. Ventral margin concave at anterior one-third in lateral view. Ventral contact margin sinuate at middle. Dorsal and ventral margins gently tapering posteriorly, dorsal half of posterior margin slightly concave, ventral half of posterior margin gradually continuing into ventral margin, making obliquely rounded posteroventral margin. In ventral and dorsal views, carapace elliptic, broadest posteriorly, with compressed anterior areas. In anterior view, carapace ovate.

Surface with prominent spinous nodes. Anterior rim armoured with seven small tubercles, anterior area behind rim smooth, wide and shallow. Subcentral tubercle prominent, high and covered by a vertical row of three densely placed small nodes. Short, faint ridges running from subcentral tubercle, one toward eye tubercle, and spinous one toward anteroventral area. Posteroventral rim armoured with nine small tubercles. Posterodorsal tubercle with three spinous nodes. Area of posteroventral ridge marked by two spinous nodes. In immature stage, surface reticulated.

Eye tubercle distinct. Normal pore canals scattered. Radial pore canals with bulbous enlargement, numerous along anterior margin and coarser along posterior margin.

Marginal infold moderately broad. Line of concrescence coincides with inner margin. Selvage distinct. No vestibule. Hinge holamphidont, median bar denticulated. Muscle scar field in subcentral tubercle. Muscle scar pattern not observable.

Dimensions.—Measurements of pooled specimens are given below.

S	*Loc*	*N*	*Me*	*OR*
L	28 G	2	L	0.76-0.77
			H	0.45-0.46
L	37 G	1	L	0.83
			H	0.45
C	27 G	1	L	0.79
			H	0.45
			W	0.20
C	37 G	1	L	0.77
			H	0.44
			W	0.19
L	(Adult-1) 28 G	1	L	0.65
			H	0.37
L	(Adult-1) 36 G	1	L	0.67
			H	0.33
L	(Adult-1) 35 G	2	L	0.67-0.68
			H	0.37-0.38
R	(Adult-1) 35 G	1	L	0.51
			H	0.31

Types.—Holotype UMUT-CA 8420, a left valve (Pl. 49, fig. 3b. Text-fig. 9, fig. 1); figured paratype UMUT-CA 8421, a right valve (Pl. 49, fig. 3a).

Type-locality.—Loc. 37 (Sample no. 1, G Sand).

Remarks.—This species is closely similar to *Trachyleberis* sp. A, described by ISHIZAKI, 1968 from Uranouchi Bay, Kochi Prefecture. In fact, it is highly probable that both species is conspecific. The species is actually close to the genus *Actinocythereis* in having at least two horizontal rows of spinous nodes.

Occurrence.—This species occurs only from the G Sand, 12 specimens in total are obtained.

Subfamily Pterygocythereidinae PURI, 1957

Genus *Lixouria* ULICZNY, 1969

Lixouria nipponica n. sp.

Pl. 50, figs. 7a-c. Text-fig. 9, figs. 2a, b.

Diagnosis.—A species of the genus *Lixouria* characterized by development of alae with keel running smoothly from

anterior margin to posterior margin.

Description.—Carapace subtrapezoidal, inflated ventrally in lateral view. Anterior margin obliquely rounded, with 10-13 spines along anteroventral margin. Dorsal contact margin straight but dorsal margin slightly sinuate in lateral view. Anterior and posterior cardinal angles obtuse. Ventral margin convex in lateral view and nearly parallel to dorsal margin. Ventral contact margin sinuate at anterior one-third. Posterior margin narrowly and obliquely rounded and truncated obliquely. Posterior extremity with blunt spines, lowest is the largest. Ventrolateral alae strong and with keel running smoothly from anterior margin to posterior margin without interuption by spines. Surface smooth. Carapace ovate in dorsal view, widest in posterior one-third. In anterior view, carapace isosceles triangular, with slightly inflated sides and nearly straight base.

Normal pore canals simple and numerous. Radial pore canals straight, moderate in number. Some along the anterodorsal margin bifurcate. Eye tubercle obscure but depression for eye in front of anterior tooth distinct in inner view.

Marginal infold narrow along anterior and posterior margins. Left valve overhanging along dorsal margin. Inner margin coincides with line of concrescence along anterior and posterior margins except for anteroventral and posteroventral margins, where vestibule developed rather deeply. Hinge holamphidont with crenulate median element. Anterior socket of right valve small.

Muscle scar field flattened. Muscle scars consisting of a j-shaped frontal scar and a vertical row of four oval adductor scars, of which median two elongate.

Dimensions.—Measurements of pooled specimens are given below.

S	*Loc*	*N*	*Me*	*OR*
C	29 F	1	L	0.72
			H	0.43
			W	0.42
R	29 F	1	L	0.67
			H	0.36
L	28 G	1	L	0.70
			H	0.39
C (Adult-1)	28 G	1	L	0.56
			H	0.29
			W	0.32
C	29 G	1	L	0.70
			H	0.41
			W	0.42
C	30 G	1	L	0.70
			H	0.41
			W	0.38
C	29 H	1	L	0.73
			H	0.41
			W	0.38

Types.—Holotype UMUT-CA 8424, a complete carapace (Pl. 50, fig. 7c); figured paratypes, UMUT-CA 8425, a right valve (Pl. 50, fig. 7a. Text-fig. 9, fig. 2b); UMUT-CA 8419, a left valve (Pl. 50, fig. 7b. Text-fig. 9, fig. 2a).

Type-locality.—Loc. 29 (Sample no. 45, F Silt).

Remarks.—This species resembles *Lixouria aquila* RUGGIERI, 1972 from Pliocene of Italy, but differs in the shape of the alae and vestibule. It is also closely allied to *Incongruellina* (*Lixouria*) *unicostulata* ULICZNY, 1969 from the Pliocene of western Greece, but in the new species, the keeled edge of alae runs continuously from anterior margin to posterior margin.

Occurrence.—This species occurs rarely in the E, F, G and H members.

Subfamily Buntoniinae
APOSTOLESQU, 1961

Genus *Buntonia* HOWE, 1935

Buntonia hanaii n. sp.

Pl. 50, figs. 4a, b.

Buntonia sp. HANAI, 1961, p. 373, text-fig. 14, figs. 1a, b.
—— sp.: HANAI et al., 1977, p. 53.

Diagnosis.—A species of the genus *Buntonia* characterized by reticulation restricted to posterior one-third of carapace. Reticulation consisting of a few strong ridges running nearly parallel to posterior margin and a few cross ridges tending to converge posteriorly.

Description.—Carapace oblong ovate in lateral view, highest at middle i. e. at anterior cardinal angle. Anterior margin broadly rounded and bordering by strongly developed marginal rim. Both dorsal and ventral margins slightly convex, nearly parallel each other in right valve and gradually tapering posteriorly in left valve. Ventral contact margin sinuate at middle. Posterior margin truncated at posterior end. Posterior cardinal angle protruding in left valve. Carapace elliptic and compressed in dorsal view, and elliptic in anterior view. Left valve larger than right.

Posterior half of carapace surface with a few strong ridges being nearly parallel to posterior margin. Ridges connected by cross ridges tending to converge posteriorly. Surface otherwise smooth.

Normal pore canals simple, moderate in number, scattered over entire surface and in a line along anterior marginal rim. Radial pore canals numerous, straight, and with bulbous enlargement. Some bundled up and some bifurcate.

Valves shallow. Marginal infold broad along anterior margin and narrow along posterior margin. Vestibule narrow, otherwise line of concrescence coincides with inner margin.

Hinge holamphidont, with crenulated median element, and short. Anterior tooth of right valve situated in middle of carapace length. Muscle scar field subcentral. Muscle scars consisting of a j-shaped frontal scar and a vertical row of four adductor muscle scars. Dorsal one of adductor muscle scars crescent, median two elongate, and ventral one ovate. A large additional scar occuring in dorsal area.

Dimensions.—Measurements of specimens from Sample no. 60 of the H Sand (Loc. 29).

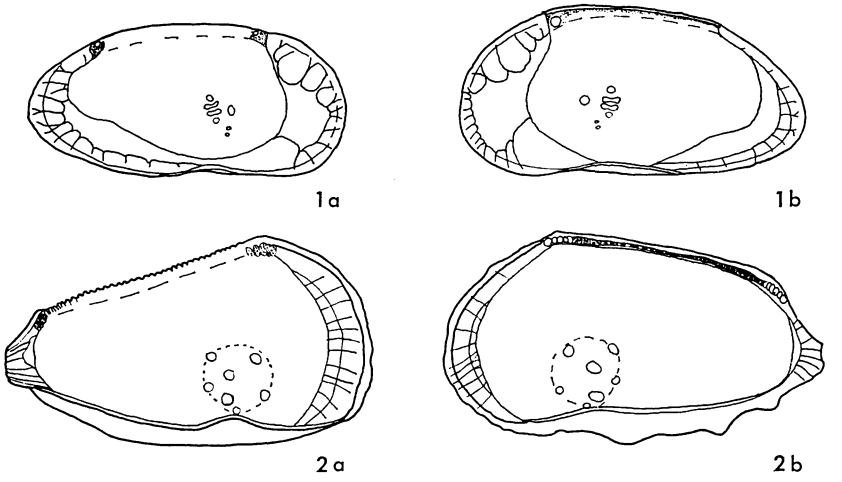
S	*Me*	*N*	$\bar{X}$	*OR*
L	L	3	0.610	0.59-0.63
	H	3	0.373	0.34-0.39
R	L	2		0.58-0.59
	H	2		0.33-0.36
C	L	3	0.600	0.59-0.62
	H	3	0.350	0.34-0.37
	W	3	0.267	0.24-0.29
L (Adult-1)	L	1		0.51
	H	1		0.29
R (Adult-1)	L	1		0.50
	H	1		0.28
L (Adult-2)	L	1		0.41
	H	1		0.22

Types.—Holotype, UMUT-CA 8427, a left valve (Pl. 50, fig. 4b); figured paratype, UMUT-CA 8428, a right valve (Pl. 50, fig. 4a).

Type-locality.—Loc. 29 (Sample no. 60, H Sand).

Remarks.—This species is very similar to *Buntonia* sp. of VALENTINE, 1976, from the Holocene shelf deposits of Santa Monica Bay, the west coast of the United States, in lateral view, but different in posterior ornamentation. For the distribution pattern of radial pore canals and details of the hingement of *B. hanaii* n. sp. see illustrations made by HANAI (1959b).

Occurrence.—All type specimens were obtained from the H Sand where they are abundant. This species occurs commonly from the B, F and G members.



Text-fig. 10. Internal views. a, left valve; b, right valve.
Figs. 1a, b. *Cytheroma? hanaii* YAJIMA, n. sp.
Holotype, CA 8413; Sample no. 35, Loc. 33, G Sand. ×85.
Figs. 2a, b. *Paracytheridea bosoensis* YAJIMA, n. sp.
2a. Paratype, CA 8416; Sample no. 55, Loc. 18, C Silt. ×80.
2b. Holotype, CA 8415; Sample no. 55, Loc. 18, C Silt. ×90.

Family Cytheruridae G. W. MÜLLER, 1894

Subfamily Cytherurinae
G. W. MÜLLER, 1894

Tribe Paracytheridini PURI, 1957

Genus *Paracytheridea* G. W. MÜLLER, 1894

Paracytheridea bosoensis n. sp.

Pl. 50, figs. 6a, b. Text-fig. 10, figs. 2a, b.

Diagnosis.—A species of the genus *Paracytheridea* characterized by a prominent swelling of shoulder part of wing-like expansion and faintly reticulate surface.

Description.—Carapace subtrapezoidal in lateral view. Anterior margin obliquely rounded. Dorsal margin nearly straight. Ventral margin obscured by wing-like lateral expansion of carapace. Ventral contact margin slightly sinuate near middle. Posterior margin tapering rapidly to form pointed extremity. In dorsal view, carapace broadly ovate. In anterior view, carapace triangular, with inflated lateral and relatively flat ventral surfaces.

Surface irregularly and broadly reticulated by thin and low ridges. Two faint marginal ridges running parallel to anterior, ventral and posterior margins. Wing-like lateral expansion prominent. Subcentral swelling of muscle scar field low but distinct. Trace of muscle scars prominent on outer surface.

Eye tubercle obscure. Normal pore canals, sieve type, with large sunken pore plate and a large central opening, moderate in number, and scattered evenly. Radial pore canals straight, approximately ten in number along anterior margin.

Marginal infold narrow. Selvage and flange distinct. Vestibule very narrow or obscure. Hinge merodont, straight type (HANAI, 1957c).

Muscle scar consisting of two frontal scars, upper one large and lower one

small, and a vertical row of four adductor muscle scars, dorsomedian one divided.

Dimensions.—Measurements of specimens from Sample no. 55 of the C Silt (Loc. 18).

S	*Me*	*N*	$\bar{X}$	*s*	*V*	*OR*
L	L	1				0.61
	H	1				0.33
R	L	6	0.620	0.015	2.40	0.60-0.64
	H	6	0.317	0.009	2.80	0.30-0.32

Types.—Holotype, UMUT-CA 8415, a right valve (Pl. 50, fig. 6a. Text-fig. 10, fig. 2b); figured paratype, UMUT-CA 8416, a left valve (Pl. 50, fig. 6b. Text-fig. 10, fig. 2a).

Type-locality.—Loc. 18 (Sample no. 55, C Silt).

Remarks.—This species is similar to *Paracytheridea neolongicaudata* ISHIZAKI, 1966, from the Hatatate Formation (Late Miocene), but differs in the shape of alae.

Occurrence.—This species is abundant in the C Silt, commonly from the G Sand, and rarely from the E and H members.

Family Paradoxostomatidae BRADY and NORMAN, 1889

Subfamily Cytheromatinae ELOFSON, 1939

Genus *Cytheroma* G. W. MÜLLER, 1894

Cytheroma? hanaii n. sp.

Pl. 50, figs. 5a, b.
Text-fig. 10, figs. 1a, b.

Diagnosis.—A species of the genus *Cytheroma?* characterized by an anterior large anti-slip tooth in right valve.

Description.—Carapace ovate in lateral view. Anterior margin obliquely and broadly rounded. Dorsal margin slightly convex. Ventral margin nearly straight, ventral contact margin slightly sinuate at middle. Posterior margin narrowly rounded. In dorsal view, carapace tumid.

Carapace thin and somewhat pelucid. Surface smooth. Eye tubercle obscure. Normal pore canals, open type, moderate in number, scattered evenly. Radial pore canals, approximately 30 in number along entire margin, and dense along anteroventral margin. Some of them bifurcate, particularly along anterior and posterior margins.

Marginal infold very wide anteriorly and posteroventrally, narrow ventrally and posterodorsally. Inner margin not parallel to outer margin, curved gently along anterior margin and making straightened s-shaped along posteroventral margin. Vestibule deep along anterior margin and shallow along posteroventral margin.

