

## Pliocene Shells from the Omma Formation around Kanazawa City, Japan

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### Introduction and Acknowledgments

Along the Japan Sea coast of Japan, the Pliocene transgression had widely left the marine deposits called the Wakimoto stage (MINATO *et al.*, 1965). These Pliocene strata distributed along the Japan Sea coast have been famous for their abundant occurrence of molluscan fauna called the "Omima-Manganji Fauna". Starting from the southwest Hokkaido, through Akita, Niigata, Sado and Nagano districts, the Pliocene Wakimoto stage containing rich molluscan fauna can be traced to the Kanazawa area of Ishikawa Prefecture.

In Hokuriku region including the Kanazawa, Toyama and Noto districts, the Pliocene marine strata (Himi formation) have a wide distribution and can be divided into three major types of facies in accordance with the different conditions of sedimentation (KASENO, 1963, 1964). They are the Omima facies, the Yabuta facies and the "Natsukawa" facies.

The writers have engaged in the study of the Pliocene strata and molluscan shells in Hokuriku region as a part of the investigation of the Pliocene transgression along the Japan Sea coast region of Japan.

The present article deals with the molluscan fauna found in the Omima formation around Kanazawa city, one of the most famous locality of the Pliocene marine molluscs in Japan.

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### Previous Studies on the Omima Shells

The Pliocene Omima formation designated here has been called the "Omima-sô" in Japanese, and widely known among the Japanese geologists and paleontologists. It has been named by various authors in somewhat different ways in English usage, such as the Omima sandstone beds, the Omima sand beds, or the Omima formation. The name Omima (or Onma) has been derived from the place name, the Omima (now pronounced as Ôkuwa) village situated in the left side of the River Saigawa — a classical locality of the Pliocene molluscan fossils around Kanazawa city since the first report by M. YOKOYAMA (1927). He published a paper on the fossil molluscan shells collected from several localities (Ôkuwa, Kakuma, Tagami and Nagaé etc.) around Kanazawa city, list up 120 species in total, and described several new and important species.

Immediately after the YOKOYAMA's report, the geology and stratigraphy of the

Cenozoic formations in the vicinity of Kanazawa city was studied by K. MOCHIZUKI and T. ONOYAMA. ONOYAMA carried out a detailed investigation of the Neogene strata and reported the occurrence of 125 species of molluscan shells from the Omma formation, indicating that almost all species of the Omma molluscan fauna belong to the forms living in cold water environment. T. OINOMIKADO (1934) also studied the Omma shells and distinguished three fossil zones within the Omma formation in ascending order as follows: (1) *Anadara amacula* zone, (2) *Pseudamiantis tauyensis* zone and (3) *Turritella saishuensis* zone.

Then, Y. OTUKA (1936) found a rich molluscan fauna from Manganji village, Kotomo-mura, Akita Prefecture, and recognized a remarkable resemblance between the Omma and Manganji faunas. After him, the "Omma-Manganji Molluscan Fauna" has been widely accepted among the Japanese geologists and paleontologists as representing a distinguished type of molluscan fauna indicating the Pliocene transgression along the Japan Sea coast of Japan. Hereafter, HATAI and NISIVAMA (1939) added several species to the Omma molluscan fauna.

A comprehensive work dealing with the Omma molluscan fauna as a whole, however, has not been performed until recent years, except for some papers referred to the species belonging to *Turritella*, *Patinopecten*, *Pseudamiantis*, *Thracia* etc. The present writers have collected and examined many specimens from important localities around Kanazawa city, and preliminarily summarized them four years ago (KASENO *et al.*, 1961), and wrote a paper on the unconformable phenomena at the base of the Omma formation (KASENO and MATSUURA, 1964).

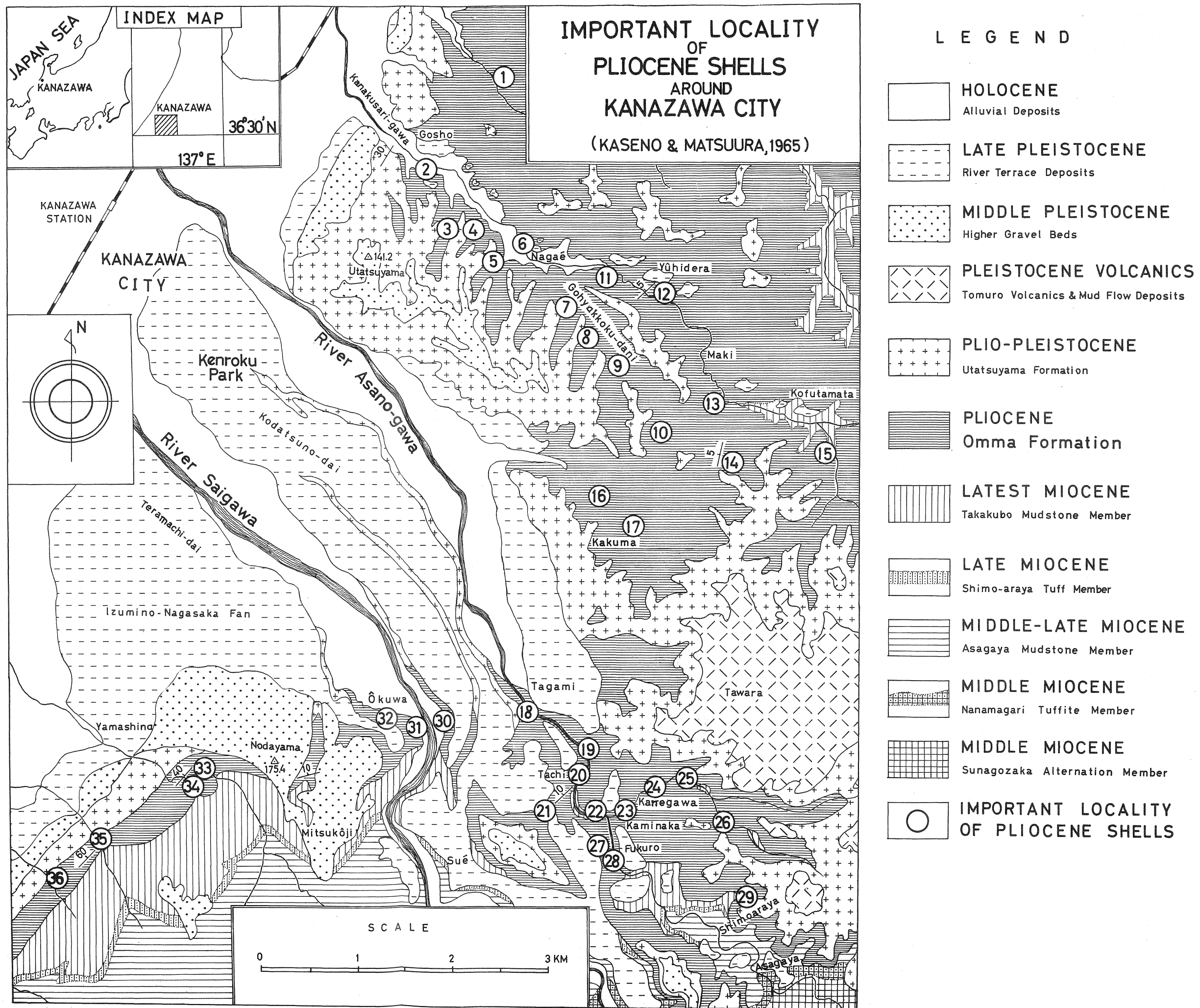
### Geology and Stratigraphy

After the geologic and stratigraphic studies by K. MOCHIZUKI (1930 a, b) and T. ONOYAMA (1933), the more detailed stratigraphic investigations have been performed by several workers since 1946, and reported by N. IKEBE (1949) and M. ITIHARA *et al.* (1950). Some details have been added and emended by one of the present writers (KASENO) and N. NAKANISHI, which were summarized in the sheet survey of the Geological Survey of Japan by I. IMAI (1959). Further, the stratigraphic relations and fossil contents of the Omma formation have been examined by the present writers in recent years (KASENO *et al.*, 1961; KASENO and MATSUURA, 1964).

Thus, the Cenozoic formations in the vicinity of Kanazawa city are now stratigraphically divided into several members as briefly given in Table 1. The geologic map of the area around Kanazawa city is shown in Text-figure 1.

Table 1. Stratigraphic division of the Cenozoic formations in the vicinity of Kanazawa city.

Age	Standard division in Japan	Standard division in Hokuriku	Stratigraphic division in Kanazawa area	Lithology and Important Fossils	Maximum thickness in meters
Holocene			Alluvial deposits	sand, mud, gravel	
Late Pleistocene			River terrace deposits	terrace gravel	
Middle Pleistocene			Higher gravel beds	gravel, sand, mud	
			Tomuro volcanics and mud flow deposits	lava dome of hornblende andesite and pyroclastics	
Lower Pleistocene and Plio-Pleistocene	Shibikawa stage	Hanyū stage	Utatsuyama formation	conglomerate, sandstone and mudstone. Non-marine fossils	150
Pliocene	Wakimoto stage	Himi stage	Omna formation	yellowish brown sandstone, bluish grey sandstone. Marine molluscs	150
Latest Miocene	Kitaura stage	Otogawa stage	Takakubo mudstone member	siltstone, mudstone and tuff	200
Late Miocene	Funakawa stage		Shimo-araya tuff member	andesitic tuff white pumice tuff	60
Middle-Late Miocene	Onnagawa stage	Higashi-bessho stage	Asagaya mudstone member	mudstone	150
Middle Miocene	Nishikurosawa stage	Kurosedani stage	Nanamagari tuffite member	tuffaceous sandstone and mudstone. tuff breccia	100
			Sunagozaka alternation member	tuffaceous sandstone, mudstone <i>Operculina</i>	170
	Daishima stage		Iwōzen formation	rhyolitic tuff breccia, volcanic breccia	500
Early Miocene	Nishioga stage	Iwaine stage	"Andesitic pyroclastics"	andesite lava andesitic pyroclastics	1000
		Nirehara stage	"Conglomerate"	conglomerate	150



Text-figure 1. Geologic map in the vicinity of Kanazawa city, with important localities of Pliocene shells.