Hingement lophodont. Hinge margin of left valve provided with an anterior small socket, a smooth long bar with small round projections at each end, and a shallow posterior socket. Hinge margin of right valve composed of corresponding elements to those of left valve, with socket-like end of groove. A large round anti-slip tooth projecting below anterior socket-like end of groove.

Muscle scars in anteromedian area and composed of a large round frontal scar and a vertical row of four adductor muscle scars, in which the median two are elongate.

Dimensions.—Measurements of specimens from Sample no. 35 of the G Sand (Loc. 33).

S	*Me*	*N*	$\bar{X}$	*OR*
C	L	3	0.547	0.54-0.55
	H	3	0.268	0.265-0.27
	W	3	0.143	0.14-0.15
L	L	1		0.49
	H	1		0.24
R	L	2		0.49
	H	2		0.24

Types.—Holotype, UMUT-CA 8413, a complete carapace (Pl. 50, figs. 5a, b. Text-fig. 10, figs. 1a, b).

Type-locality.—Loc. 33 (Sample no. 35, G Sand).

Remarks.—This species is close to *Cytheroma variabilis* G. W. MÜLLER, 1894 illustrated by UFFENORDE (1975) from the Adriatic Sea, but is different in the lateral outline. A large round anti-slip tooth in the anterior part of right valve hingement characterizes this species. The writer is inclined to assign considerable taxonomic value to this anti-slip tooth. Since anti-slip tooth has not been found in the species of the genus *Cytheroma* yet, the writer tentatively places this species in the genus *Cytheroma* with question.

Occurrence.—This species occurs rarely in the B Member, the F Silt, the G Sand, and the H Sand.

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Sampling localities

1. An exposure, 500 m E. of the Hitomi Shrine, Hitomi, Kimitsu-shi.
2. An exposure, 250 m E. of the Hitomi Shrine, Hitomi, Kimitsu-shi.
3. An exposure in the precincts of the Hitomi Shrine, Hitomi, Kimitsu-shi.
4. A cliff fronting the Koito River, 150 m NW. of the Hitomi Shrine, Hitomi, Kimitsu-shi (Loc. 87 of KOZIMA, 1966a, b).
5. An exposure, 50 m N. of the Kimitsu storing reservoir, Godo, Kimitsu-shi (Loc. 86 of KOZIMA, 1966a, b).
6. An exposure, 100 m SSE. of the Godo bus-stop, Godo, Kimitsu-shi.
7. An exposure, 100 m ESE. of the Godo bus-stop, Godo, Kimitsu-shi (Exposures at Locs. 5, 6 and 7 are found to be continuous).
8. An exposure at the flank of a hill on which the Gymnasium of the Shin-Nittetsu Co. Ltd. stands, Owada, Kimitsu-shi.
9. An exposure of road cutting situated in the western side of the Owada junction, Owada, Kimitsu-shi (Loc. 85 of KOZIMA, 1966a, b).
10. A cliff situated in the eastern side of the Owada junction, Sakata, Kimitsu-shi.
11. An exposure, 100 m SSE. of the Owada Bridge, Owada, Kimitsu-shi (Loc. 88 of KOZIMA, 1966a, b).
12. A cliff along the highway route 16, about 300 m N. of the Owada Elementary School, Sakata, Kimitsu-shi.
13. An exposure behind the bus-stop at the entrance of the Shin-Nittetsu Co. Ltd., Sakata, Kimitsu-shi.
14. A cliff at the flank of a hill on which the Shin-Nittetsu Club stands, 200 m N. of the Sakata Elementary School, Sakata, Kimitsu-shi (Loc. 84 of KOZIMA, 1966a, b).
15. An exposure, 300 m S. of the Sakata bus-stop, Honnawa, Sakata, Kimitsu-shi.
16. A cliff, 100 m WNW. of the Osekiya Pond, Honnawa, Sakata, Kimitsu-shi.
17. An exposure along the highway route 16, 150 m WSW. of the Hatazawa Bridge, Sakata, Kimitsu-shi (Loc. 82 of KOZIMA, 1966a, b).
18. An exposure, 200 m NNE. of the Sengen

Shrine, Hatazawa, Kisarazu-shi (Loc. 81 of KOZIMA, 1966a, b).

19. An exposure along the highway route 16, 400 m SW. of the Obama bus-stop, Obama, Kisarazu-shi (Loc. 80 of KOZIMA, 1966a, b).
20. An exposure, 200 m E. of the Obama bus-stop, Obama, Kisarazu-shi.
21. An exposure, 350 m NNE. of the Kimitsu Station, Sakata, Kimitsu-shi.
22. An exposure, 600 m E. of the Kimitsu Station, Kuboyama, Kubo, Kimitsu-shi.
23. A cliff, 1 Km ESE. of the Kimitsu Station, Kuboyama, Kubo, Kimitsu-shi.
24. A cliff, 600 m NNE. of the Kuzoin Temple, Kita-Koyasu, Kimitsu-shi.
25. A cliff, 350 m NNW. of the Namioka Elementary School, Katsudoyatsu, Okubo, Kisarazu-shi.
26. A cliff, 500 m SSW. of the Sakurai Post Office, Sakurai, Kisarazu-shi (Loc. 78 of KOZIMA, 1966a, b and Loc. 1 of KIKUCHI, 1972b).
27. A cliff, 400 m N. of the Nozoin Temple, Sakurai, Kisarazu-shi (Loc. A of KIKUCHI, 1972b).
28. A cliff, 300 m ESE. of the Shofukuji Temple, Josai, Kisarazu-shi.
29. An exposure, 300 m SW. of the Shounji Temple, Senzoku, Josai, Kisarazu-shi.
30. An exposure, 300 m S. of the Kisarazu Second Junior High School, Takabe, Josai, Kisarazu-shi.
31. An exposure, 300 m SSE. of the Kisarabu Second Junior High School, Bouchiyatsu, Josai, Kisarazu-shi.
32. An exposure, 600 m S. of the Hie Shrine, Josai, Kisarazu-shi.
33. An exposure, 450 m S. of the old Hirakawa Bridge, Nakagoyatsu, Josai, Kisarazu-shi.
34. An exposure, 150 m SW. of the Chiba Prefectural Kazusa Museum, Ota, Kisarazu-shi (Loc. 68 of KOZIMA, 1966a, b).
35. A cliff, 100 m S. of the Chiba Prefectural

Explanation of Plate 49

Figs. 1a, b. *Trachyleberis* sp.
- 1a. Lateral view, young instar, right valve (CA 8423; Sample no. 1, Loc. 37, G Sand). ×60.
- 1b. Lateral view, young instar, left valve (CA 8422; Sample no. 1, Loc. 37, G Sand). ×60.

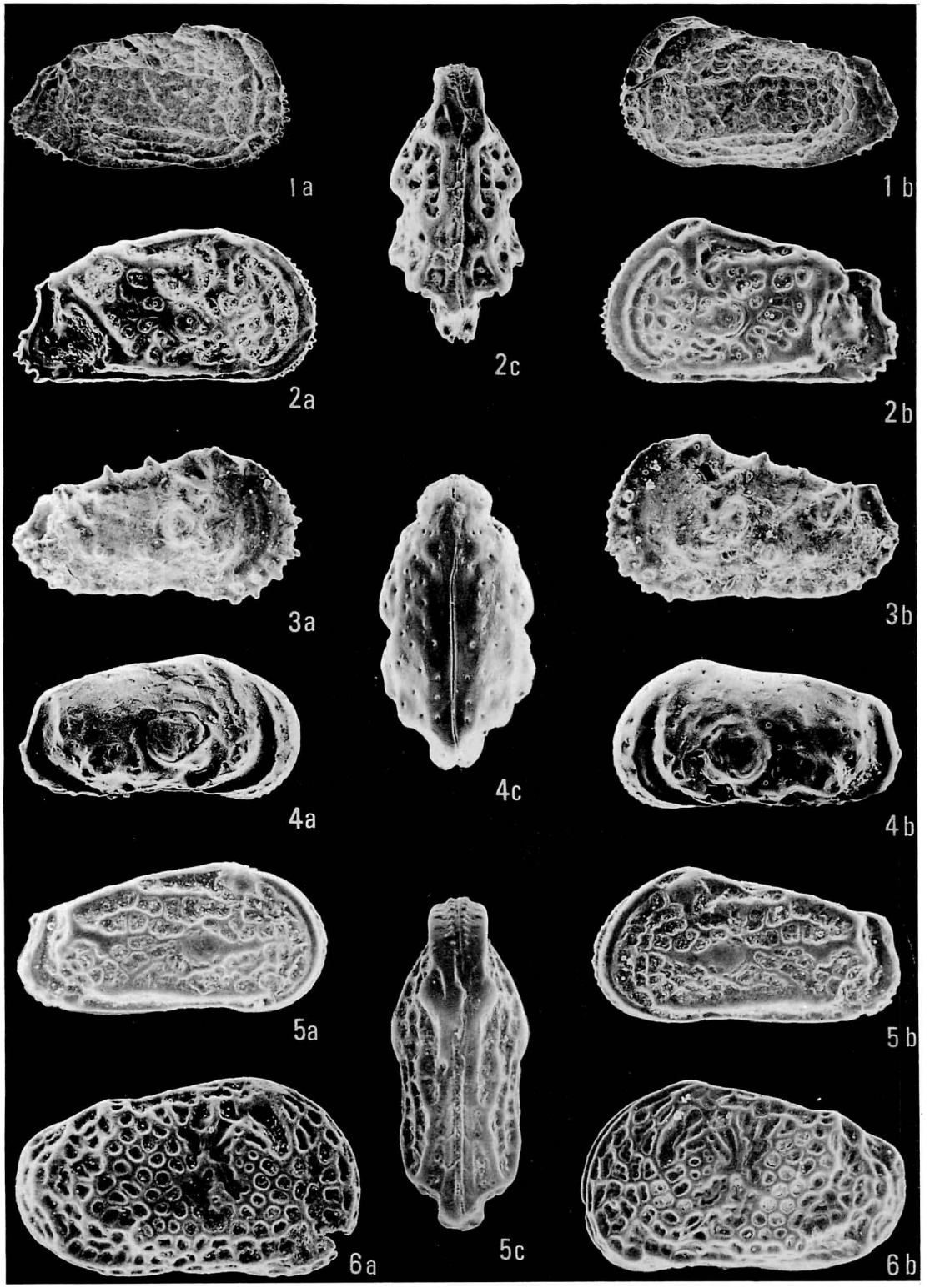
Figs. 2a-c. *Cornucoquimba tosaensis* (ISHIZAKI, 1968).
- 2a. Lateral view, adult right valve (CA 8440; Sample no. 60. Loc. 29, H Sand). ×70.
- 2b. Lateral view, adult left valve (CA 8441; Sample no. 60, Loc. 29, H Sand). ×70.
- 2c. Dorsal view, adult complete carapace (CA 8442; Sample no. 60, Loc. 29, H Sand). ×60.

Figs. 3a, b. *Actinocythereis kisarazuensis* YAJIMA, n, sp.
- 3a. Lateral view, adult right valve (Paratype, CA 8421; Sample no. 1, Loc. 37, G Sand). ×90.
- 3b. Lateral view, adult left valve (Holotype, CA 8420; Sample no. 1, Loc. 37, G Sand). ×90.

Figs. 4a-c. *Coquimba ishizakii* YAJIMA, n. sp.
- 4a. Lateral view, adult right valve (Paratype, CA 8432; Sample no. 55, Loc. 18, C Silt). ×90.
- 4b. Lateral view, adult left valve (paratype, CA 8431; Sample no. 55, Loc. 18, C Silt). ×90.
- 4c. Dorsal view, adult complete carapace (Holotype, CA 8430; Sample no. 55, Loc. 18, C Silt). ×90.

Figs. 5a-c. *Ambostracon ikeyai* YAJIMA, n. sp.
- 5a. Lateral view, adult right valve (Paratype, CA 8435; Sample no. 2, Loc. 41, E Member). ×90.
- 5b. Lateral view, adult left valve (Paratype, CA 8434; Sample no. 2, Loc. 41, E Member). ×90.
- 5c. Dorsal view, adult complete carapace (Holotype, CA 8433; Sample no. 2, Loc, 41, E Member). ×90.

Figs. 6a, b. *Callistocythere* sp.
- 6a. Lateral view, young instar, right valve (CA 8439; Sample no. 35, Loc. 33, G Sand). ×110.
- 6b. Lateral view, young instar, left valve (CA 8437; Sample no. 35, Loc. 33, G Sand). ×110.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6b

Kazusa Museum, Ota, Kisarazu-shi (Loc. 69 of KOZIMA, 1966a, b).

36. An exposure, 200 m NNW. of the new Ota Bridge, Ota, Kisarazu-shi (Loc. 70 of KOZIMA, 1966a, b).
37. An exposure, 300 m NNE. of the Chiba Prefectural Kazusa Museum, Ota, Kisarazu-shi.
38. An exposure, 1 Km S. of the Kazusa-Kiyokawa Station, Nakao, Kisarazu-shi.
39. An exposure, 1 Km SSE. of the Kazusa-Kiyokawa Station, Nakao, Kisarazu-shi.
40. A cliff, 600 m SW. of the Kazusa-Kiyokawa Station, Sugo, Kisarazu-shi.
41. A cliff, 700 m W. of the Kazusa-Kiyokawa Station, Nakao, Kisarazu-shi (Loc. 5 of KIKUCHI, 1972b).
42. A cliff, 500 m ESE. of the Kazusa-Kiyokawa Station, Nakao, Kisarazu-shi (Loc. 9 of KIKUCHI, 1972b).

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Explanation of Plate 50

Figs. 1, 2, *Ambostracon ikeyai* YAJIMA, n. sp.

1. Adductor muscle scars of right valve (Paratype, CA 8435 ; Sample no. 2, Loc. 41, E Member). ×330.
2. Normal pore canal opening on exterior surface, located close to the subcentral tubercle of left valve (Paratype, CA 8434; Sample no. 2, Loc. 41, E Member). ×6000.

Figs. 3a, b. *Pseudopsammocythere tokyoensis* YAJIMA, n. sp.

3a. Lateral view, adult right valve (Holotype, CA 8410; Sample no. 512, Loc. 28, H Sand). ×100.

3b. Lateral view, adult left valve (Paratype, CA 8411; Sample no. 512, Loc. 28, H Sand). ×100.

Figs. 4a, b. *Buntonia hanaii* YAJIMA, n. sp.

4a. Lateral view, adult right valve (Paratype, CA 8428; Sample no. 60, Loc. 29, H Sand). ×75.

4b. Lateral view, adult left valve (Holotype, CA 8427; Sample no. 60, Loc. 29, H Sand). ×75.

Figs. 5a, b. *Cytheroma? hanaii* YAJIMA, n. sp.