### The Omma Formation

*Stratigraphy* The Omma formation around Kanazawa city usually attains 120~150 meters in thickness, resting conformably or unconformably on the Takakubo mudstone member (Latest Miocene). In the northeast areas (Tsurube and Maki) of the Kanazawa city, the Omma formation gradually changes from the underlying Takakubo member, the lowest boundary of the former being conventionally defined by the base of a pumice tuff layer (2~20 meters thick). In the southeast areas (Chôshi, Fukuro, Shimo-araya) along the River Asanogawa, on the contrary, the Omma formation covers unconformably the Takakubo and lower members as diagrammatically shown in Text-figure 2. In the southern areas (Ôkuwa, Mitsukôji and Yamashina), the relation between the Omma formation and the Takakubo member seems to be unconformable. The Omma formation is covered unconformably by the Utatsuyama formation (Pliopleistocene), the basal conglomerate of the latter being widely recognized around Kanazawa city.

*Facies and Lithology* The Omma formation around Kanazawa city is usually composed of fine to medium, partly coarse sandstone with silty insertions at places. In general the grain size becomes coarser from lower to upper, sometimes granule-bearing in the middle and upper horizons. Thin layers of small pebble conglomerate are sometimes inserted in the upper horizon, and thin basal conglomerate layer of 1~1.5 meters thick is found in the southern area.

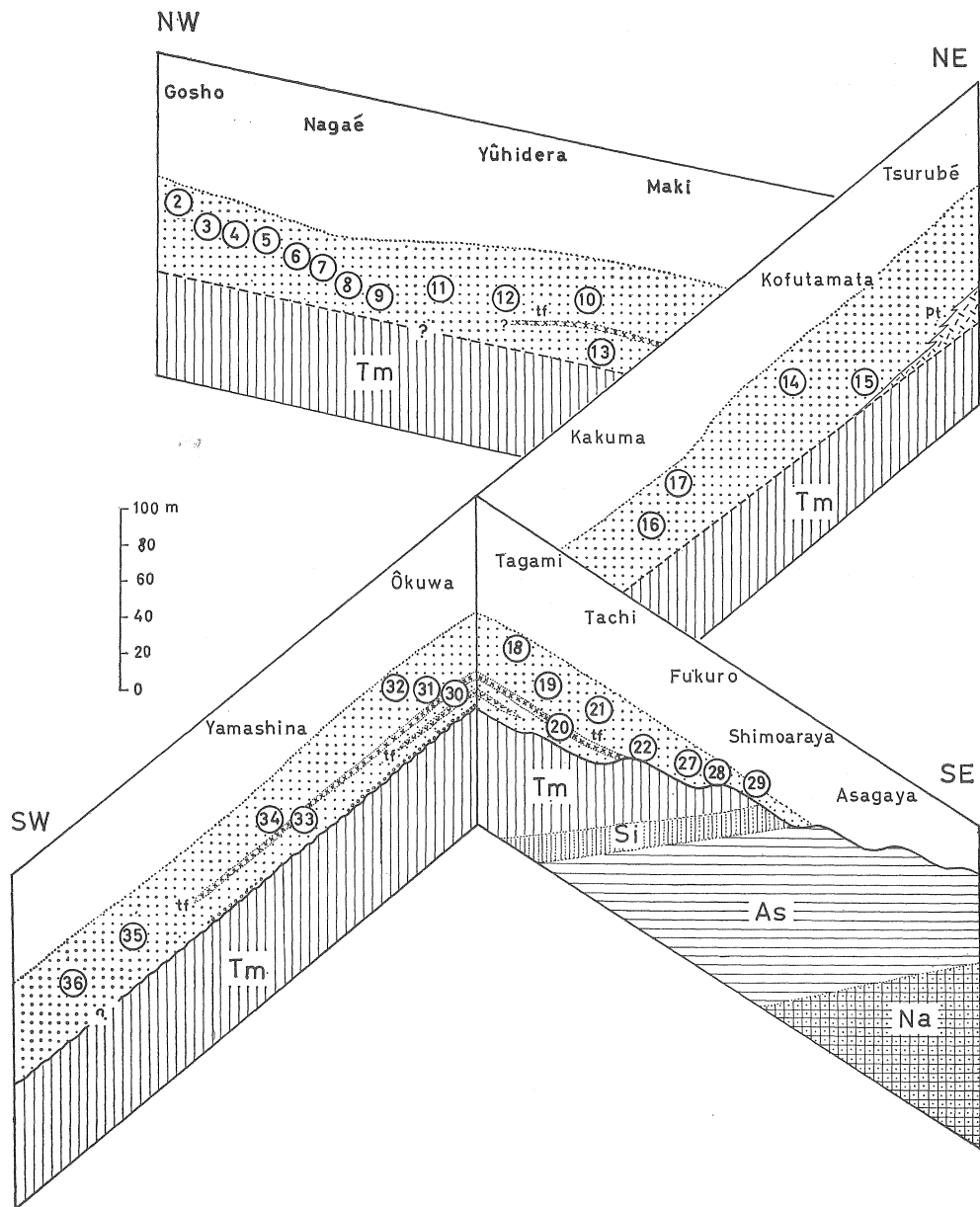
The lower part of the Omma formation is usually composed of bluish grey fine sandstone with insertions of one or two layers of white fine tuff. The bluish grey fine sandstone contains molluscan shells abundantly, appearing yellowish brown in weathered portions. The middle part of the Omma formation is generally yellowish brown in color, sometimes contains impressions of molluscan shells, and inserted with thin layers of grey silt. The upper part of the Omma formation is composed of coarse or very coarse sandstone, and partly characterized by remarkable cross-laminations.

The stratigraphic relations and facies as well as the stratigraphic positions of important localities of molluscan shells are schematically shown in Text-figure 2.

The fossil-bearing bluish grey fine sandstone constituting the lower part of the Omma formation shows a uniform lithologic character in all places around Kanazawa city. According to NOHARA (1961, MS), the values of grain size analyses are as follows:

Md (Median diameter)	0.1 ~ 0.2 mm.
So (Coefficient of sorting)	1.3 ~ 1.4
Sk (Skewness)	0.9 ~ 1.2

The silt fraction of the bluish grey fine sandstone yielding molluscan shells is usually 5~20 %.



Text-figure 2. Stratigraphic relation, lithology and important fossil localities of the Omma formation around Kanazawa city.

Omma formation : dotted portion is bluish grey fine sandstone yielding molluscan fossils and microfossils; pt—coarse pumice tuff; tf—thin layer (10 ~ 20 cm) of fine tuff; numerals in circle showing the stratigraphic position of fossil locality correspond to those in Text-figure 1; blanc portion represents yellowish brown sandstone.

Basal boundary : solid line—unconformity  
broken line—conformity

Pre-Omma formation : Tm—Takakubo mudstone member; Si—Shimo-araya tuff member;  
As—Asagaya mudstone member; Na—Nanamagari tuffite member.

According to a rough estimation of the mineral composition of bluish grey fine sandstone of the lower part of the Omma formation, the heavy minerals are usually poor in amount, being 0.5~1.5 weight % in most samples. Among the light minerals, quartz is less abundant, and the relative abundance is : plagioclases > quartz > potash feldspars. Among the heavy minerals, hypersthene, augite and biotite are common; hornblende, zircon, chlorite and muscovite are present; such opaque minerals as pyrite, hematite, limonite and magnetite are also associated with (NOHARA, 1961, MS). The results of mineral analyses mentioned above suggest that the supply source of the fine sand constituting the lower part of the Omma formation largely depends on the acid or intermediate volcanic rocks and pyroclastic rocks exposed on the surface of the hinterland at that time.

*Microfossils Contained* The bluish grey fine sandstone constituting the lower part of the Omma formation usually contains abundant remains of smaller foraminifers. CUSHMAN and OZAWA (1928) described some species of Polymorphinidae from the Omma formation for the first time. After them, the benthonic calcareous smaller foraminifers have been studied by K. ASANO (1939) and other workers, but the details have not been published as yet. Smaller foraminifers from the Omma formation around Kanazawa city seem to be more than 70 species in total, and the following species are rather common among them : *Bolivina seminuda* CUSHMAN, *Bulimina marginata* D'ORBIGNY, *Cassidulina sublimbata* ASANO and NAKAMURA, *Cassidulina yabei* ASANO and NAKAMURA, *Cibicides lobatulus* (WALKER and JACOB), *Dentalina setanaensis* ASANO, *Guttulina sadoensis* CUSHMAN and OZAWA, *Hanzawaia nipponica* ASANO, *Lagena striata* (D'ORBIGNY), *Nonion japonicum* ASANO, *Nonion manpukujiense* OTUKA, *Pseudopolymorphina ishikawaensis* CUSHMAN and OZAWA, *Pseudopolymorphina okuwaensis* CUSHMAN and OZAWA, *Rotalia japonica* HADA, and *Sigmoidella kagaensis* CUSHMAN and OZAWA.

Among the benthonic foraminifers, calcareous forms are dominant, and arenaceous ones are very poor. Planktonic foraminifers are rather poor in general. Other than foraminifers, such microfossils as ostracods, radiolarians, diatoms and pollen and spores are also found in the bluish fine sandstone of the Omma formation, but details remained unknown.

*Megafossils Excluding Molluscs* In association with rich molluscan shells, the occurrence of various megafossils has been known from the Omma formation around Kanazawa city.

As the marine vertebrate fossils the whale bones and shark teeth sometimes occur, although their taxonomic determination and description have not been published. Pinniped remains belonging to *Eumetopias jubata* SCHREBER have been collected and described (KASENO, 1951).

Various species of echinoid fossils have been known, and studied by MORISHITA (1955, 1960) on the following species : *Echinarachnius mirabilis* (A. AGASSIZ),



*Echinarachnius tenuis* YOSHIWARA, *Echinarachnius tsudai* MORISHITA, and *Clypeaster virescens* DÖDERLEIN.

As the crustacean fossils, fragments of crabs have been frequently obtained. Further, *Coronula diadema* (LINNE), a species of Cirripedia attaching to the whales, has been frequently known.

The occurrence of brachiopod shells is rather rare in the Omma formation around Kanazawa city. Fragments of plant leaves are also known rarely, but not enough to generic or specific discrimination.

### Occurrence of Molluscan Shells

The lower part of the Omma formation composed of bluish grey fine sandstone yields molluscan fossils everywhere around Kanazawa city. Important 36 localities are referred to in the present article, and the following 14 localities among them are especially investigated in detail:

- Locality 6 Higashi-nagaé
- Locality 9 Nagaé-gohyakkokudani
- Locality 12 Yuhidera
- Locality 14 Maki
- Locality 16 Kakuma
- Locality 18 Tagami-honmachi
- Locality 20 Tachi
- Locality 22 Kaminaka
- Locality 25 Kanegawa
- Locality 27 Fukuro
- Locality 29 Shimo-araya
- Locality 31 Ōkuwa
- Locality 32 Ōkuwa
- Locality 34 Yamashina

Important localities mentioned above and their stratigraphic positions are shown in Text-figure 1 and Text-figure 2.

The fossil molluscan shells in the lower part of the Omma formation are mostly thanatocoenose and gregariously crowded to form a shell bed of 10~30 cm thickness in usual. Some examples of the mode of occurrence of the molluscan shells are shown in Figs. 2~6 of PLATE XX.

Some shell beds are dominantly composed of detached pelecypod shells of large size, being usually embedded nearly horizontally in association with minor shells of pelecypods and gastropods. Some shell beds are composed of one species only; for example, conjoined valves of *Glycymeris yessoensis* (SOWERBY) as shown in Fig. 6 of PLATE XX, and, *Turritella saishuensis* YOKOYAMA laid horizontally in random orientation as shown in Fig.5 of PLATE XX.

Table 2. List of molluscan shells from 14 fossil localities of the Pliocene Omma formation around Kanazawa city.

For each species, such ecological data as (1) recent geographic distribution, (2) bathymetric range, and (3) bottom character are shown as far as possible. For 14 localities, (4) frequency of occurrence and (5) state of preservation are also given.

- (1) Recent geographic (latitudinal) distribution : After KURODA and HABA (1952).
- (2) Bathymetric range : N.....Neritic, No.....Intertidal, N<sub>1</sub>.....Euneritic (~20-30 m), N<sub>2</sub>.....Mesoneritic (20-30~50-60 m), N<sub>3</sub>.....Subneritic (50-60~100-120 m), N<sub>4</sub>.....Bathynetric (100-120~200-250 m), B.....Bathyal (200-250~800-1200 m).
- (3) Bottom character : R : Rock, G : Gravel, S : Sand, M : Mud, s : sandy, m : muddy.  
In the columns of 1), 2) and 3), [ ] or ( ) indicate uncertain value or estimation.
- (4) Frequency of occurrence : va : Very abundant, a : Abundant, c : Common, r : Rare.
- (5) State of preservation :
  - : mostly conjoined valves
  - × : mostly broken shells
  - △ : mostly worn shells

Table 2-1

Specific Name	(1) Recent Geographic (Latitudinal) Distribution		(2) Bathy- metric Range	(3) Bottom Character	(4) Frequency of Occurrence and (5) State of Preservation													
	Pacific Coast	Japan Sea Coast			Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.		
					6	9	12	14	16	18	20	22	25	27	29	31	32	34
					Higashi-nagae	Gohyakkokudani	Yohidera	Maki	Kakuma	Tagami	Tachi	Kaminaka	Kanegawa	Fukuro	Shimo-araya	Okuwa	Okuwa	Yamashina
<i>Haliotis (Euhaliotis) gigantea</i> GMELIN	31°~36°	~39°	N <sub>1</sub>	R, G		r												
<i>Puncturella nobilis</i> A. ADAMS	39°~46°	36°~46°	N <sub>1</sub>	R, S, G										r				
<i>P. fastigiata</i> A. ADAMS	35°~41°	~41°	N <sub>3-4</sub>	G, S										r				
<i>P. sp. No. 1</i>			[N]	[R, G]						r								
<i>P. sp. No. 2</i>			[N]	[R, G]										r				
<i>Collisella sp.</i>															r ×			
<i>Acmaea (Niveotectura) pallida</i> (GOULD)	35°~42°	~46°	N <sub>0-4</sub>	R, G										r ×				
<i>Lepeta sp.</i>										r				r				
<i>Machaeroplax sp. No. 1</i>									r									
<i>M. sp. No. 2</i>						r												
<i>Turcica sp.</i>										r				r				
<i>Minolia pseudobscura</i> (YOKOYAMA)		36°	[N~B]											r	c			
<i>Solariella sp.</i>							c	r						c	△			
<i>Tristichotrochus multiliratus</i> (SOWERBY)	35°~42°	40°~43°	N <sub>0-1</sub>	R, G	r				r							c	c	
<i>Lirularia sp.</i>			[N]	[S]				r	c	r	r		c					c
<i>Umbonium (Suchium) akitanum</i> SUZUKI						c			r		r		r ×				r ×	

<i>Starkeyna sobrina</i> (A. ADAMS)	33°~35°	~36°	N <sub>1</sub>	S	r	r	c	c		r	r		c	r	r		c
<i>Homalopoma amussitatum</i> (GOULD)	38°~51°	34°~46°	N <sub>1</sub>	R, S						r				r	△		
<i>Plesiothyreus</i> sp.										r ×				r	c		r
<i>Cocculina</i> sp.														r			
<i>Putilla</i> sp.			[N]														
<i>Alvania</i> ( <i>Arsenia</i> ) <i>akibai</i> YOKOYAMA			[N]		c		r			r	r						
<i>A. asura</i> (YOKOYAMA)	39°~42°		[N]					r									
<i>Turritella saishuensis</i> YOKOYAMA			[N]		va	a	c ×	c	a	va	r ×	r ×	a	a	c ×		c
<i>T. (Neohaustator) andenensis</i> OTUKA var.	[32°(?)]	[32°~42°]								r	△						c
<i>Macrophragma tokyoensis</i> (PILSBRY)	~0°~34°	~41°	N <sub>0</sub>	R, G													c
<i>Tachyrhynchus venustellus</i> (YOKOYAMA)			[N]		a	c	c	r	c	a	c	c	c	c	a	r	r
<i>T. tuberculosus</i> (YOKOYAMA)					c	r	c		a	c	r		a				c
<i>Bittium (Stylidium) horinjiense</i> OINOMIKADO et IKEBE					r	r					c	a			c		c
<i>B. sp. No. 1</i>								r		r					r		
<i>B. sp. No. 2</i>																	r ×
<i>B. sp. No. 3</i>																	
<i>Heliacus</i> sp.					r												
<i>Nodiscala</i> sp. (n. sp. ?)												r					
<i>Amaea</i> sp.					r				r			r			r		
<i>Epitonium (Depressiscula)</i> <i>auritum</i> (SOWERBY)	~0°~35°	~41°	N <sub>1</sub>	S											r		
<i>E. (Boreoscala) yabei echigonum</i> KANEHARA					r	△	r					r					
<i>Eulima</i> sp.															r		
<i>Balcis</i> sp.												r					

Table 2-2 (continued)

Specific Name	(1) Recent Geographic (Latitudinal) Distribution		(2)  Bathy- metric Range	(3)  Bottom Character	(4) Frequency of Occurrence and (5) State of Preservation													
	Pacific Coast	Japan Sea Coast			Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	
					6	9	12	14	16	18	20	22	25	27	29	31	32	34
<i>Niso dorcas</i> (KURODA et HABE) var.						r			r	r								
<i>Lunatia pila</i> (PILSBRY)	?~44°	36°~46°	N <sub>1-2</sub>	S	a	a	a	c	a	c	a	c	a	c	a	c	c	c
<i>Mammilla yokoyamai</i> MAKINO (MS)									r	c	r					r		
<i>M.</i> sp.																	r ×	
<i>Neverita (Glossaulax) reiniana</i> (DUNKER)	31°~35°	~37°	N <sub>1-2</sub>	S, mS	r △	r ×		c	c	c	r	r	r	c	r	c		c
<i>Tectonatica janthostomoides</i> (KURODA et HABE)	31°~42°	~43°	N <sub>1-2</sub>	S	a	a	a	c	a	a	a	c	a	c	a	c	c	c
The operculum of <i>T. janthostomoides</i>					r △						c				c			c
<i>Mallurium otohimeae</i> HABE ?	[26°~34°]		[N <sub>2-4</sub> ]												r			
<i>Crepipatella lingulata</i> (GOULD)	51°														r ×			
<i>Tugurium exutum</i> (REEVE)	~0°~35°	~40°	N <sub>2</sub>	sM	c												a	a
<i>Semicassis minor</i> (KÜSTER)						r ×												
<i>Ceratostoma (Ocenebra) japonica</i> (DUNKER)	33°~51°	~41°	N <sub>0-1</sub>	R, G	a	c			r	c	c		c	c	c	c	r	r
<i>Trophonopsis kagaensis</i> HATAI et NISIYAMA								c			c	c	r	r	r	r		c
<i>T. (Boreotrophon) candelabrum</i> (REEVE)	34°~39°	~46°(?)	N <sub>1-2</sub>	M	r △					r			r		r	r		
<i>T. (B.) nipponicus</i> (YOKOYAMA)	35°~44°	36°~38°	N <sub>4</sub> ~B	S	r													
<i>Mitrella bicincta</i> (GOULD)	~0°~41°	~43°	N <sub>0-1</sub>	R, G, S								r			r			