5a. Lateral view, adult right valve (Holotype, CA 8413; Sample no. 35, Loc. 33, G Sand). ×100.

5b. Lateral view, adult left valve (Holotype, CA 8413; Sample no. 35, Loc. 33, G Sand). ×100.

Figs. 6a, b. *Paracytheridea bosoensisa* YAJIMA, n. sp.

6a. Lateral view, adult right valve (Holotype, CA 8415; Sample no. 55, Loc. 18, C Silt). ×90.

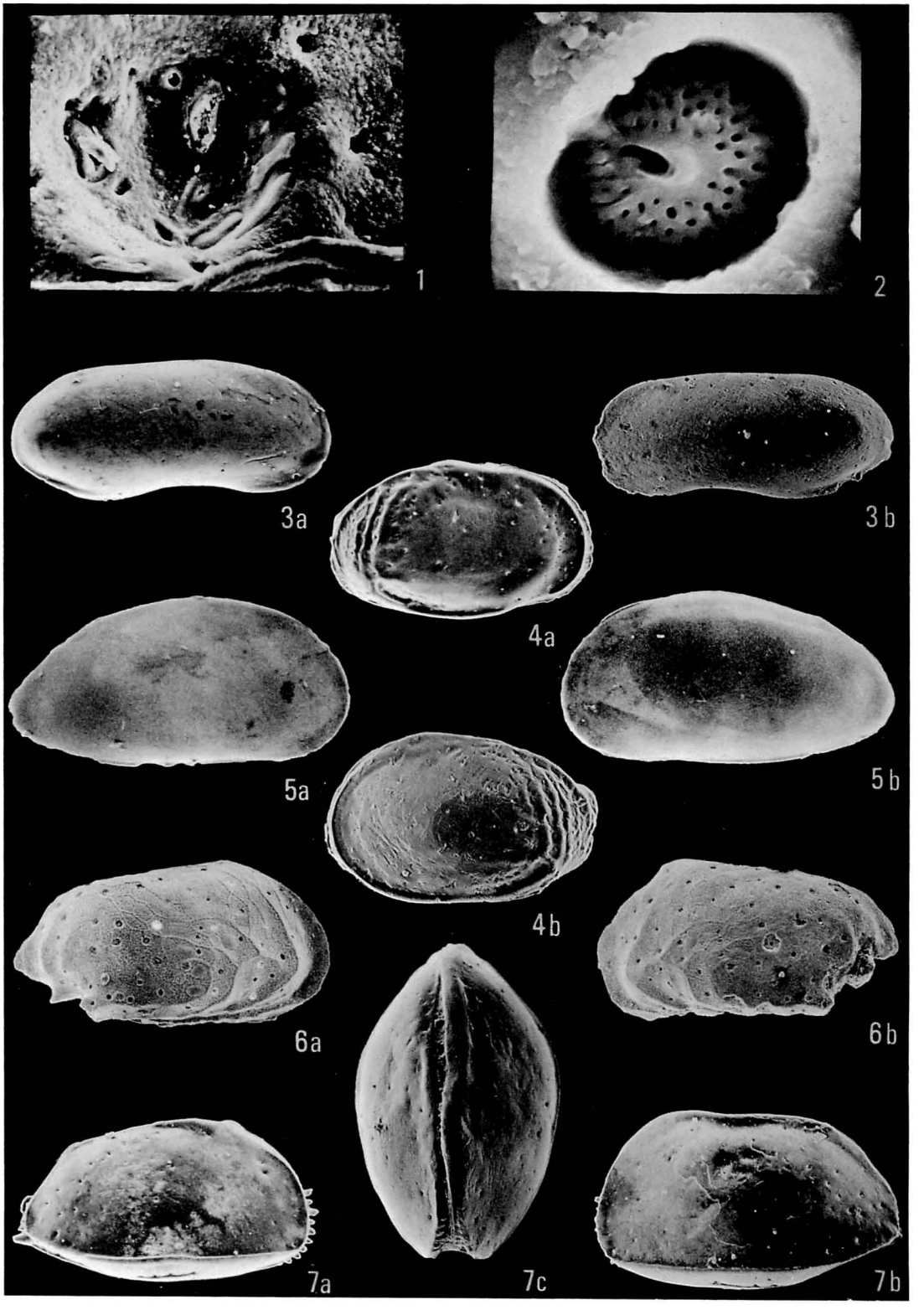
6b. Lateral view, adult left valve (Paratype, CA 8416; Sample no. 55, Loc. 18, C Silt). ×90.

Figs. 7a-c. *Lixouria nipponica* YAJIMA, n. sp.

7a. Lateral view, adult right valve (Paratype, CA 8425; Sample no. 45, Loc. 29, F Silt). ×70.

7b. Lateral view, adult left valve (Paratype, CA 8419; Sample no. 513, Loc. 30, G Sand). ×70,

7c. Dorsal view, adult complete carapace (Holotype, CA 8424; Sample no. 45, Loc. 29, F Silt). ×70.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房総半島東京湾沿岸，木更津周辺地域の海成更新統より産出する介形虫の群集構成を明らかにするため，まず露頭での岩相，層序関係，貝化石と砂管の産状等の観察に基いて古環境の復元を試みた。当地域には2つの堆積輪廻が認められる。下部の輪廻 (B→E) には親潮型の貝化石が，上部 (F→H) には黒潮型の貝化石が多く産出する。下部輪廻上部のD礫層と部層の下部は，付近の河のデルタの末端部らしい。上部輪廻のG砂層はほぼ下末吉海進期に相当する。

3種類の介形虫化石群集が識別される。i) 内湾砂底の群集は，B, C, E 部層中に見られ，内湾砂底の種の他に岩礁地の潮間帯，アマモ場，内湾泥底に生息する種も混合している。ii) 内湾泥底群集はFシルト層中に見られ，その種の多様性は低く，泥底を這う3種が全群集の90%を占める。iii) シルト質砂底群集は，Cシルト層中の砂のレンズおよびG砂層とH部層中に見られ，水深20～50 m のシルト質砂底に生息する種の他に浅海のさまざまな環境より流入した種を含み，異地性群集である。Cシルト層の群集は *Paracytheridea bosoensis* を主体とするのに対し，G砂層，H部層のものは，*Loxoconcha laeta* を主体とする点で差異が認められる。

8新種 *Pseudopsammocythere tokyoensis*, *Ambostracon ikeyai*, *Coquimba ishizakii*, *Actinocythereis kisarazuensis*, *Lixouria nipponica*, *Buntonia hanaii*, *Paracytheridea bosoensis*, *Cytheroma? hanaii* を記載し，1種 (*Cornucoquimba tosaensis* (ISHIZAKI, 1968)) を再記載した。*Pseudopsammocythere*, *Ambostracon*, *Lixouria* の3属の産出は日本からは最初の報告である。

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 112, pp. 410-416, pl. 51, December 30, 1978

695. LOWER JURASSIC AMMONITES FROM THE HIGUCHI GROUP, SOUTHWEST JAPAN*

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Abstract. MIKAMI and MIYAGAWA studied the geology in and around the Higuchi Group, which has been considered as Jurassic based on the preliminary study on some ammonites obtained from gravels of a river floor, and first succeeded in collecting some ammonites and bivalves from an exposure. We systematically describe these ammonites, *Fontanelliceras* cfr. *fontanellense*, *Arieticeras* sp. and *Canavaria* sp. They are typical Tethyan ammonites and regarded as representative species in the *Fontanelliceras fontanellense* Zone of the Domerian Substage in the Mediterranean Region.

Introduction

The southwest part of Shimane Prefecture indicated in Fig. 1 is mainly occupied by the Upper Palaeozoic rocks which are overlain by the Cretaceous Kwanmon Group and volcanic rocks and in part intruded by some Cretaceous igneous rocks. The existence of the Jurassic in this area was first reported by IMAMURA et al. (1966) and the Jurassic was named as the Higuchi Group. The fossils from the group were ammonites and bivalves, and those ammonites were preliminarily considered to indicate a Lower Jurassic age by T. SATO (IMAMURA et al., 1966). The ammonites were, however, obtained from gravels of a river floor. Recently, MIKAMI and MIYAGAWA have studied the geology of this area and obtained some more ammonites and bivalves from exposures

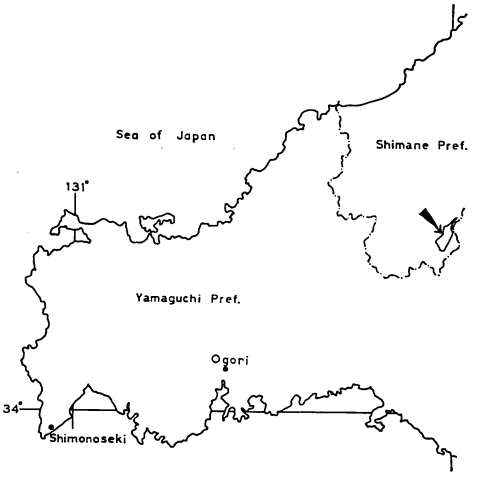

Fig. 1. Map showing the studied area.

* Received Dec. 27, 1977; read Jan. 22, 1977 at Koganei.

of the Higuchi Group and also from gravels of the River Higuchi-zawa. As the ammonites from the Higuchi Group have not been described yet, here we give systematic descriptions on the ammonites collected by MIKAMI and MIYAGAWA.

We express our sincere gratitude to Professor Emeritus Tatsuro MATSUMOTO of Kyushu University for his supervision, to whom we dedicate this paper to commemorate his retirement. We also express our gratitude to members of the Geology Club of Yamaguchi Prefecture who donated Yamaguchi University some additional specimens, although they were not directly quoted in this paper.

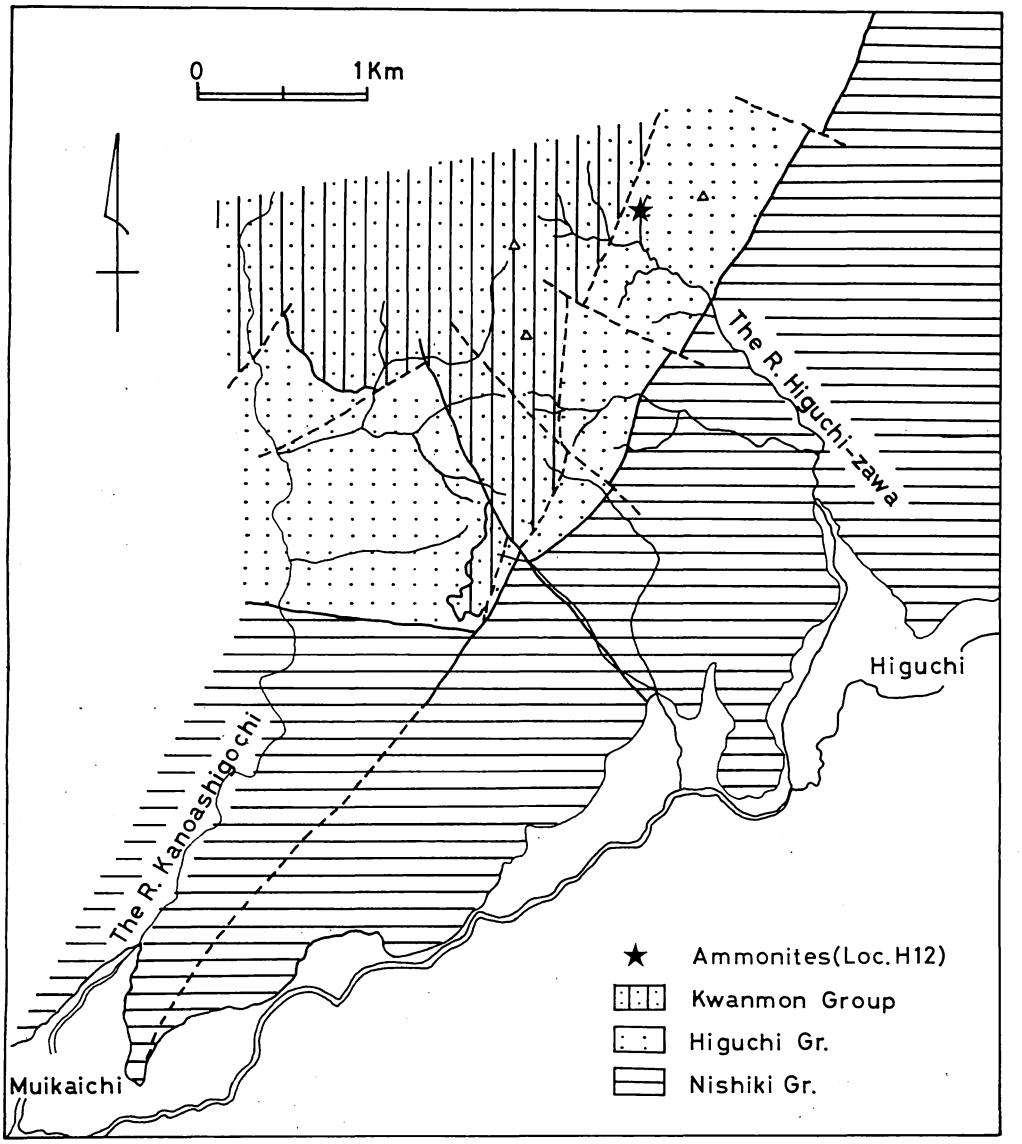

Fig. 2. Geological map around the Higuchi Group.

Geological setting

The Higuchi Group is distributed around Muikaichi-cho, Shimane Prefecture (Fig. 1), and its succession is observable along the River Higuchi-zawa and the River Kanoashigochi (Fig. 2). The strata show a general trend of E-W in the southwestern area and that of NW-SE in the northeastern area. They show a homoclinal structure, with a northward or northeastward inclination. The total thickness is about 890 m, and the group is lithostratigraphically divided into two formations. The Lower Formation, 600 m, is composed of conglomerate and sandstone and the Upper, 290 m, is of black sandy shale, shale and fine sandstone (Fig. 3). The locality of the ammonites is in the shaly part of the Upper Formation. The bivalves were obtained from the Upper Formation and also the middle and upper parts of the Lower Formation. The contact between the Higuchi Group and the Palaeozoic Nishiki Group is a fault and that between the Higuchi Group and the Cretaceous Kwanmon Group is an unconformity in some part and a fault in other part.