<i>M. sp.</i>					c		r	c	r	r ×	c	c	r	r	c				
<i>Indomitrella lischkei</i> SMITH	24°~39°	~41°	N <sub>1-2</sub>	S, sM								r	c		r				
<i>I. tokyoensis</i> (YOKOYAMA)										r			c						
<i>Nassarius (Zeuxis) caelatus</i> (A.ADAMS)	~0°~35°	~41°	N <sub>1</sub>	mS, sM	a	c	r				r	r				r	c		
<i>Tritia luteola</i> (SMITH) var.	[33°]		[N <sub>0-1</sub> ]	[S]	c	c		r	c	c	a	a	r	c	a				c
<i>Neptunea (Barbitonia) arthritica</i> (BERNARDI)	36°~45°	40°~46°	N <sub>1-4</sub>	R, S	r ×	r △			r △	r	r ×	r △							
<i>Siphonalia cassidariaeformis</i> (REEVE) var.	[31°~35°]	[~41°]	[N <sub>1-2</sub> ]	[S]	r △	r			r ×				r		r ×	r			
<i>S. spadicea</i> (REEVE)	33°~39°	~42°	N <sub>2-3</sub>	S, mS, sM						r						r	r		
<i>S. fusoides</i> (REEVE)	32°~41°	32°~38°	N <sub>2</sub>	mS, S												r			
<i>Nassaria sp.</i> (n. sp. ?)																r			
<i>Searlesia japonica</i> YOKOYAMA					a	c		c	c	a	a	c ×	a	c	c	r ×	c	c	
<i>Babylonia elata</i> (YOKOYAMA)																			
<i>Plicifusus ozawai</i> (YOKOYAMA)			[N - B]		a	r △	r		r		r		r			r	r		
<i>Ootomella sp.</i> (n. sp. ?)									r										
<i>Fusinus perplexus</i> (A.ADAMS)	31°~42°	~42°	N <sub>1-2</sub>	S						r ×							c	c	c
<i>Olivella spretoides</i> YOKOYAMA			N <sub>3-4</sub>	S	a		a	a	c	c	c	r △	a		c	c	c	c	c
<i>Oliva mustelina</i> LAMARCK	11°~35°	~38°	N <sub>1</sub>								r					r			
<i>Fulgoraria masudae</i> HAYASAKA								c											r
<i>Cancellaria (Merica) kobayashii</i> (YOKOYAMA)			[N]		r					r	c		r						
<i>C. japonica lischkei</i> (YOKOYAMA)										r									
<i>Sydaphera spengleriana</i> (DESHAYES)	~0°~39°	~40°	N <sub>1-2</sub>	S			r				c					r	r		
<i>Admete murayai</i> (YOKOYAMA)	39°		[N - B]		r						c	r		r	c				a
<i>A. sp.</i>					r ×														

Table 2-3 (continued)

Specific Name	(1) Recent Geographic (Latitudinal) Distribution		(2) Bathy- metric Range	(3) Bottom Character	(4) Frequency of Occurrence and (5) State of Preservation													
	Pacific Coast	Japan Sea Coast			Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.		
					6	9	12	14	16	18	20	22	25	27	29	31	32	34
<i>Narona (Solatia) nodulifera</i> (SOWERBY)		~40°	N <sub>1-2</sub>	S									r	△	r			
<i>Cypraeolina cotamago</i> (YOKOYAMA)	27°~35°	~40°	N <sub>3</sub>	S				r							r			c
<i>Antiplanes contraria</i> (YOKOYAMA)	39°~44°	36°~44°	N <sub>2-3</sub>		a		c	c	a	r	c	r	r			r	c	c
<i>Rectiplanes sanctaioannis</i> (SMITH)	39°~44°	36°~42°	N <sub>2~B</sub>														r	
<i>Paradrillia inconstans</i> (SMITH)	~0°?~35°	~41°	N <sub>1-2</sub>	sM	c													
<i>P. dainichiensis</i> (YOKOYAMA)	30°?~35°	~41°	N <sub>2</sub>							c								
<i>Inquisitor</i> sp.					c					r			r		r			
<i>Suavodrillia declivis</i> (v. MARTENS)	34°~46°	36°~46°	N <sub>1-4</sub>		a	r	×			c	c	r		c	c	a		c
<i>Tomopleura</i> sp.					r	△					r							
<i>Propebela (Turritoma) yokoyamai</i> ONOYAMA			[N <sub>1</sub> ]	[S]	a	c	r	×		c	c	a	a	a	c	a		c
<i>P. (T.) turricula candida</i> (YOKOYAMA)	45°?	36°~45°																
<i>Ophioidermella ogurana</i> (YOKOYAMA)					a	c		r	a	c	a	c	c	c	c	a	r	c
<i>O. miyatensis</i> (YOKOYAMA)	39°~46°	35°~46°	N <sub>1</sub>	S	c	c				c	c	r	c	r	c	r		
<i>Granotoma dissoluta</i> (YOKOYAMA)	39°	41°			c	r	r	r	r	c	r					r		
<i>Guraleus tabatensis</i> (TOKUNAGA)	34°~	~37°	N <sub>1</sub>	S, M									c					
<i>G. sp. ?</i>										c	r			r	r			

<i>Pseudoetrema fortilirata</i> (SMITH)	31°~38°	~39°	N <sub>1-2</sub>	mS, sM	r						c	c	r	r				
<i>Nannodriella</i> sp. (n. sp. ?)					r						r	r△			c			
<i>Oenopota kagana</i> (YOKOYAMA)			[N]		c		r	r			c	r		r			r ×	
<i>O.</i> sp. ?							r				r	r						
<i>Terebra lischkeana</i> DUNKER	31°~39°	~38°	N <sub>1</sub>		c	r		r	r	r	r <sup>×</sup> △	r△	r ×	c	r		r	
<i>Menestho incisa</i> (YOKOYAMA)					r									r				
<i>M.</i> sp. (n. sp. ?)											r							
<i>Odostomia</i> sp. No. 1			[N]	[R, S]	c	r			c		c	c		c	c	r		
<i>O.</i> sp. No. 2			[N]	[R, S]	c				c	c	c				r			
<i>O.</i> sp. No. 3			[N]	[R, S]							r	r					r	
<i>O.</i> sp. No. 4			[N]	[R, S]								r						
<i>O.</i> sp. No. 5			[N]	[R, S]								r						
<i>Paracingulina triarata</i> (PILSBRY)	33°~39°	~37°	N <sub>1</sub>	S, M										c				
<i>Leucotina</i> sp. No. 1					r	r		c	r									
<i>L.</i> sp. No. 2									r		c				c			
<i>Actaeopyramis</i> sp.											r							
<i>Turbonilla</i> ( <i>Chemnitzia</i> ) <i>infantula</i> DALL et BARTSCH	38°	36°							r		r							
<i>T.</i> ( <i>Ptycheulimella</i> ) <i>inscitula</i> YOKOYAMA					a	c	a	r		c	c	c	c	c	c	r	c	
<i>T.</i> ( <i>P.</i> ) sp. No. 1			[N]	[R, S]	c			r		c	r		r	c	r		c	
<i>T.</i> ( <i>P.</i> ) sp. No. 2			[N]	[R, S]												r		
<i>T.</i> ( <i>Paramormula</i> ) <i>paucicostulata</i> TOKUNAGA	38°							r		r		r	r	r			r	
<i>T.</i> sp.			[N]	[R, S]								r						
<i>Pupa</i> sp.									r								r	



Table 2-4 (continued)

Specific Name	(1) Recent Geographic (Latitudinal) Distribution		(2) Bathy- metric Range	(3) Bottom Character	(4) Frequency of Occurrence and (5) State of Preservation													
	Pacific Coast	Japan Sea Coast			Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.		
					6	9	12	14	16	18	20	22	25	27	29	31	32	34
<i>Ringicula (Ringiculina) doliaris</i> GOULD	31°~42°	~42°	N <sub>1-2</sub>	M, S	a	r	r		a	a	a	c	a	c	a		r	c
<i>R. (R.) yokoyamai</i> TAKEYAMA	34°?				a	r			a	r	a	c	a	c	a			r
<i>Coleophysis (Sulcoretusa) minima</i> (YAMAKAWA)	33°~39°	~37°	N <sub>1-2</sub>	m S		r	c	r△		c	c	c	r	c	c	r		c
<i>Pyrumculus phialus</i> (A. ADAMS)	34°~43°	~40°	N <sub>1~B</sub>	m S			r			r				r	r			
<i>Rhizorus tokunagai</i> (MAKIYAMA)	31°~38°	~40°	N <sub>1-2</sub>	m S	r			r	r	a	a	r	c	c	a	r	r	r
<i>Adamnestia japonica</i> (A. ADAMS)	29°~35°	~35°	N <sub>1~B</sub>	S	c△	c	c	c△	c	a	c		c		a		r	
<i>Decorifer insignis</i> (PILSBRY)	33°		N <sub>0</sub>	S, M					r	r	c			r				
<i>D. sp.</i>									r									
<i>Philine argentata</i> GOULD	34°~42°	~42°	N <sub>1-2</sub>	M, S						r				r	r			
<i>Cavolina longirostris</i> (BLAINVILLE)			pelagic										c					
<i>C. uncinata</i> (d'ORBIGNY)			pelagic						r									
<i>Dentalium (Dentale) weinkauffi</i> DUNKER	31°~35°	~41°	N <sub>1-2</sub>	m S, M	c△	a					r			r△		a	r	
<i>Antalis rhabdotum</i> (PILSBRY)	31°~39°	~41°	N <sub>3~B</sub>		r△										c	a		r
<i>Entalinopsis nivosum</i> (KURODA et KIKUCHI)	31°~35°	~40°	N <sub>3~B</sub>		a△	r			r							c	r	
<i>Ennucula tenuis</i> (MONTAGU)		36°~46°	N <sub>1-3</sub>	m S			r○	a			c	r						c○
<i>E. niponica</i> (SMITH) var.	[33°~42°]	[~37°]	[N <sub>2-4</sub> ]		r	r○				r	r				r	a○	r	c○

<i>Acila (Truncacila) insignis</i> (GOULD)	32°~42°	32°~43°	N <sub>1-4</sub>	mS	a○	a○	c○	a	a○	a○	c○	a	a○	c	a	r	c○	a
<i>A. divaricata</i> (HINDS)	30°?~35°	35°~45°	N <sub>1-3</sub>	mS			r			c							c○	
<i>Nuculana robai</i> (KURODA)		36°~39°	N <sub>3-4</sub>	M														
<i>N. (Thestylea) yokoyamai</i> KURODA	33°~40°	32°~41°	N <sub>3~B</sub>	SM	r		r											r
<i>Saccella sematensis</i> (SUZUKI et ISHIZUKA)	31°~32°	32°~41°	N <sub>3~B</sub>	S						c							c	
<i>S. gordonis</i> (YOKOYAMA)	31°~35°	31°~36°	N <sub>2-4</sub>						r								a○	
<i>Yoldia (Cnesterium) notabilis</i> YOKOYAMA	32°~45°	32°~46°	N <sub>1-4</sub>	S	c	c○		c	a○	a○	c○	r×	a○	c	a	c	c	a
<i>Y. (C.) excavata</i> DALL		43°~46°						r	c	r								
<i>Arca miyatesis</i> OYAMA								r	c	r	c	r		r	c			c
<i>Acar plicata</i> (DILLWYN)	~0°~39°	~41°	N <sub>0-1</sub>	R													c	
<i>A. sp.</i>																	a	
<i>Pseudogrammatodon dalli</i> (SMITH)	34°~41°	~43°	N <sub>1</sub>	R, S, M													r×	
<i>Anadara amacula</i> (YOKOYAMA)								c	a○	va○	r×		a○	a		c	a	c
<i>A. (Scapharca) satowi ommaensis</i> OTUKA																	r	
<i>Glycymeris yessoensis</i> (SOWERBY)	34°~44°	34°?~46°	N <sub>1-2</sub>	S	c×	va○	r	a	c×	c	a○	va	a○	a○	a	a	a	a
<i>G. nipponicus</i> (YOKOYAMA)		40°	N <sub>3-4</sub>	S			a				r						r○	
<i>Limopsis (Pectunculina) crenata</i> A. ADAMS	31°~41°	~42°	N <sub>2~B</sub>	S, mS, sM	a○	c	a		r		r×	r×					a○	a
<i>L. obliqua</i> A. ADAMS	35°		N <sub>3-4</sub>	S	r	r	a		r		r×						r	r
<i>Aspalima (Nipponolimopsis) decussata</i> (A. ADAMS)		41°	N <sub>2~B</sub>														c	
<i>Solamen diaphana</i> (DALL)	35°~36°	~41°	N <sub>2-4</sub>	mS, sM	r	r○	a			a							r	r
<i>Crenella</i> sp. No. 1											r							
<i>C. sp. No. 2</i> (n. sp. ?)										c	r	r	c				r	c
<i>Modiolus difficilis</i> KURODA et HABE	35°~51°	~47°	N <sub>1</sub>	R	r○	r	a	a○	a○	c○	r	c	r	c	r	c	r	c△
																	c×	c



<i>Astarte (Tridonta) borealis</i> (SCHUMACHER)	35°~45°	35°~46°	N <sub>1-3</sub>	S, M			c							r x									
<i>A. (T.) bennetti</i> DALL	38°~	~46°	N <sub>3-4</sub>				c																
<i>Venericardia (Megacardia) kiiensis</i> <i>cipangoana</i> YOKOYAMA	[31°~35°]	[~41°]	[N <sub>2-4</sub> ]	[S]				c	r	c	○	a x	r x	c x	r		r						
<i>V. (Cyclocardia) ferruginea</i> CLESSIN	33°~42°	32°~42°	N <sub>3~B</sub>	S			a	c	a	a	c	c	c	c	c	c	c						
<i>V. (Miodontiscus) prolongata</i> <i>nakamurai</i> (YOKOYAMA)		41°?~59°	N <sub>2-4</sub>				a	○	c			r	c	r	r x	r x							
<i>Joannisiella cumingi</i> (HANLEY)	23°~35°	~41°	N <sub>1-2</sub>	S, M												r	○	c	○	r			
<i>Felaniella usta</i> (GOULD)	33°~45°	37°~46°	N <sub>1</sub>	S			a	○	a	○	r		a	○	c	a	○	r	c	c	c		
<i>Thyasira tokunagai</i> KURODA et HABE	35°~64°												c	r							r	r	
<i>Axinopsida subquadrata</i> (A. ADAMS)	39°~42°	36°~?	N <sub>1-2</sub>	sM			r	r	c	c	r	a	c		c	c	c					c	
<i>Lucinoma annulata</i> (REEVE)	31°~41°	~41°	N <sub>1</sub>	sM			r	r	○			r	○	c	r		c	○		c			
<i>Alucinoma crassiuscula</i> (YOKOYAMA)		37°					r	r	r					r		c	○		r	r			
<i>A. sp. ?</i>														r	r	r	r						
<i>Pillucina sp.</i>														r									
<i>Pillucina (Wallucina) lamyi</i> (CHAVAN)	31°~35°	~37°	N <sub>1-4</sub>																				
<i>Bellucina civica</i> (YOKOYAMA)	32°~36°	~36°	N <sub>3-4</sub>				a								r	x	△				a	r	
<i>Nemocardium (Keenaea) samarangae</i> (MAKIYAMA)	32°~36°	32°~41°	N <sub>2</sub>	mS, S, sM			r	x		a	r	r	x		r							r	
<i>Clinocardium shinjiense</i> (YOKOYAMA)									c	○	r	r	r	c		r							
<i>Cl. fastosum</i> (YOKOYAMA)			[N <sub>2-4</sub> ]	[S]			a	○	a	○	c	c	c	a	○	c	c	c	c	r	c	a	a x
<i>Fulvia sp.</i>							r	c						a	a	a	a	a	a	r			c
<i>Pitar (Costellipitar) chordata</i> (RÖMER) ?	[12°?~34°]	[~41°]	[N <sub>1-4</sub> ]	[m S]			r								r								r
<i>Callista chinensis</i> (HOLTEN)	23°~39°	~40°	[N <sub>1</sub> ]	[S]											c		r	○		c	○	c	○
<i>Saxidomus purpuratus</i> (SOWERBY)	32°~42°	~43°	N <sub>1</sub>	G, M																			r
<i>Dosinia (Dosinella) angulosa</i> (PHILIPPI)	14°~41°	~41°	N <sub>1</sub>	M, S			a							a	○	a	○	a	○	a			r



<i>Macoma calcarea</i> (GMELIN)	33°~72°	32°~46°	N <sub>1</sub> ~B	sM	r	c	○	a	○	r	c	○		r	c	r	○		c		a					
<i>M. middendorffi</i> DALL		41°~65°		mS		r	×																			
<i>M. praetexta</i> (v. MARTENS)	23°~35°	~43°	N <sub>1</sub>							r						r										
<i>M. nipponica</i> (TOKUNAGA)	33°~42°	32°~42°	N <sub>1-3</sub>	mS	r	c					c	a						a	c							
<i>M. anser</i> OYAMA			N <sub>0-1</sub>																							
<i>M. (Rexithaerus) sector</i> OYAMA	23°~41°	~46°	N <sub>1</sub>	S, M	c	△	a	○	r	a	○	a	○	a	○	a	a	c	○	a	○	a	○	c	c	c
<i>M. sp. No. 1</i>																										
<i>M. sp. No. 2</i>																										
<i>Heteromacoma yantaiensis</i> (CROSSE et DEBEAUX)	30°~43°	~43°	N <sub>0</sub>	R																						
<i>Fabulina nitidula</i> (DUNKER)	~0°~35°	~41°	N <sub>1-2</sub>	mS, S						r	c	c	c	○	c	c	a	○	c			c	c			
<i>Peronidia lutea</i> (WOOD)	39°~72°	40°~46°	N <sub>1-2</sub>	mS	r	a	○	r	a	○	a	○	c	c	a	c	○	a	a	c		c	c	a	○	
<i>Siliqua pulchella</i> (DUNKER)	31°~39°	~40°	N <sub>1</sub>	S		r	×																			
<i>S. alta</i> (BRODERIP et SOWERBY)	42°~48°	42°~46°	N <sub>1</sub>	S		r	○		r	r	○															
<i>Solen krusensternii</i> SCHRENCK	34°~45°	33°~46°	N <sub>1</sub>	mS	r	c	○			r	○	r			c	r	a	○	a							
<i>Hiatella orientalis</i> (YOKOYAMA)	25°~41°		N <sub>1</sub>	R					r	c						r			r							
<i>Panope japonica</i> A. ADAMS	34°~43°	~46°	N <sub>1</sub>	mS		r	r		a	○	a	○	c	c			c	○	a		r					
<i>Anisocorbula modesta</i> (GOULD)	31°~42°	~43°	N <sub>0-4</sub>	S															r							
<i>Cryptomya busoensis</i> YOKOYAMA	34°~43°	35°~42°	N <sub>1-2</sub>	sM		c	c	a	○	c	a	c	c	c	r	r	c							a	○	
<i>Mya (Arenomya) japonica</i> JAY	31°~72°	~46°	N <sub>0-1</sub>	mS, sM							c	○	a											r		
<i>M. cuneiformis</i> (BöHM)																										
<i>Zirfaea subconstricta</i> (YOKOYAMA)	25°~35°	~39°	N <sub>0</sub>	R																						
<i>Pandora pulchella</i> YOKOYAMA						r	×	a	○			c	○	r	×	△	a	c	a	○	c	c	r	×		
<i>P. (Kennerlia) pseudobilirata</i> NOMURA et HATAI		33°~41°	N <sub>1-4</sub>										r	×												
<i>Myadora japonica</i> HABE	34°~41°	35°~41°	N <sub>1-4</sub>	S, M	c	r	c	c	c				r	c	c					a				c		
<i>Thracia kakumana</i> (YOKOYAMA)	43°	40°~46°	N <sub>1</sub>	sM		r	×		a	○	c			c	c				r					c		
<i>Cuspidaria</i> sp. (n. sp. ?)						r													r	r	r					
<i>Cardiomya gouldiana septentrionalis</i> (KURODA)	31°~34°	~41°	N <sub>1-4</sub>	S										r												

Some shell beds showing extremely gregarious occurrence are composed of broken shells of various species together with strongly worn large shells and rather fresh and perfect shells of small forms. Sometimes, scattered shells of various species showing random orientation and excellent preservation are known. Rarely, a pelecypod shell standing vertically appearing as the living state is found, but there is no proof to consider it as an autochthonous condition.

As a whole, all fossil shells in the Omma formation are more or less removed after death and transported from the habitat before entombment, some being strongly worn or crushed owing to the long duration of drift after death.

For 14 localities of the Pliocene shells around Kanazawa city, both the frequency of occurrence and the state of preservation of each molluscan species are tabulated in Table 2. Some distinguished features of the occurrence in each locality are briefly noted in the following lines :

- Loc. 1, 2 and 3. shells sparsely scattered; *Turritella saishuensis* and *Clinocardium fastosum* are dominant.
- Loc. 4. shell bed is about 5 cm thick; *Turritella saishuensis*, *Clinocardium fastosum* and *Peronidia lutea* are dominant.
- Loc. 6. dominant species is *Turritella saishuensis*.
- Loc. 9. several shell beds are discriminated; one bed is pebbly and dominant in *Peronidia lutea*; another bed is principally composed of closed valves of *Glycymeris yessoensis*; rich faunal content is similar to those of Loc. 7 and 8.
- Loc. 10. especially dominant in *Turritella saishuensis*.
- Loc. 12. inserted with thin layer of fine tuff; *Anadara amicula* is dominant; similar to Loc. 13 and 14.
- Loc. 16. shell bed is 10~20 cm thick; partly pebbly.
- Loc. 18. several shell beds along the Asano-gawa; on the river floor under the bridge (Kami-tagami-bashi) crowded layer of *Turritella saishuensis* is found.
- Loc. 19. similar to Loc. 18.
- Loc. 20. gregarious occurrence of various species in well-preserved conditions; inserted with thin layer of fine tuff.
- Loc. 21. dominant species are *Anadara amicula*, *Glycymeris yessoensis* and *Peronidia lutea*; shells are crowded to form a layer.
- Loc. 22, 23, 24, 25, 26, and 27. shells crowded to form a layer; the occurrence resembles each other.
- Loc. 28. dominant in *Anadara amicula*.
- Loc. 29. scattered shells are found between two crowded layers.
- Loc. 31. inserted with tuff layer; crowded or sparsely scattered.