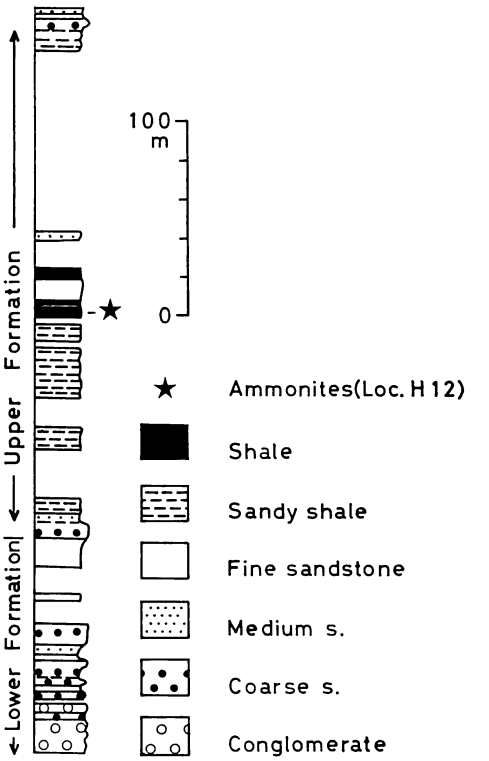

Fig. 3. A columnar section of the Higuchi Group observed in the River Higuchi-zawa.

Systematic descriptions

Superfamily Hildoceratacеae HYATT, 1867

Family Hildoceratidae HYATT, 1867

Subfamily Arieticeratinae HOWARTH, 1955

Genus *Fontanelliceras* FUCINI, 1931

Type-species. — *Harpoceras fontanellense* GEMMELLARO, 1885 (designated by VECCHIA, 1949).

Fontanelliceras cfr. *fontanellense* (GEMMELLARO)

Pl. 51, Figs. 4-7.

Cfr.

1885 *Harpoceras fontanellense* (GEMMELLARO) : GEMMELLARO, *Giorn. Sci. Nat. Econ. Palermo*, vol. 17, p. 12, pl. 2, figs. 1-2, *in* reillustration by HAAS, 1913.

1900 *Harpoceres* (*Arieticeras*) *fontanellense* GEMMELLARO: BETTONI, *Schweiz. Paläont. Gesel. Abh.*, vol. 27, p. 58-59, pl. 5, figs. 10-12.

1913 *Arieticeres* (*Vermiceras*) *fontanellense* GEMMELLARO: HAAS, *Beitr. Paläont. Oster. Ung. Orients*, vol. 26, p. 42, pl. 3, figs. 1-2.

1931 *Fontanelliceras fontanellense* GEMMELLARO: FUCINI, *Palaeontogr. Italica*, vol. 31, p. 110, pl. 8, figs. 21-26.

1931 *Fontanelliceras juliae* (BONARELLI) : FUCINI, *Ibid.*, vol. 31, p. 111, pl. 8, figs. 28-30.

1934 *Arieticeras fontanellense* GEMMELLARO: MONESTIER, *Mém. Soc. géol. France*, vol. 10, fasc. 3, no. 23, p. 68-69. pl. 10, figs. 48-52, pl. 11, fig. 9.

1947 *Echioceras* sp. α: MATSUMOTO *in* MATSUMOTO and ONO, *Sci. Rept. Fac. Sci., Kyushu Univ., Geol.*, vol. 2, no. 1, p. 26, pl. 1, fig. 1.

1947 *Echioceras* sp. β MATSUMOTO *in* MATSUMOTO and ONO, *Ibid.*, vol. 2, no. 1, p. 26.

1956 *Fontanelliceras* cfr. *fontanellense* (GEMMELLARO): ARKELL, *Jurassic geology of the world*, Oliver & Boyd Ltd., p. 421.

1962 *Fontanelliceras* cfr. *fontanellense* (GEMMELLARO): SATO, *Mém. Soc. géol. France*, no. 94, p. 59.

1962 *Fontanelliceras* sp. β: SATO, *Ibid.*, no. 94, p. 59.

1963 *Fontanelliceras* cfr. *fontanellense* (GEMMELLARO): TAKAI, MATSUMOTO and TORIYAMA ed., *Geology of Japan*, Univ. Tokyo Press, p. 84.

1968 *Fontanelliceras fontanellense* (GEMMELLARO): CANTALUPPI and BRAMBILLA, *Atti Soc. It. Sc. Nat. Museo Civ. St. Nat. Milano*, vol. 107, p. 303, pl. 28.

1971 *Fontanelliceras fontanellense* (GEMMELLARO): HIRANO, *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, vol. 21, no. 1, p. 111, pl. 16, figs. 1-4.

Material.—Eleven specimens, GK. G. 11418-11428.

Description.—The whorls are evolute, enlarging very slowly. All the ribs are simple, rather robust, straight, usually rectiradiate, sometimes somewhat prorsiradiate, and widely interspaced. They spring from the umbilical seam, keeping the strength nearly uniformly and abruptly fade away at the ventral shoulder. The venter has at least a distinct keel, but the details are not observable because of the unfavourable preservation.

Remarks.—All the specimens are embedded in parallel to the bed and compressed not only vertically but also horizontally. Because of this mode of preservation, the mensuration is omitted but figures are shown in natural scale.

Comparison.—The present specimens are closely allied to the hitherto illustrated specimens of *F. fontanellense*. They have somewhat more numerous ribs than the Toyora and the Italian specimens. The number of ribs is, however, known to show a fairly large variation (HIRANO, 1971) and therefore on this occasion the difference is regarded as non-significant. As the specimens before us are too poorly preserved to identify them precisely, we call them *F.* cfr. *fontanellense*, although no clear difference is detected in the observable characters.

Fontanelliceras juliae (BONARELLI) is said to be distinguished from *F. fontanellense* by FUCINI (1931, p. 111) in that its ribs are less numerous and somewhat rursiradiate near the aperture. These differences are minor and perhaps in the extent of variation of *F. fontanellense* as considered by CANTALUPPI and BRAMBILLA (1968). In fact the present specimens are also comparable with the specimens illustrated under the name of *F. juliae* by FUCINI (1931, p. 111, pl. 8, figs. 28-30).

Fontanelliceras retrorsicosta (OPPEL) was distinguished from *F. fontanellense* by its sharp, slightly arcuate forward and rursiradiate ribs by FUCINI (1931, p. 111, pl. 3, fig. 27). As the ribs of the present specimens are usually rectiradiate and occasionally prorsiradiate, they are distinguished from *F. retrorsicosta*.

Locality.—Three specimens, GK. G. 11418-11420, are from the exposure (loc. H 12) of the Upper Formation of the Higuchi Group in the River Higuchi-zawa, Muikaichi-cho, Shimane Prefecture and eight specimens, GK. G. 11421-11428, are from gravels at a point a few meters downstream from the loc. H 12 (Figs. 2-3).

Genus *Arieticeras* SEGUENZA, 1885

Type-species. — *Ammonites algovianum* OPPEL, 1862.

Arieticeras sp.

Pl. 51, Figs. 1a-b.

Material.—A single fragmentary specimen, GK. G. 11429.

Description.—The whorl is somewhat involute, enlarging fairly rapidly. The rib is simple, fairly robust and stronger on the outer part of the flank. It is rursiradiate on the flank and abruptly bent forward at the ventral shoulder. The interspace between the ribs is nearly as wide as to two times as wide as the rib. The rib fades away as it approaches to a strong ventral keel.

Comparison.—As the present specimen is fragmentary, the identification at the specific level is very difficult. It resembles the three specimens of *Arieticeras delcampanai* (FUCINI) illustrated by HAAS (1913, p. 68, pl. 2, figs. 13-15) in the mode of volution and ribbing, but is distinguished in that the latter species has rectiradiate ribs.

It is also similar to the specimens of *Arieticeras algovianum* (OPPEL) illustrated by CANTALUPPI and SAVI (1968, p. 240, pl. 20, figs. 9-11) and by CANTALUPPI and BRAMILLA (1968, p. 294, pl. 27, figs. 2-3) in the mode of ribbing but is distinguished by its tighter volution.

Locality.—The specimen was obtained from a gravel of a river floor at a point a few meters downstream from the exposure H 12 in the River Higuchi-zawa, in Muikaichi-cho, Shimane Prefecture (Figs. 2-3).

Genus *Canavaria* GEMMELLARO, 1886

Type-species.—*Harpoceras* (*Dumortieria*) *haugi* GEMMELLARO, 1885 (subsequently designated by HOWARTH, 1955).

Canavaria sp.

Pl. 51, Figs. 2-3.

Material.—Two specimens, GK. G. 11430-11431.

Description.—The volution is moderate, with a moderate growth of whorls. The rib is simple and somewhat strong. It starts forward from the umbilical seam, going outward radially and then curves forward again at the ventral shoulder. Thus it is somewhat flexuous on the flank and the interspace is about two or three times as wide as the rib. Some of the ribs are tuberculated at the umbilical shoulder. A keel is discernible on the venter.

Comparison.—The present specimens are similar to the specimens of *Canavaria nodosa* (FUCINI) (1931, p. 146, pl. 20, figs. 10-17) in the mode of volution and ribbing. It shows a slower growth rate of the whorl-height than *Canavaria japonica* (MATSUMOTO) (HIRANO, 1971, p. 110, pl. 15, figs. 1-6) and *Canavaria* cfr. *sicula* FUCINI (HIRANO, 1971, p. 111, pl. 15, fig. 7).

The available specimens are too poorly preserved for a precise specific identification.

Locality.—The specimens were obtained from a gravel of a river floor at a point a few meters downstream from the exposure H 12, in the River Higuchi-zawa, Muikaichi-cho, Shimane Prefecture (Figs. 2-3).

Discussion

Among the described ammonites, three specimens of *Fontanelliceras* cfr. *fontanellense* were obtained from an exposure (H 12) of the Upper Formation of the Higuchi Group and the others were from the river gravels at the point a few meters downstream from the exposure in the same

river. Because all of these three genera are representatives in the *Fontanelliceras fontanellense* Zone of Domerian, the upper substage of Pliensbachian, at least the upper part of the Upper Formation of the Higuchi Group can be correlated with the *F. fontanellense* Zone.

The genera described above have also been known from the Toyora Group about 90 km to the west of this area, and as was discussed previously (HIRANO, 1973), they are of typical Tethyan elements. Among the three, *Canavaria* is also known from the Kuruma Group (SATO, 1955, p. 114-117) in the northeast. As one specimen of *Amaltheus* from the Toyora Group and some more from the Kuruma Group have been reported, it is clear that the Tethyan and the Boreal elements intermingled in the area from Toyora via Higuchi to Kuruma, with a southwestward increasing number of Tethyan elements.

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Higuchi-zawa 樋口沢, Kanoashigochi 鹿足河内, Muikaichi-cho 六日市町,

樋口層群からの前期ジュラ紀菊石：山口・広島両県に接する島根県六日市町樋口沢には，今村・他 (1966) によりジュラ紀と思われる地層が分布していることが報告され，樋口層群と命名されている。しかし，これまでジュラ紀の証拠とされた菊石は転石しか得られてなく，又記載報告も無かった。最近，三上・宮川は樋口層群の分布とその層序及び周辺層との関係を調べ，新たに地層ならびに転石から菊石と二枚貝を若干得た。これらの菊石は *Fontanelliceras* cfr. *fontanellense*, *Arieticeras* sp., *Canavaria* sp. と判明した。いずれも西方の豊浦層群から知られている属で，地中海地方のライアス・ドメリアン亜階 *Fontanelliceras fontanellense* 帯の代表的な属である。 平野弘道・三上貴彦・宮川秀樹

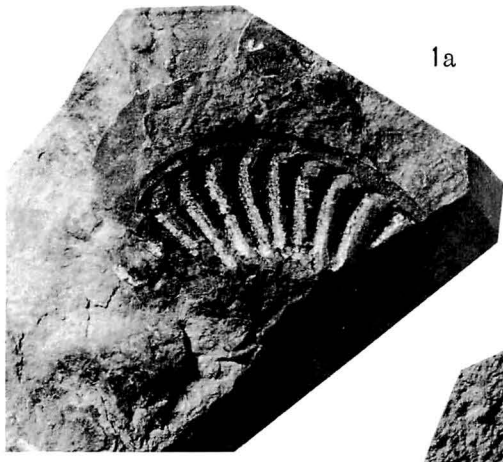
Explanation of Plate 51

(All in natural size)

Fig. 1. *Arieticeras* sp.
- 1a. GK. G. 11429, loc. A few meters downstream from the exposure H 12 in the River Higuchi-zawa, Muikaichi-che, Shimane Prefecture.
- 1b. Rubber cast of 1a.

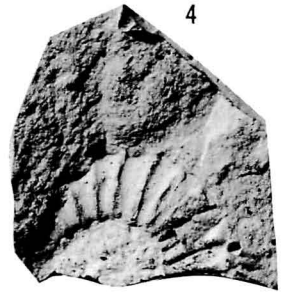
Figs. 2-3. *Canavaria*. sp.
- 2. GK. G. 11430, loc. A few meters downstream from the H 12 in the River Higuchi-zawa.
- 3. GK. G. 11431, loc. A few meters downstream from the H 12 in the River Higuchi-zawa.

Figs. 4-7. *Fontanelliceras* cfr. *fontanellense* (GEMMELLARO)
- 4, Rubber cast of GK. G. 11424, loc. A few meters downstream from the H 12 in the River Higuchi-zawa.
- 5. GK. G. 11418, loc. H 12 in the River Higuchi-zawa.
- 6. GK. G. 11421, loc. A few meters downstream from the H 12 in the River Higuchi-zawa.
- 7. GK. G. 11426, loc. Same as above.