Loc. 32. scattered shells; excellent preservation.

Loc. 33. crowded to form a layer; similar species with Loc. 34.

Loc. 34. inserted with tuff layer; *Anadara amicula* is dominant.

Loc. 35. and 36. scattered occurrence; *Clinocardium fastosum* is dominant.

Other than the molluscan shells mentioned above, trace fossils bored into the pre-Omma basement rocks are found on the unconformable surface at several locations between Chôshi and Asagaya along the River Asano-gawa (KASENO and MATSUURA, 1964). The detailed occurrence and significance of the trace fossils are not repeated here, but they undoubtedly indicate the sedimentary conditions of the Loc. 20, 21, 22, 23, 24, 25, 26, 27, 28, and 29.

### The Omma Molluscan Fauna

*Taxonomic Composition* The systematic list of the fossil molluscs occurred in the Omma formation around Kanazawa city is given in Table 3. Detailed description of each species and specimen are omitted in the present article, and only the photographs are shown in PLATE I ~ XIX. All figured specimens are registered (GKZ 70001 to GKZ 70283), and now preserved in the Geological Institute, Faculty of Science, Kanazawa University.

The systematic list given in Table 3 contains many uncertain or indetermined species, and some of them may be corrected or be established as new species in the future. Table 4 shows the taxonomic composition of the Omma molluscan fauna as a whole. It is composed of 69 families, 160 genera and 237 species in total. Among them, 178 species can be specifically identified now, although 59 species are still remained uncertain.

Table 4. Taxonomic composition of the Omma molluscan fauna in the vicinity of Kanazawa city.

	Number of Families	Number of Genera	Number of Species			
			Indetermined	Recent	Extinct	Total
Gastropoda	39	88	44	64	19	127
Scaphopoda	2	3	0	3	0	3
Pelecypoda	28	69	15	82	10	107
Total	69	160	59	149	29	237

*Water Temperature* Among the Recent species constituting the Omma molluscan fauna, the species living in the warm current are rather rare in number. As the abundant and common species found in the Omma fauna, the species of the warm current or Japonic-Kuroshio type are scarce, except for *Tugurium exutum*, *Adamnestia*



Table 3 Systematic List of Fossil Shells from the Omma Sandstone Formation around Kanazawa City, Ishikawa Prefecture, Japan.

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**GASTROPODA**

Haliotidae	<i>Haliotis (Euhaliotis) gigantea</i> GMELIN	Plate I, Fig. 1.
Fissurellidae	<i>Puncturella nobilis</i> A. ADAMS	Plate VI, Fig. 1.
	<i>P. fastigiata</i> A. ADAMS	Plate VI, Fig. 2.
	<i>P.</i> sp. No. 1	Plate I, Fig. 2.
	<i>P.</i> sp. No. 2	Plate VI, Fig. 3.
Acmaeidae	<i>Collisella</i> sp.	Plate I, Fig. 3.
	<i>Acmaea (Niveotectura) pallida</i> (GOULD)	Plate V, Fig. 33.
Lepetidae	<i>Lepeta</i> sp.	Plate I, Fig. 4.
Trochidae	<i>Machaeroplax</i> sp. No. 1	Plate I, Fig. 5.
	<i>M.</i> sp. No. 2	Plate V, Fig. 32.
	<i>Turcica</i> sp.	Plate I, Fig. 6.
	<i>Minolia pseudobscura</i> (YOKOYAMA)	Plate I, Fig. 7.
	<i>Solariella</i> sp.	Plate I, Fig. 8.
	<i>Tristichotrochus multiliratus</i> (SOWERBY)	Plate I, Fig. 9.
	<i>Lirularia</i> sp.	Plate I, Fig. 10.
	<i>Umbonium (Suchium) akitanum</i> SUZUKI	Plate I, Figs. 11, 12.
	Skeneidae	<i>Starkeyna sobrina</i> (A. ADAMS)
Turbinidae	<i>Homalopoma amussitatum</i> (GOULD)	Plate I, Fig. 15.
Phenacolepadidae	<i>Plesiothyreus</i> sp.	Plate III, Fig. 15.
Cocculinidae	<i>Cocculina</i> sp.	Plate I, Fig. 16.
Rissoidae	<i>Putilla</i> sp.	Plate I, Fig. 17.
	<i>Alvania (Arsema) akibai</i> YOKOYAMA	Plate I, Fig. 18.
	<i>A. asura</i> (YOKOYAMA)	Plate I, Fig. 19.
Turritellidae	<i>Turritella saishuensis</i> YOKOYAMA	Plate I, Fig. 20.
	<i>T. (Neohaustator) andenensis</i> OTUKA var.	Plate I, Fig. 21.
Vermetidae	<i>Macrophragma tokyoensis</i> (PILSBRY)	Plate IV, Fig. 21.
Cerithiidae	<i>Tachyrhynchus venustellus</i> (YOKOYAMA)	Plate II, Fig. 1.
	<i>T. tuberculosus</i> (YOKOYAMA)	Plate II, Fig. 2.
	<i>Bittium (Stylidium) horinjiense</i> OINOMIKADO et IKEBE	Plate II, Fig. 3.
	<i>B.</i> sp. No. 1	Plate II, Fig. 4.
	<i>B.</i> sp. No. 2	Plate IV, Fig. 20.
	<i>B.</i> sp. No. 3	Plate VI, Fig. 4.
	Architectonicidae	<i>Heliacus</i> sp.
Epitoniidae	<i>Nodiscala</i> sp. (n. sp. ?)	Plate II, Fig. 7.
	<i>Amaea</i> sp.	Plate II, Fig. 5.
	<i>Epitonium (Depressiscala) auritum</i> (SOWERBY)	Plate V, Fig. 24.
	<i>E. (Boreoscala) yabei echigonum</i> KANEHARA	Plate II, Fig. 6.

Eulimidae	<i>Eulina</i> sp.		
	<i>Balcis</i> sp.	Plate II,	Fig. 8.
	<i>Niso dorcas</i> (KURODA et HABE) var.	Plate II,	Fig. 9.
Naticidae	<i>Lunatia pila</i> (PILSBRY)	Plate II,	Fig. 29.
	<i>Mammilla yokoyamai</i> MAKINO (MS)	Plate II,	Fig. 30.
	<i>M.</i> sp.	Plate II,	Fig. 31.
	<i>Neverita</i> ( <i>Glossaulax</i> ) <i>reiniana</i> (DUNKER)	Plate II,	Figs. 32, 33.
	<i>Tectonatica janthostomoides</i> (KURODA et HABE)	Plate II,	Figs. 34, 35.
Hipponicidae	<i>Mallwium otohimeae</i> HABE ?	Plate III,	Fig. 19.
Calyptraeidae	<i>Crepipatella lingulata</i> (GOULD)	Plate V,	Fig. 34.
Xenophoridae	<i>Tugurium exutum</i> (REEVE)	Plate II,	Fig. 10.
Cassididae	<i>Semicassis minor</i> (KÜSTER)	Plate III,	Figs. 1, 2.
Muricidae	<i>Ceratostoma</i> ( <i>Ocenebra</i> ) <i>japonica</i> (DUNKER)	Plate III,	Figs. 6, 7, 8.
	<i>Trophonopsis kagaensis</i> HATAI et NISIYAMA	Plate III,	Fig. 3.
	<i>T.</i> ( <i>Boretrophon</i> ) <i>candelabrum</i> (REEVE)	Plate III,	Fig. 4.
	<i>T.</i> ( <i>B.</i> ) <i>nipponicus</i> (YOKOYAMA)	Plate III,	Fig. 5.
Columbellidae	<i>Mitrella bicincta</i> (GOULD)	Plate III,	Fig. 18.
	<i>M.</i> sp.	Plate III,	Figs. 11, 12.
	<i>Indomitrella lischkei</i> SMITH	Plate III,	Fig. 9.
	<i>I. tokyoensis</i> (YOKOYAMA)	Plate III,	Fig. 10.
Nassariidae	<i>Nassarius</i> ( <i>Zeuxis</i> ) <i>caelatus</i> (A. ADAMS)	Plate IV,	Fig. 6.
	<i>Tritia luteola</i> (SMITH) var.	Plate IV,	Figs. 7, 8.
Buccinidae	<i>Neptunea</i> ( <i>Barbitonia</i> ) <i>arthritica</i> (BERNARDI)	Plate III,	Fig. 13.
	<i>Siphonalia cassidariaeformis</i> (REEVE) var.	Plate III,	Fig. 14.
	<i>S. spadicea</i> (REEVE)	Plate III,	Fig. 16.
	<i>S. fusoides</i> (REEVE)	Plate III,	Fig. 17.
	<i>Nassaria</i> sp. (n. sp. ?)	Plate VI,	Fig. 5.
	<i>Searlesia japonica</i> YOKOYAMA	Plate IV,	Fig. 1.
	<i>Babylonia elata</i> (YOKOYAMA)	Plate IV,	Fig. 2.
	<i>Plicifusus ozawai</i> (YOKOYAMA)	Plate IV,	Figs. 3, 4.
	<i>Otomella</i> sp. (n. sp. ?)	Plate IV,	Fig. 5.
Fascioliariidae	<i>Fusinus perplexus</i> (A. ADAMS)	Plate IV,	Fig. 9.
Olividae	<i>Olivella spretoides</i> YOKOYAMA	Plate IV,	Fig. 10.
	<i>Oliva mustelina</i> LAMARCK	Plate IV,	Fig. 11.
Volutidae	<i>Fulgoraria masudae</i> HAYASAKA	Plate IV,	Figs. 12, 13.
Cancellariidae	<i>Cancellaria</i> ( <i>Merica</i> ) <i>kobayashii</i> (YOKOYAMA)	Plate IV,	Fig. 14.
	<i>C. japonica lischkei</i> (YOKOYAMA)	Plate IV,	Fig. 22.
	<i>Sydaphera spengleriana</i> (DESHAYES)	Plate IV,	Figs. 15, 16.
	<i>Admete murayamai</i> (YOKOYAMA)	Plate IV,	Fig. 17.
	<i>A.</i> sp.	Plate IV,	Fig. 18.
	<i>Narona</i> ( <i>Solatia</i> ) <i>nodulifera</i> (SOWERBY)	Plate IV,	Fig. 19.
Marginellidae	<i>Cypraolina cotamago</i> (YOKOYAMA)	Plate VI,	Fig. 7.
Turridae	<i>Antiplanes contraria</i> (YOKOYAMA)	Plate V,	Fig. 1.

	<i>Rectiplanes sanctaioannis</i> (SMITH)	Plate V,	Fig. 2.
	<i>Paradrillia inconstans</i> (SMITH)	Plate V,	Fig. 3.
	<i>P. dainichiensis</i> (YOKOYAMA)	Plate V,	Fig. 4.
	<i>Inquisitor</i> sp.	Plate V,	Fig. 5.
	<i>Suavodrillia declivis</i> (v. MARTENS)	Plate V,	Fig. 6.
	<i>Tomopleura</i> sp.	Plate V,	Fig. 7.
	<i>Propebela (Turritoma) yokoyamai</i> ONOYAMA	Plate V,	Fig. 8.
	<i>P. (T.) turricula candita</i> (YOKOYAMA)	Plate V,	Fig. 9.
	<i>Ophiodermella ogurana</i> (YOKOYAMA)	Plate V,	Fig. 10.
	<i>O. miyatensis</i> (YOKOYAMA)	Plate V,	Fig. 12.
	<i>Granotoma dissoluta</i> (YOKOYAMA)	Plate V,	Fig. 11.
	<i>Guraleus tabatensis</i> (TOKUNAGA)	Plate V,	Fig. 13.
	<i>G.</i> sp. ?	Plate V,	Fig. 14.
	<i>Pseudoetrema fortilirata</i> (SMITH)	Plate V,	Fig. 15.
	<i>Nannodriella</i> sp. (n. sp. ?)	Plate V,	Fig. 16.
	<i>Oenopota kagana</i> (YOKOYAMA)	Plate V,	Fig. 17.
	<i>O.</i> sp. ?	Plate V,	Fig. 18.
Terebridae	<i>Terebra lischkeana</i> DUNKER	Plate V,	Fig. 19.
Pyramidellidae	<i>Menestho incisa</i> (YOKOYAMA)	Plate II,	Fig. 11.
	<i>M.</i> sp. (n. sp. ?)	Plate II,	Fig. 12.
	<i>Odostomia</i> sp. No. 1	Plate II,	Fig. 13.
	<i>O.</i> sp. No. 2	Plate II,	Fig. 14.
	<i>O.</i> sp. No. 3	Plate II,	Fig. 15.
	<i>O.</i> sp. No. 4	Plate II,	Fig. 16.
	<i>O.</i> sp. No. 5	Plate II,	Fig. 17.
	<i>Paracingulina triarata</i> (PILSBRY)	Plate II,	Fig. 18.
	<i>Leucotina</i> sp. No. 1	Plate II,	Fig. 19.
	<i>L.</i> sp. No. 2	Plate II,	Fig. 20.
	<i>Actaeopyramis</i> sp.	Plate II,	Fig. 21.
	<i>Turbonilla (Chemnitzia) infantura</i> DALL et BARTSCH	Plate II,	Fig. 26.
	<i>T. (Ptycheulimella) inscitula</i> YOKOYAMA	Plate II,	Figs. 22, 23.
	<i>T. (P.)</i> sp. No. 1	Plate II,	Fig. 24.
	<i>T. (P.)</i> sp. No. 2	Plate II,	Fig. 28.
	<i>T. (Paramormula) paucicostulata</i> TOKUNAGA	Plate II,	Fig. 25.
	<i>T.</i> sp.	Plate II,	Fig. 27.
Acteonidae	<i>Pupa</i> sp.	Plate V,	Fig. 20.
Ringiculidae	<i>Ringicula (Ringiculina) doliaris</i> GOULD	Plate V,	Figs. 21, 22.
	<i>R. (R.) yokoyamai</i> TAKEYAMA	Plate V,	Fig. 23.
Retusidae	<i>Coleophysis (Sulcoretusa) minima</i> (YAMAKAWA)	Plate V,	Fig. 25.
	<i>Pyrunculus phialus</i> (A. ADAMS)	Plate VI,	Fig. 6.
	<i>Rhizorus tokunagai</i> (MAKIYAMA)	Plate V,	Fig. 26.
Scaphanderidae	<i>Adamnestia japonica</i> (A. ADAMS)	Plate V,	Fig. 27.

	<i>Decorifer insignis</i> (PILSBRY)	Plate V,	Fig. 28.
	<i>D.</i> sp.	Plate V,	Fig. 29.
Philinidae	<i>Philine argentata</i> GOULD	Plate V,	Fig. 31.
Cavolinidae	<i>Cavolina longirostris</i> (BLAINVILLE)	Plate V,	Fig. 30.
	<i>C. uncinata</i> (d'ORBIGNY)	Plate VI,	Fig. 8.

## SCAPHOPODA

Dentaliidae	<i>Dentalium (Dentale) weinkauffi</i> DUNKER	Plate VII,	Fig. 1.
	<i>Antalis rhabdotum</i> (PILSBRY)	Plate VII,	Fig. 2.
Siphonodentaliidae	<i>Entalinopsis nivosum</i> (KURODA et KIKUCHI)	Plate VII,	Figs. 3, 4.

## PELECYPODA

Nuculidae	<i>Ennucula tenuis</i> (MONTAGU)	Plate VII,	Fig. 5.
	<i>E. niponica</i> (SMITH) var.	Plate VII,	Fig. 6.
	<i>Acila (Truncacila) insignis</i> (GOULD)	Plate VII,	Fig. 7.
	<i>A. divaricata</i> (HINDS)	Plate VII,	Fig. 8.
Nuculanidae	<i>Nuculana robai</i> (KURODA)	Plate VII,	Fig. 9.
	<i>N. (Thestylea) yokoyamai</i> KURODA	Plate VII,	Fig. 10.
	<i>Saccella sematensis</i> (SUZUKI et ISHIZUKA)	Plate VII,	Fig. 13.
	<i>S. gordonis</i> (YOKOYAMA)	Plate VII,	Fig. 14.
	<i>Yoldia (Cnesterium) notabilis</i> YOKOYAMA	Plate VII,	Fig. 11.
	<i>Y. (C.) excavata</i> DALL	Plate VII,	Fig. 12.
Arcidae	<i>Arca miyatsensis</i> OYAMA	Plate VII,	Fig. 15.
	<i>Acar plicata</i> (DILLWYN)	Plate VI,	Fig. 9.
	<i>A.</i> sp.	Plate VI,	Figs. 10, 11.
	<i>Pseudogrammatodon dalli</i> (SMITH)	Plate VI,	Fig. 12.
	<i>Anadara amicula</i> (YOKOYAMA)	Plate VII,	Figs. 16, 17.
	<i>A. (Scapharca) satowi ommaensis</i> OTUKA	Plate VII,	Fig. 19.
Glycymeridae	<i>Glycymeris yessoensis</i> (SOWERBY)	Plate VI,	Fig. 16.
	<i>G. nipponicus</i> (YOKOYAMA)	Plate VI,	Fig. 17.
Limopsidae	<i>Limopsis (Pectunculina) crenata</i> A. ADAMS	Plate VI,	Fig. 13.
	<i>L. obliqua</i> A. ADAMS	Plate VI,	Fig. 14.
	<i>Aspalima (Niponolimopsis) decussata</i> (A. ADAMS)	Plate VI,	Fig. 15.
Mytilidae	<i>Solamen diaphana</i> (DALL)	Plate XIX,	Fig. 17.
	<i>Crenella</i> sp. No. 1	Plate VII,	Fig. 18.
	<i>C.</i> sp. No. 2. (n. sp. ?)	Plate XIX,	Fig. 18.
	<i>Modiolus difficilis</i> KURODA et HABE	Plate VI,	Fig. 18.
	<i>M. (Modiolusia) sirahensis</i> (JOUSSEAUME) var.	Plate VI,	Fig. 19.
Pectinidae	<i>Chlamys nipponensis</i> KURODA	Plate VI,	Figs. 21, 22.
	<i>Ch. swifti</i> (BERNARDI)	Plate VI,	Fig. 23.
	<i>Ch. cosibensis</i> (YOKOYAMA)	Plate VI,	Fig. 20.