1a

2



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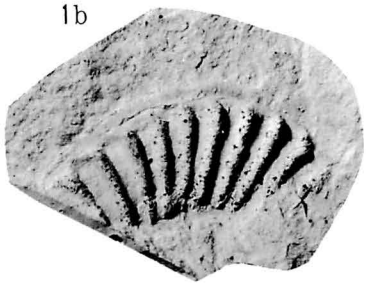

1b

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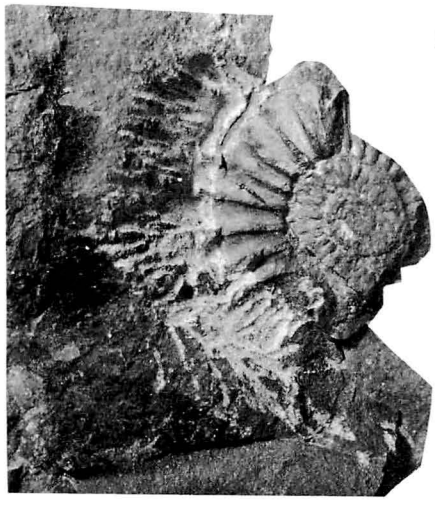
3



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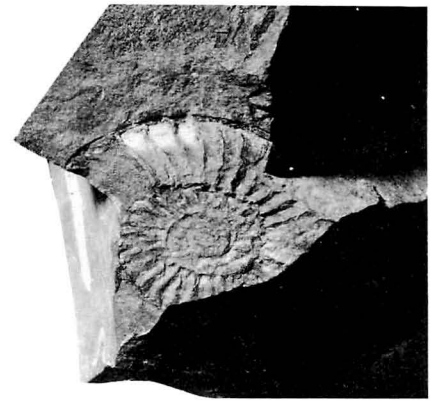

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 112, pp. 417-423, pls. 52, 53, December 30, 1978

696. A NEW SPECIES OF *BANKIA* IN PALEOGENE FOSSIL WOOD, FROM AMAKUSA, KUMAMOTO PREFECTURE, JAPAN*

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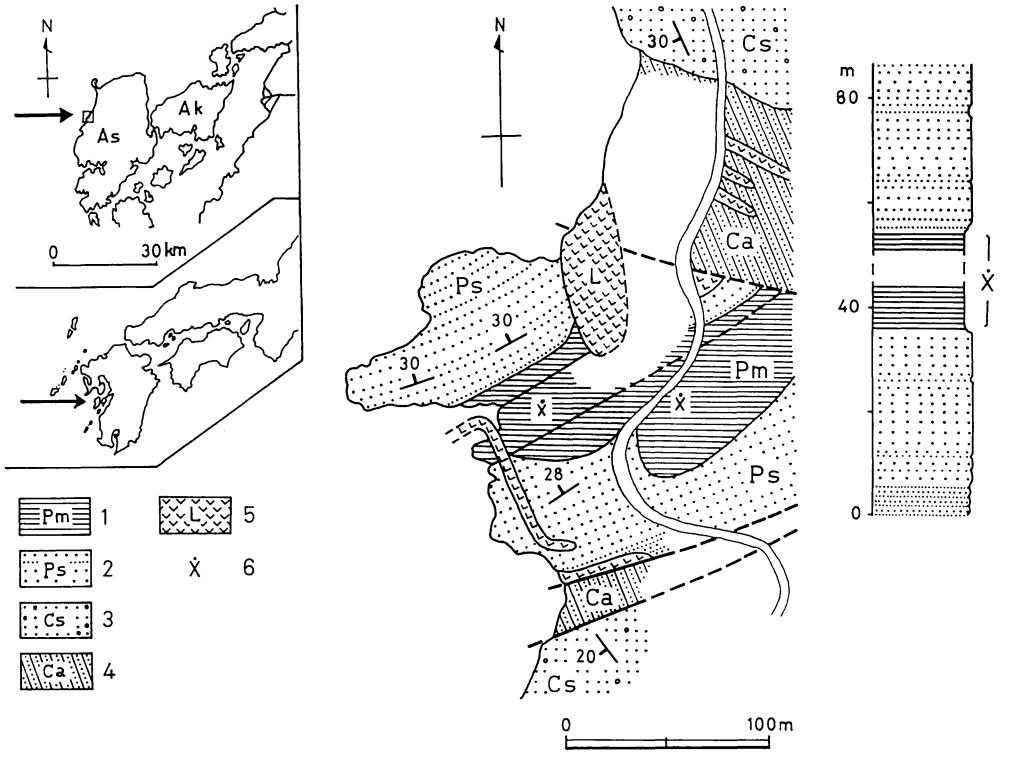
Abstract. Many tube-fossils penetrating in fossil woods, *Taxodioxylon matsuiwa* WATARI, are found from Paleogene strata cropping out at seaside exposures near Shimoda, Amakusa-machi, Amakusa-gun, Kumamoto Pref. They belong to a new species of the genus *Bankia* judging from the well preserved valves and pallets, and are described herein as a new species, *Bankia amakusensis*.

During the course of my geological study, I collected many pieces of fossil wood together with some molluscan shells from strata cropping out near a small promontory to the southwest of Shimoda, Amakusa-machi, Amakusa-gun, Kumamoto Prefecture. This fossil wood is identified as *Taxodioxylon matsuiwa* WATARI (TAKAHASHI, 1969), a fossil log which is well known from the Paleogene of North Kyushu. This paper deals with the description of a new species belonging to *Bankia*, a wood-boring bivalve genus, based on its shells and well-preserved pallets in the tube. Also a discussion is given on the geological age of the *Bankia*-bearing strata, which have not necessarily been determined.

The formation yielding the fossil wood 'Matsuiwa (pine rock)' is composed of alternations of sandstone and black shale. It attains thickness of more than 80 m (Text-fig. 1) but its geologic distribution is narrow. This formation is in fault contact with the U-IV member of the Upper Himenoura Subgroup (Upper Cretaceous) (TASHIRO, 1976) both on the north and south sides. The geological map and columnar section of this area are shown in Text-fig. 1. According to NAGAO (1926a, 1926b), the geological age of the formation which he called the Fukami Sandstone is Paleogene. Later, MATSUSHITA (1949) and MATSUSHITA et al. (1959) called it the Fukami Formation and dated it also as Paleogene. On the other hand, the geological age of the formation was regarded as Late Cretaceous by MIKI (1972, 1975). Recently, the Fukami Formation in its type area was described as Upper Cretaceous by TASHIRO & NODA (1973), TASHIRO (1976) and TASHIRO & OTSUKA (1976). The *Bankia*-bearing formation is undoubtedly correlatable with the Paleogene by the occurrence of such fossils as *Taxodioxylon matsuiwa* (see Text-fig. 2), *Venericardia* (*Venericor*) cfr. *nipponica* (see Text-fig. 2), *Crassatella* (*Eucrassatella*) cfr. *nipponensis*. Consequently it must be excluded from the Fukami Formation.

* Received Jan. 17, 1978; read Oct. 16, 1977, at Kumamoto.



Text-fig. 1. Geological map and columnar section (Paleogene group) of Shimoda area.
1: black shale (Paleogene)
2: medium sandstone (Paleogene)
3: coarse sandstone (Upper Cretaceous)
4: alternation of sandstone and shale (Upper Cretaceous)
5: lithoidite
6: *Bankia amakusensis* locality
Ak: Amakusa-Kamijima
As: Amakusa-Shimojima

The specimens described in this paper were collected at seaside exposures about 800 m south-southwest of Shimodakita of Shimoda, Amakusa-machi, Amakusa-gun, Kumamoto Prefecture and are deposited in the collection of the Faculty of Education, Kumamoto University.

Before going further, I would like to express my hearty thanks to Professor Minoru TAMURA of Kumamoto University for his continuous guidance and reading the manuscript. I also thank Dr. Masayuki TASHIRO of Kochi University, for his kind suggestion and encouragement.

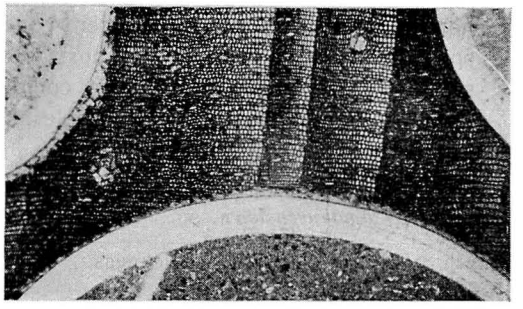
Description of Species

Family Teredinidae RAFINESQUE, 1815

Subfamily Bankiinae TURNER, 1966

Genus *Bankia* GRAY, 1842

Remarks:—The classification of the subfamily Bankiinae has been undertaken



A

B

Text-fig. 2. A: Cross section of *Taxodioxylon matsuiwa* WATARI; ×21.3; Reg. No. KE 2818.
B: Left valve of *Venericardia* (*Venericor*) cfr. *nipponica* YOKOYAMA; ×0.8; Reg. No. KE 2819.

by TURNER (1966) based on the features of soft part and the shape of pallet. The genus *Bankia* is described by him as follows: "Pallets elongate, compound, cones easily separable and removed from stalk. The cone is composed of periostracum in upper marginal part and of calcareous matter in most other part". The genus has been considered as including numerous subgenera, which can be distinguished by the shapes of pallet and sculptures of the periostracum in upper marginal part (TURNER, 1966). As no periostracum is observable in the Shimoda specimens, subgeneric position of this new species cannot be determined. This species, however, is similar to *Lyrodobankia* (=*Bankiopsis*) which has deep-cupped cones with the smooth upper margin and a small number of cones.

Bankia (s. l.) *amakusensis* OTSUKA, new species

Pl. 52, Figs. 1-12; Pl. 53, Figs. 1-12; Text-fig. 3

Description:—Shell medium for genus, subglobular, equivalve, nearly as long as high, test comparatively thin, divided into three areas—anterior slope, disc and posterior slope; umbo small, located at a point of one third of length from front, rising high above dorsal margin; beak strongly incurved; anterior slope subtriangular, provided with about 50 fine denticulated ridges of which upper 20 or so are distinct and widely spaced from each other and lower 30 or so are narrow and closely spaced; disc divided into anterior and posterior parts by umbonal-ventral sulcus; anterior part of disc, occupying about 1/3 width of disc, ornamented by denticulated ridges which continue to those on anterior slope forming nearly a right angle; posterior part of disc broader than anterior part, nearly smooth except for growth lines; posterior slope semicircular, posterior margin rounded, anterior portion slightly convex; apophysis narrowly elongated and slightly curved; cross section of apophysis nearly circular; ventral condyle at end of internal

ridge corresponding to umbonal-ventral sulcus distinct; inner shelf strongly elevated.

Pallets calcareous, with stalk and blade; stalk columnar, straight, occupying about 1/3 length of pallet; blade formed by about 8 cones; about 3 cones of distal part small, nearly circular, closely spaced; the other cones large, distantly spaced; horizontal section of the larger cones spindle-shaped; the outer side of horizontal section of the larger cones more convex than the inner one; cones separable and easily removed from stalk.

Table 1. Measurements of *Bankia* (s.l.) *amakusensis*, n. sp.

Shell specimens	Length	Height	Thickness
KE 2791, right internal mold	4.5	4.3+	2.0
KE 2792, right innternal mold	4.1+	4.0+	–
KE 2793, right external mold	4.4	–	1.8
KE 2794, right valve	4.3	–	2.2+

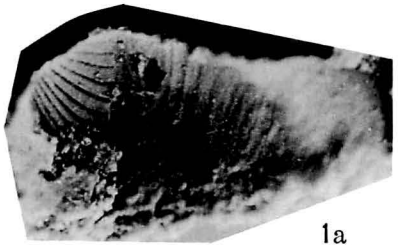
Pallet specimens	Total length	Length of stalk	Length of blade	Diameter of blade
KE 2794	12.1+	4.0+	8.1	1.8+
KE 2795	11.5+	3.0+	8.5+	2.0+
KE 2796	–	3.8+	–	2.0

Observation:—The tube is calcareous, twisting, narrow at the posterior extremity and gradually enlarges into the rounded anterior extremity. The cross section of the tube is circular. The anterior extremity is about 5 mm in diameter in most specimens. The entire length of the tube is about 80 mm in most specimens. The test is smooth and formed with about four calcareous layers. The ratio of the diameter of the anterior extremity to the thickness of the test is 16.0±0.1. The tube is filled up by calcareous sand or mud. Though I collected about 200 valves and about 50 pallets, the material of this new species is represented only by in-

Explanation of Plate 52

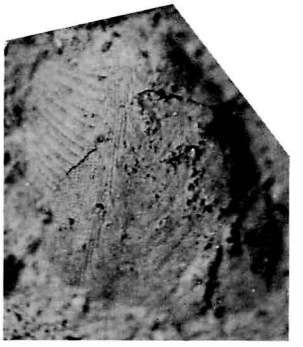
Bankia (s.l.) *amakusensis*, new species

1a, b. External mold of right valve; showing surface ornamentation (1a) and surface ornamentation of anterior slope (1b); ×12; Reg. No. KE 2793.
2. External mold of right valve; showing surface ornamentation of anterior slope; ×10; Reg. No. KE 2797.
3. Cross section of anterior slope of valve; showing surface ornamentation of denticulated ridges; ×47; Reg. No. KE 2798.
4. External mold of right valve; showing surface ornamentation; ×18; Reg. No. KE 2799.
5. Right valve (holotype); showing surface ornamentation; ×10; Reg. No. KE 2800.
6a, b. Internal mold of right valve (paratype); showing surface ornamentation (6a) and posterior dorsal part (6b); ×7.6; Reg. No. KE 2791.
7. Cross section of right valve in tube; ×5.2; Reg. No. KE 2801.
8. Cross section of left valve in tube; ×7; Reg. No. KE 2802.
9. Cross section of left valve in tube; ×8; Reg. No. KE 2803.
10. Umbonal-ventral section of left valve in tube; ×7; Reg. No. KE 2804.
11. Umbonal-ventral section of right valve in tube; ×5.4; Reg. No. KE 2805.
12. Umbonal-ventral section of both valves in tube; ×10; Reg. No. KE 2806.



1a

1b



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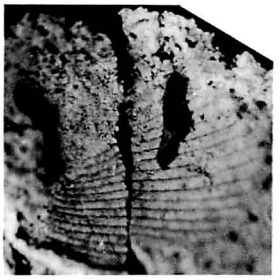

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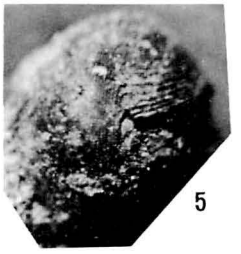

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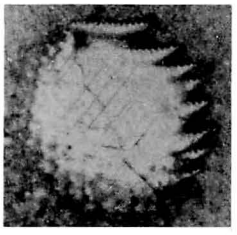
6a



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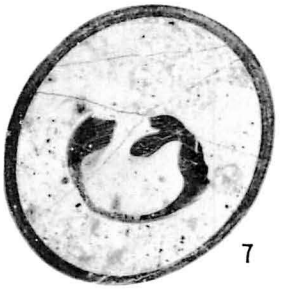

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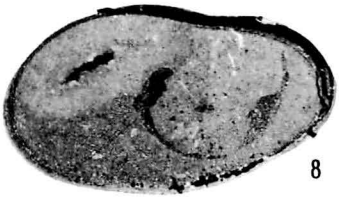
6b



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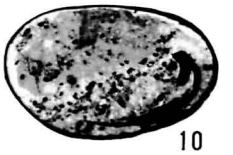
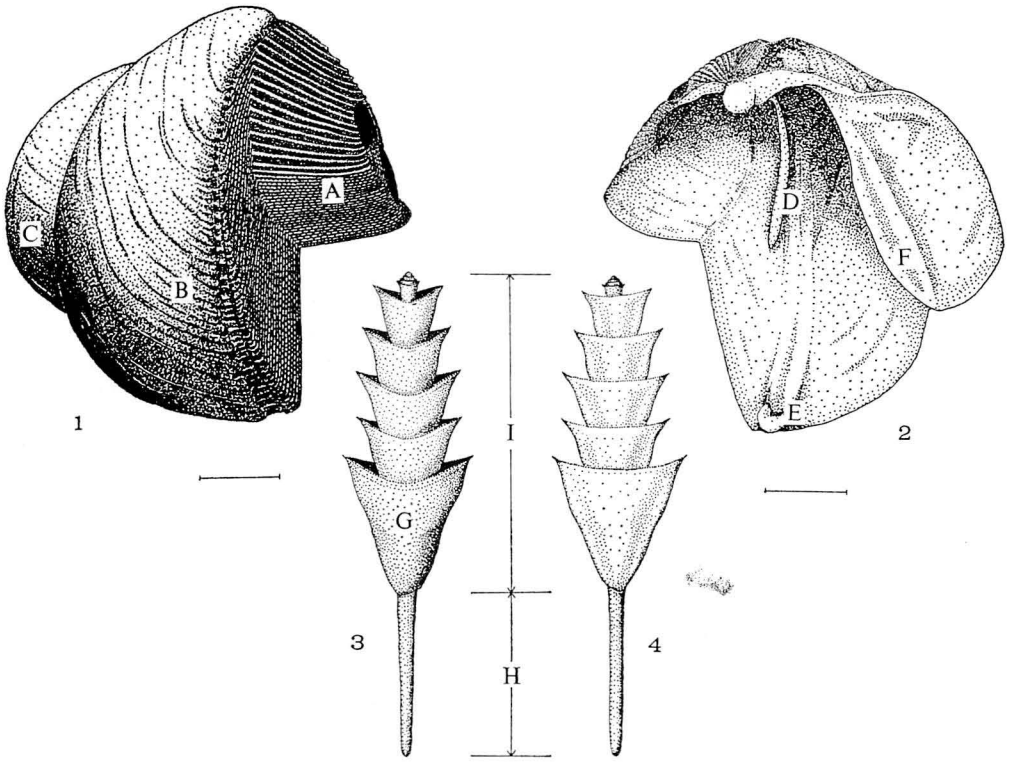


10

12

11



Text-fig. 3. *Bankia* (s. l.) *amakusensis*, new species
1: External surface ornamentation of right valve,
(A: anterior slope, B: disc, C: posterior slope)
2: Internal structure of right valve,
(D: apophysis, E: ventral condyle, F: inner shelf)
3: Outer surface of pallet,
(G: cone, H: stalk, I: blade)
4: Inner surface of pallet.
* scale: 1mm.

complete shells and pallets. The tissue of the woods is replaced almost completely by calcite. The wood is light-brown in color in weathered specimens and black in color in fresh specimens.

Comparison:—The fossil pallets have been known in *Bankia parisiensis* DESHAYES (TURNER, 1966) described from the Eocene of France. This species differs from *Bankia parisiensis* in having an elongate pallet and less number of the cones. *Teredo matsushimaensis* HATAI, 1951 (HAYAMI, 1966), from the Lower Cretaceous Miyako Group, Iwate Prefecture, differs markedly from the new species in its larger size of tube and valves. *Bankia amakusensis* is similar to *Bankia* (*Lyrodobankia*) *carinata* GRAY (TURNER, 1966, 1969) (=*B.* (*Bankiopsis*) *caribbea* CLENCH and TURNER, 1946) in having the cones which are deep-cup shaped, a smooth margin and in having not crowded at the distal end. However, the number of the cone is less in this species than in *Bankia*

(*Lyrodobankia*) *carinata*. Furthermore, the number of the denticulate ridge on the valve is more numerous in this species than in *Bankia* (*Lyrodobankia*) *carinata*.

Occurrence:—The specimens of this new species are found in fossil woods, *Taxodioxyloy matsuiwa* WATARI, occurring as nodules in a black shale, at the seaside exposures about 800 m south-southwest of Shimodakita of Shimoda, Amakusa-machi, Amakusa-gun, Kumamoto Prefecture.

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Explanation of Plate 53

Bankia (s.l.) *amakusensis*, new species

1. One pair pallets (paratype); showing surface structure of blade; ×12; Reg. No. KE 2807.
2. Vertical section of pallet; ×14; Reg. No. KE 2808.
3. Diagonal section of pallet in tube; ×5.5; Reg. No. KE 2809.
4. Vertical section of one pair pallets; ×14; Reg. No. KE 2796.
5. Cross section of pallets; showing cross section of larger cones; ×28; Reg. No. KE 2810.
6. Pallet (paratype); showing outer surface of larger cone; ×9; Reg. No. KE 2811.
7. Pallet in tube; showing cross section of larger cone; ×9; Reg. No. KE 2812.
8. Left valve and pallets in tube (paratype); ×9; Reg. No. KE 2813.
9. Diagonal section of valve (lower) and vertical section of pallet (upper) in tube; ×7; Reg. No. KE 2814.
10. Cross section of both valves in tube; 3.5; Reg. No. KE 2815.
11. Vertical section of tubes; ×1.7; Reg. No. KE 2816.
12. Cross section of tubes; ×1.6; Reg. No. KE 2817.

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Soc. Japan, spec. pap. no. 19, p. 1-102, 23 text-figs., 12 pls.

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Amakusa 天草, Amakusa-gun 天草郡, Amakusa-Kamijima 天草上島, Amakusa-machi 天草町, Amakusa-Shimojima 天草下島, Shimoda 下田, Shimodakita 下田北

熊本県天草産古第三紀化石木中の *Bankia* の一新種: 熊本県天草郡天草町下田付近の古第三系から *Taxodioxylon matsuiwa* WATARI の珪化木に穿孔した管状化石を採集した。化石は保存良好な殻とパレットにより, *Bankia* 属に含まれる新種であることが認められたので, ここに新種 *Bankia amakusensis*, n. sp. として記載した。大塚雅勇

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 112, pp. 424-433, pl. 54, December 30, 1978

697. NEW SPECIES OF *APIOTRIGONIA* AND *SENIS* FROM THE UPPERMOST CRETACEOUS OF HOKKAIDO*

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Abstract. *Apiotrigonia hetonaiana* sp. nov. from the Hakobuchi Group and the Chinomigawa Formation in Hokkaido, is probably a derivative from *Apiotrigonia crassoradiata* NAKANO. The former is restricted to the Upper Campanian and Maestrichtian, while the latter is known from the Lower to Middle Campanian in Hokkaido, Shikoku and Kyushu. *Senis japonica* sp. nov. is an edentulous bivalve, occurring from the Hakobuchi Group (Maestrichtian) in Hokkaido. This is the first record of *Senis* in the Cretaceous of Japan.

Introduction and Acknowledgements

This paper deals with the description of two new bivalve species, *Apiotrigonia hetonaiana* sp. nov. and *Senis japonica* sp. nov., and also *Apiotrigonia crassoradiata* NAKANO from the Hetonaian of the Upper Cretaceous in Hokkaido. NAGAO and OTATUME (1938) referred the specimens from two localities, 'Hetonai' and 'Omagari', both at Tomiuchi, Iburi District, Hokkaido, to *Trigonia subovalis* JIMBO var. *minor* YABE and NAGAO. The specimens from 'Hetonai' are actually referable to *Apiotrigonia hetonaiana* sp. nov., and the specimens from 'Omagari' belong to *Apiotrigonia crassoradiata* NAKANO. *Apiotrigonia hetonaiana* sp. nov. may have been derived from *Apiotrigonia crassoradiata* NAKANO in the same lineage. The former is restricted in the Upper Campanian and Maestrichtian. On the other hand, the latter is known from the Lower to Middle Campanian (NAKANO, 1957, 1960; NODA and TASHIRO, 1972; TASHIRO and NODA, 1972; TASHIRO, 1976). *Senis japonica* sp. nov., is probably the first species of this genus known from the Japanese Cretrceous.

Before going into the description, I wish to express my sincere thanks to Professor Minoru TAMURA of Kumamoto University, for his kind encouragement and reading of this manuscript. I also thank Emeritus Professor Tatsuro MATSUMOTO of Kyushu University for supplying me precious data about the Hakobuchi Group and his kind advice.

* Received Jan. 23, 1978; read Oct. 15, 1977 at Kumamoto.

Systematic description

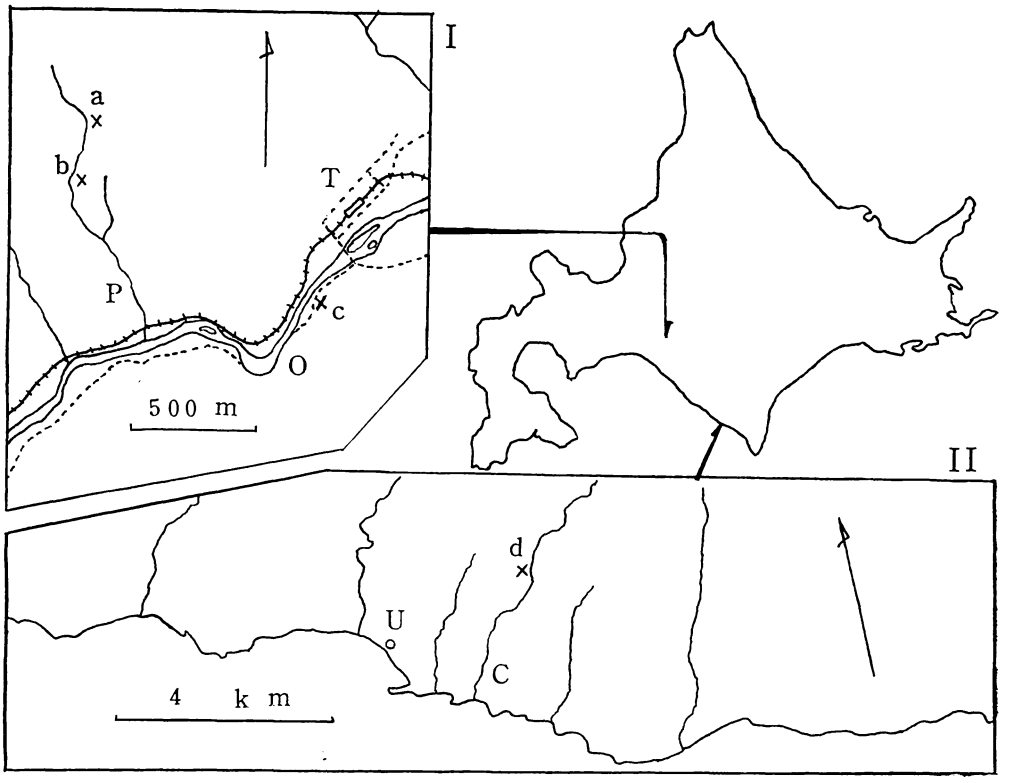
Family Trigoniidae LAMARCK, 1819

Genus *Apiotrigonia* COX, 1952

Apiotrigonia hetonaiana, sp. nov.

Plate 54, Figs. 1-4, Text-fig. 2

1938. *Trigonia subovalis* JIMBO var. *minor*: NAGAO and OTATUME; *Jour. Fac. Sci., Hokkaido Imp. Univ.*, ser. 4, vol. 4, nos.



Text-fig. 1: Maps showing fossil localities
I. Tomiuchi Area, O: Omagari P: Panketosanosawa T: Tomiuchi
a: *Apiotrigonia hetonaiana*, sp. nov.
b: *Senis japonica*, sp. nov.
c: *Apiotrigonia crassoradiata* NAKANO
II. Urakawa Area, U: Urakawa C: Chinomigawa
d: *Apiotrigonia hetonaiana*, sp. nov.

1-2, pp. 42-43, pl. 1, figs. 7 and (?) 9 (non. fig. 8).

Material:—The holotype (KE 2776) is a left valve collected from Panketosanosawa of Tomiuchi, Hokkaido. Three paratypes (KE 2777-KE 2779) were collected from the same locality as the holotype. Two other paratypes (KE 2780-KE 2781) are internal and external moulds of right valves collected from Chinomigawa of Urakawa, Hokkaido.

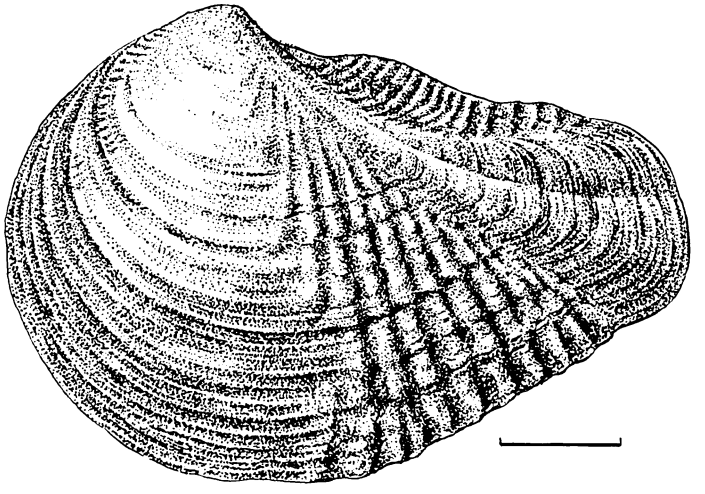
Description:—Shell large for *Apiotrigonia*, triangularly subovate, longer than high, moderately inflated; anterior margin semicircular; ventral margin nearly straight or slightly convex on anterior half and a little concave on posterior half; posterodorsal margin nearly straight except for weakly concave umbonal region; siphonal margin short, well rounded; umbo weakly prominent, a little opisthogyrous, located at about one-fourth of length from front of valve; escutcheon narrow, wedge-shaped, well depressed, ornamented with about 15 plain and horizontal costellae; area narrow, smooth except for fine

growth lines; disk ornamented with about 12 broad and low subradial costae which are crossed by growth lines on the posterior half the foremost subradial costa extends from a point on marginal carina a little behind the umbo toward ventral margin; two or more anterior subradial costae short, stretch nearly vertically but do not reach ventral margin; next four or more costae long, subvertical, sometimes bifurcated on ventral part; several remaining costae run obliquely; anterior half of the disk nearly smooth except for irregularly spaced growth lines; subinternal surface of anterior half of disk characterized by numerous and fine radial striae; posterior carina not elevated, only visible as a boundary line between smooth area and costellated escutcheon; marginal carina not angulated except for near umbo, forming a broad and blunt ridge, by which the disk is boundered from depressed postero-dorsal part; median groove of area narrow but distinct; inner anterior margin finely crenulated; inner postero-ventral margin coarsely crenulated; inner postero-dorsal margin more coarsely crenulated than anterior marginal crenulations but more finely than postero-ventral margin; These three sorts of the crenulations are related to the subradial costae on posterior half of disk, subinternal radial striae on anterior half of disk and horizontal costellae on escutcheon.

Measurements (in mm):—

Specimen	Length	Height	Thickness
KE 2776, l. v.	50.2	36.0	9.5
KE 2777, r. int. mol.	49.8	33.4	—
KE 2780, r. v.	49.8	34.3	9.7
KE 2778, r. ext. mol.	44.8	29.4	6.0
KE 2779, l. v.	8.5	4.4	1.0
KE 2782, imperfect r. int. mol.	41.2+	26.5+	—

Observation:—This species is characterized by the fine crenulations on the inner anterior margin. The number of crenulations are 18 or more in the distance of 1 cm along the margin of the adult specimens. The concentric or subhorizontal costae which are one of the important characters of *Apiotrigonia* ('anterior series' by NAKANO, 1957; MAEDA and KAWABE, 1966; TASHIRO, 1972) appear on the anterior half of the disk in the immature



Text-fig. 2· *Apiotrigonia hetonaiana*, sp. nov., scale: 1 cm.

specimen of this species (See pl. 1, fig. 3). The radial striae on the subinternal surface of the anterior half of the disk are particularly crowded on the upper part of the anterior marginal region. The striae are observable on the disk, if the surface is more or less weathered.

Remarks:—These specimens are undoubtedly conspecific with a part of the specimens which was described by NAGAO and OTATUME (1938) as "*Trigonia subovalis* JIMBO var. *minor* YABE and NAGAO" from Tomiuchi (Hetonai), Hokkaido. One of their specimens (NAGAO and OTATUME, 1938: pl. 1. fig. 7) is an internal mould of right valve which is similarly charcterized by the marginal crenulations of three orders. The other specimen (fig. 9) shows ill-preserved surface ornamentation, but has weak subradial costae on the posterior half of the disk.

Comparison:—This species is closely similar to *Apiotrigonia crassoradiata* NAKANO, 1957 (TASHIRO, 1976) from the Lower Campanian of the Izumi Group of Shikoku, and the Middle Campanian of the Upper Himenoura Subgroup of Koshikijima island of Kyushu, in having a smooth area and the occasionally bifurcated subradial costae on the posterior half of the disk. This species can however, be discriminated from *Ap. crassoradiata* by the entirely smooth anterior half of the disk and the finely crenulated inner anterior margin. *Apiotrigonia obsoleta* NAKANO, 1957 (TASHIRO, 1972) from the Izumi Group and the Lower Himenoura Subgroup of Kyushu, somewhat resembles this species in the smooth area and the nearly smooth anterior half of the disk, but *Ap. obsoleta* clearly differs from this species in the smaller shell, smaller number of the subradial costae on the posterior half of the disk (4-7 in *obsoleta* and 12 or so in this form), and not crenulated inner anterior margin. This species is distinguishable from "*Megatrigonia* (*Apiotrigonia*) *subovalis* (JIMBO)" (LIVEROVSKAJA, 1959) from the Cenomanian of Penzhinskoja by the elongated outline and the more numerous subradial costae on the posterior half of the disk. "*Apiotrigonia*" *dampierensis* SKWARKO (1969) from the Lower Cretaceous of Western Australia has the radial striae on the anterior half of the disk like the present new species. The radial striae of the present species are, however, subinternal. *Ap. hetonaiana* sp. nov. differs from "*Ap.*" *dampierensis* in the costellated escutcheon.

Occurrence:—Dark greenish sandstone of the middle part of the Fukaushi Sandstone of the Hakobuchi Group at Panketosanosawa of Tomiuchi, Iburi District, Hokkaido: Maestrichtian (Upper Hetonaian), *Inoceramus shikotanensis* Zone by MATSUMOTO (1959). Greenish grey and coarse sandstone of the uppermost part of the Chinomigawa Formation (KANIE, 1966) at Chinomigawa of Urakawa, Hidaka District, Hokkaido: upper Upper Campanian or Maestrichtian (Upper part of Lower Hetonaian), a little younger than *Inoceramus schmidti* Zone.

Apiotigonia crassoradiata NAKANO

Plate 54, Fig. 5, Text-fig. 3

1938. *Trigonia subovalis* JIMBO var. *minor:* NAGAO and OTATSUME; *Jour. Fac. Sci., Hokkaido Imp. Univ.*, ser. 4, vol. 4, nos. 1-2, pp. 42-43, pl. 1, (?) fig. 8 (non. figs. 7 and 9).

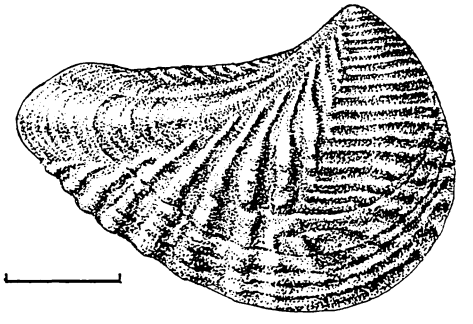
1957. *Apiotrigonia crassoradiata* NAKANO; *Japan. Jour. Geol. Geogr.*, vol. 28, nos. 1-3, p. 113, pl. 8, figs. 11, 12.

1975. *Apiotrigonia* (*Apiotrigonia*) *crassoradiata:* HAYAMI; *Univ. Mus., Univ. Tokyo, Bull.*, no. 10, p. 115.

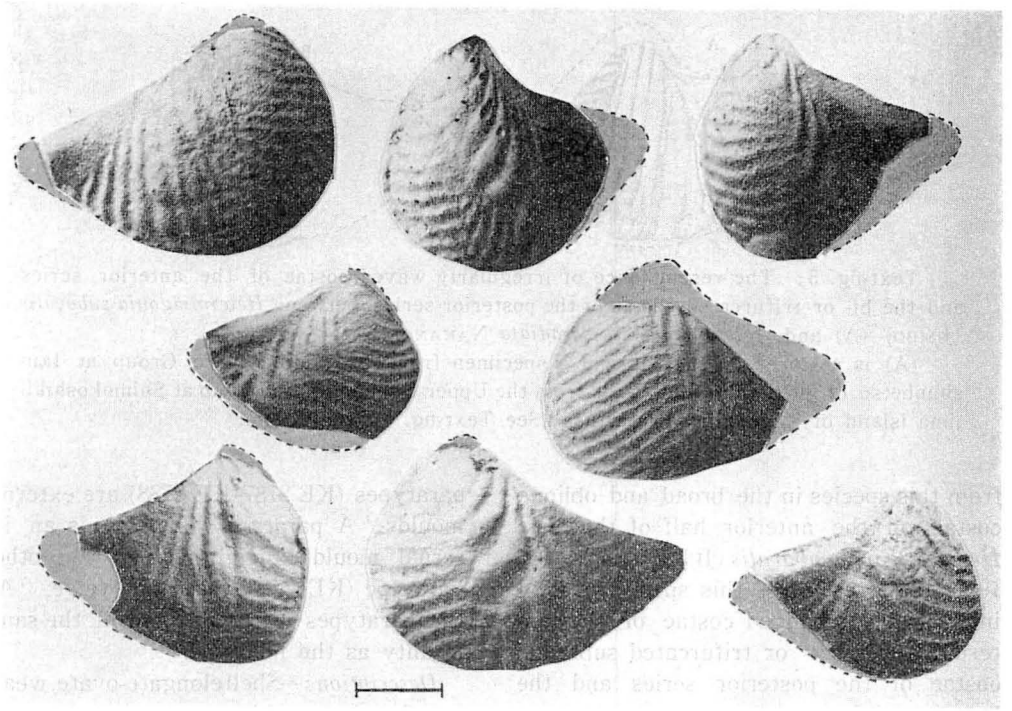
1976. *Apiotrigonia crassoradiata:* TASHIRO, *Palaeont. Soc. Japan, Spec. Pap.*, no. 19, p. 57, pl. 7, figs. 4-6.

Description:—Shell pyriform, longer than high, moderately inflated; anterior margin semi-circular; ventral margin weakly arched on anterior and nearly straight or slightly sinuated on posterior; siphonal margin small, well rounded; postero-dorsal margin weakly concave; umbo small, slightly opisthogyrous, a little prominent, located at about one-fourth of length from front of valve; escutcheon narrow, ornamented with about 20 plain and subhorizontal costellae; area entirely smooth except for very fine growth lines; disk ornamented with two sorts of plain costae; costae of the anterior series is distributed on anterior half of disk, concentric or subhorizontal, about 15 in number; costae of the posterior series distributed on posterior half of the disk; among the costae of the posterior series three or more anterior ones short, subvertical or slightly opisthocline start from the points on a marginal carina near umbo but soon disappear without reaching ventral margin; next two or more costae broadly spaced, stretch subvertically and weakened near the ventral margin; succeeding eight or more costae strong, subvertical on anterior but gradually becoming prosocline on posterior; posterior carina indistinct, but a sulcus extends along the boundary between the costellated escutcheon and the smooth area; median groove very weak; marginal carina indistinct except for near umbo; an elevated but not angulated ridge which bounds the depressed postero-dorsal part from the main part of the shell, extends from umbo to postero-ventral margin; the ridge merges into the marginal carina on umbonal region.

Remarks:—Three imperfect specimens (KE 2783-2785) were collected from the Fukaushi Sandstone at Omagari of Tomiuchi, Hokkaido. The locality is probably identical with the locality by NAGAO and OTATUME (1938), where "*Trigonia subovalis* var. *minor*" was described by them. *Apiotrigonia crassoradiata* NAKANO is known from the Izumi Group (NAKANO, 1957; NODA and TASHIRO, 1972) and the Upper Himenoura Subgroup (TASHIRO and NODA, 1972; TASHIRO, 1976). The Izumi and Himenoura specimens are characterized by the smooth area, the broad and strong subradial costae on the posterior half of the disk (posterior series) and the large size for *Apiotrigonia*. The subradial costae are sometimes bi- or trifurcated near the ventral margin in some adult specimens. The arrangement of the costae of anterior series is considerably variable in the adult stage as shown in Text-fig.



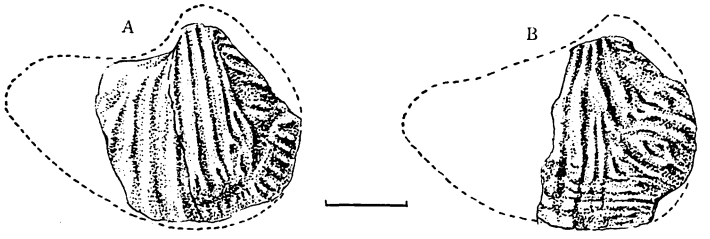
Text-fig. 3: *Apiotrigonia crassoradiata* NAKANO, scale: 1 cm. This is illustrated chiefly on the basis of the specimens from the Izumi Group at Himezuka of Dogo, Matsuyama City, Ehime Prefecture.



Text-fig. 4: Figures showing the variable ornamentations on the disk of *Apiotrigonia crassoradiata* NAKANO, from the IIa Member (Middle Campanian) of the Upper Himenoura Subgroup at Fukkire-ura of Shimokoshiki-jima island, Kagoshima Prefecture. scale 1 cm.

4. The specimen from the Fukaushi Sandstone (pl. 1, fig. 5) is small in size and does not possess such bi- or trifurcated subradial costae on the disk. This is, however, undoubtedly identified with *Apiotrigonia crassoradiata* NAKANO by the smooth area and the broad and strong costae of the posterior series. *Trigonia subovalis* var. *minor* by NAGAO and OTATUME (1938, pl. 1, fig. 8) from the Fukaushi Sandstone is probably another example of this species.

Comparison:—Apiotrigonia crassoradiate NAKANO is easily distinguishable from *Apiotrigonia minor* (YABE and NAGAO) (1928; YEHARA, 1915) from the Gyliakian of the Middle Yezo Group of Hokkaido, by the smooth area and broader and stronger subradial costae of the posterior series. *Apiotrigonia obsoleta* NAKANO, 1957 (see also TASHIRO, 1972) from the Izumi Group of Shikoku and the Lower Himenoura Subgroup of Kyushu, and *Apiotrigonia hetonaiana* sp. nov. are similar to this species in having a smooth area. *Ap. obsoleta*, however, differs from this species in the smaller shell size, less numerous subradial costae of the posterior series and nearly effaced costae of the anterior series. The distinction between *Ap. hetonaiana* sp. nov. and this species was mentioned already. *Columbitrigonia jackassensis* POULTON (1977) and *Trigonia condoni* PACKARD (1921) both from the Lower Cretaceous of North America, resemble this species in having strong costae of the posterior series and a smooth area. The American species, however, differ



Text-fig. 5: The resemblance of irregularly waved costae of the anterior series and the bi- or trifurcated costae of the posterior series, between *Heterotrigonia subovalis* (JIMBO) (A) and *Apiotrigonia crassoradiata* NAKANO (B).

(A) is restored on the basis of a specimen from the Middle Yezo Group at Ikushunbetsu of Hokkaido, and (B) is from the Upper Himenoura Subgroup at Shimokoshikijima island of Kagoshima Prefecture (See Text-fig. 4). scale 1 cm.

from this species in the broad and oblique costae on the anterior half of the disk. *Heterotrigonia subovalis* (JIMBO) (NAKANO, 1957, 1961) resembles this species in having variably arranged costae of the anterior series, bi- or trifurcated subradial costae of the posterior series and the large size of the valve, but the former differs from the latter in having distinct radial costellae on the area. If the area were broken off it might be difficult to discriminate whether the specimen belongs to *Ap. crassoradiata* or *Het. subovalis* (see Text-fig. 5).

Occurrence:—Greenish gray sandstone of the Fukaushi Sandstone of the Hakobuchi Group at Omagari of Tomiuchi, Iburi District, Hokkaido : Lower Campanian (lower Hetonaian), *Inoceramus orientalis orientalis* Zone.

Family Cultellidae DAVIES, 1935

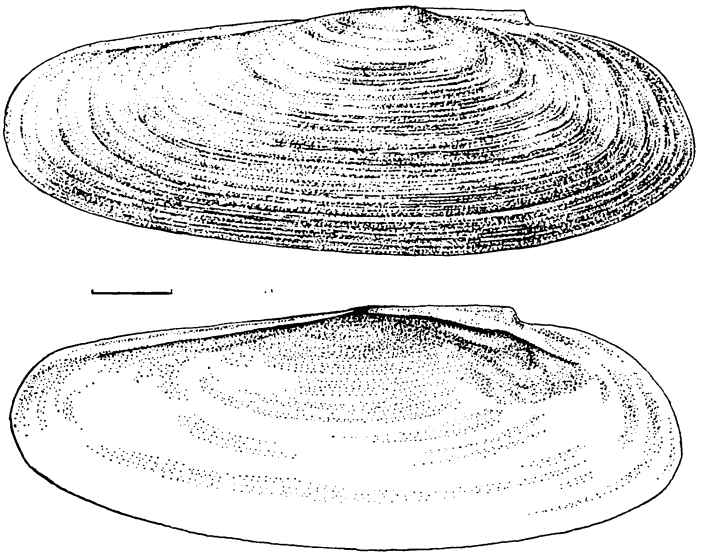
Genus *Senis* STEPHENSON, 1953

Senis japonica, sp. nov.

Plate 54, Figs. 6-10, Text-fig. 6

Material:—The holotype (KE 2786) is a left valve collected at Panketosanosawa of Tomiuchi (Hetonai), Hokkaido. The paratypes (KE 2787-KE 2788) are external moulds. A paratype (KE 2789) is an internal mould of right valve. The other paratype (KE 2790) is a left valve. All the paratypes were collected at the same locality as the holotype.

Description:—Shell elongate-ovate, weakly inflated ; test thin ; antero-dorsal margin straight or slightly convex, occupied about a half length of valve ; anterior margin rounded or somewhat truncated on upper side ; ventral margin very long, weakly arched ; posterior margin subtruncated, a little oblique to posterior, nearly straight ; postero-dorsal margin short, nearly straight, occupying about one-third of length of valve ; umbo small, improminent, situated at about four-sevens of length from front of valve ; a bluntly elevated ridge extends from umbo to antero-dorsal margin ; posterior carina weak, not angulated, extends from umbo to postero-ventral margin ; ligament external, narrowly elongated along postero-dorsal margin, from umbo to a mid-point of the margin ; lunule and escutcheon indistinct ; posterior area triangular, nearly flat ; surface smooth except for fine growth line which are somewhat crowded near ventral margin ; hinge area smooth without teeth ; nymph elongated below antero- and postero-dorsal



Text-fig. 6: *Senis japonica*, sp. nov.
A: external view of left valve, B: internal view of right valve. scale 1 cm.

margins, occupying about two-thirds of valve length; nymph on posterior margin is shorter but wider than on anterior; pallial line and pallial sinus indistinct; posterior adductor scar small, weakly prominent under postero-dorsal margin; anterior adductor scar indistinct; inner margin smooth.

Measurements (in mm):—

Specimen	Length	Height	Thickness
KE 2786, l. v.	68.8	25.6	5.4
KE 2790, l. v.	51.2	18.7	2.5
KE 2787, l. ext. mol.	68.0+	28.0	3.0
KE 2788, r. ext. mol.	55.4+	22.9	4.3
KE 2789, r. int. mol.	64.9+	23.5	—

Observation and Remarks:—This species is rather uniform in outline. It is characterized by the posterior location of the umbo and the edentulous hinge. It resembles the species belonging to the genera *Phaxas, Siliqua* and *Leptosolen* in the elongatedly ovate outline, but differs from them in lacking hinge tooth. Some species of the genus *Gari* and allied genera of the Psammobiinae show similarly elongated outline, but the present species differs from them in the not angulated posterior carina and undeveloped hinge tooth. The present new species probably belongs to the genus *Senis* in view of the edentulous hinge structure and the elongated valve.

Comparison:—*Senis elongatus* STEPHENSON (1953) from the Woodbine Formation of North America, is the only comparable species because no other species has been referred to *Senis*. This species can be discriminated from *Senis elongatus* by the more posteriorly located umbo and the not angulated outline.

Occurrence:—Greenish gray sandstone or siltstone of the upper part of the Fukaushi Sandstone of the Hakobuchi Group at Panketosanosawa of Tomiuchi, Iburi District, Hokkaido: Maestrichtian (Upper Hetonaian), *Inoceramus hetonaianus* Zone.

Repository

The specimens described in this paper are preserved in the Faculty of Education, Kumamoto University (Kumamoto 860).

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NODA, M. and TASHIRO, M. (1973) : The fauna from Dogo-Himezuka, Matsuyama City and its stratigraphic significance.

Explanation of Plate 54

Apiotrigonia hetonaiana sp. nov.

Fig. 1. Left valve, holotype (KE 2776), Loc. Panketosanosawa of Tomiuchi, Iburi District, Hokkaido; 1a: lateral view, ×1. 1b: dorsal view, ×1. 1c: umbonal view, showing subinternal radial striations, ×1.

Fig. 2. Internal mould of right valve, paratype (KE 2777), ×1, Loc. ditto.

Fig. 3. Immature stage of left valve, paratype (KE 2779), ×3, Loc. ditto.

Fig. 4. Right valve, paratype (KE 2780), Loc. Chinomigawa of Urakawa, Hidaka District, Hokkaido; 4a: plaster cast of external mould, ×1. 4b: internal mould, ×1.

Apiotrigonia crassoradiata NAKANO

Fig. 5. Gum cast of imperfect external mould (KE 2783), ×1, Loc. Omagari of Tomiuchi, Iburi District, Hokkaido.

Senis japonica sp. nov.

Fig. 6. Left valve, holotype (KE 2786), ×1, Loc. Panketosanosawa of Tomiuchi, Iburi District, Hokkaido.

Fig. 7. Left valve, paratype (KE 2790), ×1, Loc. ditto.

Fig. 8. Gum cast of left external mould, paratype (KE 2787), ×1, Loc. ditto.

Fig. 9. Internal mould of right valve, paratype (KE 2789), ×1, Loc. ditto.

Fig. 10. Gum cast of external mould, imperfect right valve, paratype (KE 2788), ×1, Loc. ditto.

1a

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1b

3

1c

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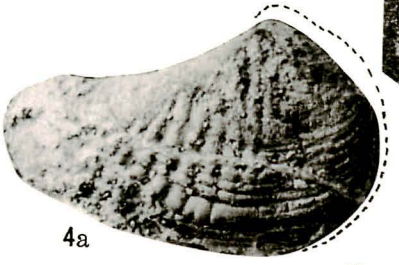

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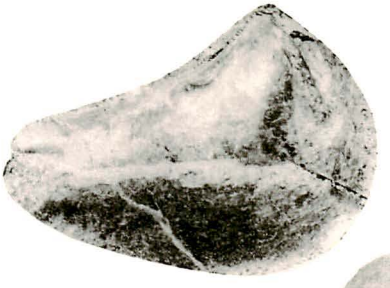

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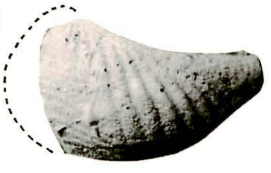

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10

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北海道最上部白亜系より産する二枚貝 *Apiotrigonia* と *Senis* の2新種:

新種 *Apiotrigonia hetonaiana* sp. nov. は，函淵層群と乳呑川層より産し，その時代は，カンパニアン上部からマストリヒシアンである。本種は，おそらく *Apiotrigonia crassoradiata* NAKANO から由来したものと思われる。なお，*Ap. crassoradiata* は，九州や四国ではカンパニアン下部から中部に出現し，今回，北海道のカンパニアン下部（函淵層群）にも産出が確認された。新種 *Senis japonica* sp. nov. は函淵層群の上部（マストリヒシアン）から産する。なお，本属に属する種の産出は，本邦の白亜系ではこの報告が最初である。

田 代 正 之

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第122回例会は1978年10月14日(土)に山形大学理学部において開催された(参加者74名)

個人講演

超微量試料による酸素・炭素同位体比測定についての問題点 .....新妻信明

本邦中部白亜系の放散虫群集について .... 中世古幸次郎

Cryptocephalic and cryptothoracic *Nassellaria* from the Shimanto Group (Part 2) ..... NISHIMURA, A. and NAKASEKO, K.

"OST" と海綿の sterraster — 相模湾産海綿の一個体について .....井上雅夫

Phosterophora, a new genus of the planktonic foraminiferal family Candeinidae..... ..... SAITO, T.

Late Miocene and early Pliocene planktonic foraminifera from the northwestern corner of Hokkaido ....SAITO, T. and THOMPSON, P.R.

On *Acervoschwagerina* from the Yoganeyama Limestone, Gifu Prefecture, Japan .... SASHIDA, K.

鍋山層・出流層の紡錘虫生層序と時代論 小林文夫

紡錘虫種構成からみた"鍋山フォーナ"の特異性について..... 小林文夫

Some Upper Paleozoic corals from Turkey .....KATO, M.

Marine bivalves from the Upper-most Formation of the Upper Himenoura Subgroup in Kyushu, Japan..... .....TASHIRO, M. and OTUKA, M.

本邦上部白亜系の *Nanonavis* 類について .... 田代正之・山本勝吉

北海道チュロニアンから産出したイノセラムスの新種について .....野田雅之・村本喜久雄

A catalogue of species and subspecies of the Glycymerididae from Japan and its adjacent areas.....MATSUKUMA, A.

Geloina の産出層準(中新世)におけるマングローブ林の存在 .....山野井徹・糸魚川淳二

第四紀古谷泥層(静岡県牧ノ原台地下)における貝化石の産状と古生態 ....池谷仙之・堀江善祐

Basic morphology and chemical composition of tetragonitid ammonite jaws in comparison with those of living cephalopods, Part 1. Fundamental morphology ....KANIE, Y., TANABE, K. and FUKUDA, Y.

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Taxonomic study of jaw morphology in some Upper Cretaceous ammonites from Japan and Sakhalin .....TANABE, K., KANIE, Y., HIRANO, H. and OBATA, I.

The jaw morphology of ammonites and its ecological implications ....LEHMANN, U., FUKUDA, Y., OBATA, I., KANIE, Y., HIRANO, H. and TANABE, K.

A new gaudryceratine ammonite from the Cretaceous of Eastern Hokkaido .... MATSUMOTO, T. and YOSHIDA, S.

赤石山地四万十帯産アンモナイトについて .... 松本達郎・岡田博有・桜井貞彦

Lower Carboniferous brachiopods from the Odaira Formation in the Kitakami Mountains.....TAZAWA, J. and KATAYAMA, T.

Ostracodes from the *Yabeina* Zone of the Akasaka Limestone, Gifu Prefecture, Central Japan .....ADACHI, S. and IGO, Hy.

A preliminary note on ostracodes from the Ananai Formation, Shikoku....ISHIZAKI, K.

Ontogenetical investigation of surface features and normal pores in *Spinileberis quadriaculeata* (Ostracoda) by means of SEM ....IKEYA, N., NISHII, K. and NIITSUMA, N.

成田層中にカクレガニ科の存在していた可能性について .....福田芳生

日本海沿岸上部新生界中の渦鞭毛藻化石,その1 ——七谷層—— .....松岡数充

常盤地域の珪藻層序と層序上の問題点について ..... 小泉格

"*Coscinodiscus yabei*" グループの時空分布につ

SYSTEMATIC INDEX

(New Series No. 105—No. 112)

PALAEOZOOLOGY

Protozoa

Coelenterata

Mollusca

Arthropoda

PALAEOBOTANY

INDEX OF FAMILIES, GENERA AND SPECIES

Notes: Words listed are names of families, genera and species, which are either described or illustrated in the articles in Transactions and Proceedings of the Palaeontological Society of Japan, New Series, Nos. 105-112. Words in bold-faced type are names of newly proposed taxa.

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Abbreviations of the fields of study

Ag.	Applied geology
Biost.	Biostratigraphy
Brach.	Brachiopods
C	Cenozoic
Cal.	Calcareous algae
Cephal.	Cephalopods
Conod.	Conodonts
Foram.	Foraminifers
Fusul.	Fusulinaceans
Gg.	General geology
Gp.	General paleontology
Hg.	Historical geology
In.	Invertebrates
M	Mesozoic
Mg.	Marine geology
Mo.	Molluscs
Nannopl.	Nannoplankton
P	Paleozoic
Paly.	Palynology
Pe.	Paleoecology
Pg.	Petroleum geology
Pl.	Plants
Q	Quaternary
R	Recent
Radiol.	Radiolarians
Rg.	Regional geology
St.	Stratigraphy
Sd.	Sedimentology
Tg.	Tectonic geology
Ver.	Vertebrates

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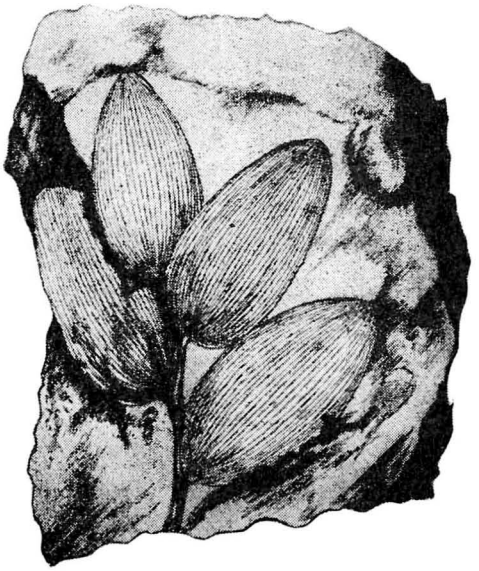

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The heading in Japanese commemorates the handwriting of Prof. Matajiro YOKOYAMA, father of Japanese palaeontology, who was a professor of stratigraphy and palaeontology at the Geological Institute, Imperial University of Tokyo.

The fossil on the cover: Original figure of *Podozamites Reinii* GEYLER, 1877, from the Tetori group. GEYLER's description marked the onset of modern palaeontology in Japan.

CONTENTS

Number 105 (Published April 30, 1977)

Transcations

Number 106 (Published June 30, 1977)

Transactions

Number 107 (Published September 15, 1977)

Transactions

Number 108 (Published November 15, 1977)

Transactions

Number 109 (Published April 30, 1978)

Transactions

Number 110 (Published June 30, 1978)

Transactions

Number 111 (Published September 30, 1978)

Transactions

Number 112 (Published December 30, 1978)

Transactions

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第123回 例会	金沢大学	1979年6月9,10日	1979年4月5日

講演申込先：〒113 東京都文京区弥生 2-4-16 日本学会事務センター 日本古生物学会行事係

福岡大学における1979年年会では1月21日午後にコロキウム「国際対比の見地からみた日本および近接地の白亜紀化石」(世話人 松本達郎) が開催される。

金沢大学における例会ではコロキウム「時計としての化石——その分解能」(世話人代表 小西健二) と手取層群化石産地への巡検 (案内者 松尾秀邦) が予定されている。

お知らせ

○**化石28号** (昭和53年9月30日発行, A5版111ページ, 1800円) が刊行されました。オリジナル論文, 時の話題, 経験談, 概説, 提言, 回想, インタナショナル・リポートニューズ, 新刊案内などが豊富に掲載されています。「化石」は以前は予約前払いの購読制をとってきましたが, 現在は継続予約者名簿を作成し, 登録された方々へ, 発行の都度, 雑誌をお送りし, 誌代を後払いしていただく方法をとっております。御希望の方は, はがきに氏名および送本先住所を明記の上, 下記にお申込み下さい。

〒980 仙台市荒巻字青葉 東北大学理学部地質学古生物学教室内 化石編集部
(振替口座 仙台 17141)

○第26回万国地質学会 (International Geological Congress) が1980年7月7日～17日にパリで開催されます。

○本会名誉会員・元会長鹿間時夫君は, 昭和53年12月12日に逝去されました。
ここに謹んで哀悼の意を表します。 日本古生物学会

行事係より

○プログラム編成の必要上講演の内容についてあらかじめお訊ねすることがありますので御了承下さい。

◎ 文部省科学研究費補助金 (研究成果刊行費) による。

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CONTENTS