	<i>Pecten (Notovola) albicans</i> (SCHRÖTER)	Plate VIII, Figs. 1, 2, 3, 4.
	<i>P. (N. ) puncticulatus</i> DUNKER var.	Plate VIII, Fig. 5.
	<i>Painopecten yessoensis</i> (JAY)	
	Plate X, Fig. 1; Plate XI, Fig. 1; Plate XII, Fig. 1; Plate XIII, Fig. 1.	
	<i>P. tokyoensis hokurikuensis</i> AKIYAMA	Plate IX, Figs. 1, 2.
	<i>P. kurosawensis</i> (YOKOYAMA)	Plate VIII, Fig. 6; Plate IX, Fig. 3.
Limidae	<i>Limatula kurodai</i> OYAMA	Plate IX, Fig. 4.
	<i>Lima sowerbyi nipponica</i> OYAMA	Plate XI, Fig. 5; Plate XVIII, Fig. 4.
	<i>Mantellum hakodatense</i> (TOKUNAGA)	Plate XI, Fig. 7.
Anomiidae	<i>Anomia cytaeum</i> GRAY	Plate VIII, Fig. 7.
	<i>Monia umbonata</i> (GOULD)	Plate X, Figs. 2, 3.
Ostreidae	<i>Ostrea (Crassostrea) gigas</i> THUNBERG	Plate XII, Fig. 2.
	<i>Notostrea musashina</i> (YOKOYAMA)	Plate XII, Fig. 3.
Astartidae	<i>Astarte (Tridonta) borealis</i> (SCHUMACHER)	Plate VIII, Figs. 8, 9.
	<i>A. (T.) bennetti</i> DALL	Plate VIII, Fig. 10.
Carditidae	<i>Venericardia (Megacardia) kiiensis cipangoana</i> YOKOYAMA	Plate XI, Fig. 2.
	<i>V. (Cyclocardia) ferruginea</i> CLESSIN	Plate XI, Figs. 3, 4.
	<i>V. (Miodontiscus) prolongata nakamurai</i> (YOKOYAMA)	Plate XI, Fig. 6.
Diplodontidae	<i>Joannisiella cumingi</i> (HANLEY)	Plate XI, Fig. 8; Plate XIX, Fig. 15.
	<i>Felaniella usta</i> (GOULD)	Plate XI, Fig. 9.
Thyasiridae	<i>Thyasira tokunagai</i> KURODA et HABE	Plate XIII, Fig. 2.
	<i>Axinopsida subquadrata</i> (A. ADAMS)	Plate XIII, Fig. 4.
Lucinidae	<i>Lucinoma annulata</i> (REEVE)	Plate XIII, Fig. 5.
	<i>Alucinoma crassiuscula</i> (YOKOYAMA)	Plate XIII, Fig. 6.
	<i>A. sp. ?</i>	Plate XIII, Fig. 7.
	<i>Pillucina</i> sp.	Plate VI, Fig. 24.
	<i>Pillucina (Wallucina) lamyi</i> (CHAVAN)	Plate XIII, Fig. 3.
	<i>Bellucina civica</i> (YOKOYAMA)	Plate XIII, Fig. 8.
Cardiidae	<i>Nemocardium (Keenaea) samarangae</i> (MAKIYAMA)	Plate XIII, Fig. 9.
	<i>Clinocardium shinjiense</i> (YOKOYAMA)	Plate XIII, Fig. 10.
	<i>Cl. fastosum</i> (YOKOYAMA)	Plate XIII, Fig. 11.
	<i>Fulvia</i> sp.	Plate XIII, Fig. 12.
Veneridae	<i>Pitar (Costellipitar) chordata</i> (RÖMER) ?	Plate XIV, Fig. 1.
	<i>Callista chinensis</i> (HOLTEN)	Plate XIV, Fig. 2.
	<i>Saxidomus purpuratus</i> (SOWERBY)	Plate XIX, Fig. 14.
	<i>Dosinia (Dosinella) angulosa</i> (PHILIPPI)	Plate XV, Fig. 1.
	<i>D. (Phacosoma) japonica</i> (REEVE)	Plate XV, Fig. 2.
	<i>Mercenaria simpsoni</i> (GOULD)	Plate XIV, Figs. 3, 4.
	<i>M. yokoyamai</i> (MAKIYAMA)	Plate XIV, Figs. 5, 6, 7.
	<i>Veremolpa</i> sp.	Plate XIV, Figs. 8, 9.

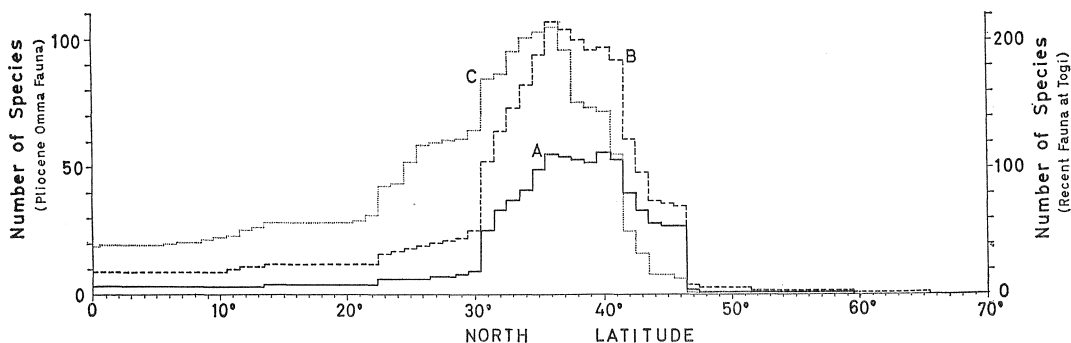
	<i>Callithaca (Protocallithaca) adamsi</i> (REEVE)	Plate XV, Figs. 3, 4.
	<i>C. (P.) adamsi</i> (REEVE) var.	Plate XV, Fig. 5.
	<i>Pseudamiantis tauyensis</i> (YOKOYAMA)	Plate XVI, Figs. 1, 2, 3.
	<i>P. sp.</i> (n. sp. ?)	Plate XVI, Fig. 4.
	<i>Liocyma aniwana</i> DALL	Plate XIV, Fig. 10.
	<i>L. sp.</i>	Plate XIV, Fig. 11.
	<i>Gemma sp. ?</i>	Plate XIV, Fig. 12.
	<i>Paphia amabilis</i> (PHILIPPI)	Plate XV, Fig. 6.
	<i>Clementia vaiheletti</i> MABILLE	Plate XVI, Figs. 5, 6.
Mactridae	<i>Spisula (Mactromeris) voyi</i> (GABB)	Plate XVII, Fig. 3.
	<i>S. sp.</i>	Plate XVII, Fig. 1.
	<i>Mactra sp.</i>	Plate XVII, Fig. 2.
Tellinidae	<i>Macoma calcarea</i> (GMELIN)	Plate XVII, Figs. 4, 5, 7, 9.
	<i>M. middendorffi</i> DALL	Plate XVII, Fig. 6.
	<i>M. praetexta</i> (v. MARTENS)	Plate XVIII, Fig. 5.
	<i>M. nipponica</i> (TOKUNAGA)	Plate XVII, Fig. 12.
	<i>M. anser</i> OYAMA	Plate XVIII, Fig. 2.
	<i>M. (Rexilhaerus) sector</i> OYAMA	Plate XVII, Figs. 10, 11.
	<i>M. sp. No. 1</i>	Plate XVII, Fig. 13.
	<i>M. sp. No. 2</i>	Plate XVII, Fig. 8.
	<i>Heteromacoma yantaiensis</i> (CROSSE et DEBEAUX)	Plate XVIII, Fig. 1.
	<i>Fabulina nitidula</i> (DUNKER)	Plate XVIII, Fig. 3.
	<i>Peronidia lutea</i> (WOOD)	Plate XVIII, Fig. 6.
Solenidae	<i>Siliqua pulchella</i> (DUNKER)	Plate XVIII, Fig. 7.
	<i>S. alta</i> (BRODERIP et SOWERBY)	Plate XVIII, Fig. 8.
	<i>Solen krusensternii</i> SCHRENCK	Plate XVIII, Fig. 9.
Hiatellidae	<i>Hiatella orientalis</i> (YOKOYAMA)	Plate XVIII, Fig. 10.
	<i>Panope japonica</i> A. ADAMS	Plate XVIII, Figs. 11, 12.
Corbulidae	<i>Anisocorbula modesta</i> (GOULD)	Plate XIX, Fig. 20.
Myidae	<i>Cryptomya busoensis</i> YOKOYAMA	Plate XIX, Fig. 1.
	<i>Mya (Arenomya) japonica</i> JAY	Plate XIX, Figs. 2, 3,
	<i>M. cuneiformis</i> (BÖHM)	Plate XIX, Fig. 4.
Pholadidae	<i>Zirfaea subconstricta</i> (YOKOYAMA)	
Pandoridae	<i>Pandora pulchella</i> YOKOYAMA	Plate XIX, Figs. 9, 10.
	<i>P. (Kimmerlia) pseudobilirata</i> NOMURA et HATAI	Plate XIX, Fig. 11.
Myochamidae	<i>Myadora japonica</i> HABE	Plate XIX, Figs. 5, 6, 7, 8.
Thracidae	<i>Thracia kakumana</i> (YOKOYAMA)	Plate XIX, Fig. 12.
Cuspidariidae	<i>Cuspidaria sp.</i> (n. sp. ?)	Plate XIX, Fig. 13.
	<i>Cardiomya gouldiana septentrionalis</i> (KURODA)	Plate XIX, Fig. 16.

*japonica*, *Bellucina civica* and *Paphia amabilis*. The warm current species such as *Macrophragma tokyoensis*, *Oliva mustelina*, *Paradrillia inconstans*, *Saccella gordonis*, *Lima sowerbyi nipponica* and *Pillucina lamyi* etc. are also found in the Omma fauna, but rare in general.

The cold current species, on the contrary, show usually abundant occurrence in the Omma fauna. As the Recent species living in the cold water conditions, or the species of the Oyashio type we can enumerate the following characteristic ones found abundantly or commonly in the Omma formation : *Tectonatica janthostomoides*, *Lunatia pila*, *Antiplanes contraria*, *Ophiodermella miyatensis*, *Yoldia notabilis*, *Yoldia excavata*, *Ennucula tenuis*, *Glycymeris yessoensis*, *Modiolus difficilis*, *Patinopecten yessoensis*, *Astarte borealis*, *Venericardia prolongata nakamurai*, *Felaniella usta*, *Axinopsida subquadrata*, *Mercenaria stimpsoni*, *Callithaca adamsi*, *Liocyma aniwana*, *Spisula voyi*, *Peronidia lutea*, and *Thracia kakumana* etc. Further, as the Recent cold water species occurring rarely in the Omma fauna we can enumerate the following species : *Puncturella nobilis*, *Acmaea pallida*, *Homalopoma amussitatum*, *Alvania asura*, *Neptunea arthritica*, *Rectiplanes sanctaioannis*, *Propebela turricula candida*, *Nuculana robai*, *Chlamys swifti*, *Astarte bennetti*, *Thyasira tokunagai*, *Macoma middendorffi*, and *Siliqua alta* etc.

Other than the species of the Recent Oyashio type mentioned above, such fossil species of Oyashio type as *Clinocardium shinjiense*, *Clinocardium fastosum*, and *Mercenaria yokoyamai* etc. are frequently found in the Omma fauna. Remarkable leading fossils characterizing the Omma-Manganji fauna, that is, *Turritella saishuensis*, *Patinopecten kurosawensis* etc. are undoubtedly the cold water species. Further, the following fossil species also seem to suggest the cold current types based on our knowledge of the fossil assemblages in other known localities in Japan : *Umbonium akitanum*, *Fulgoraria masudae*, and *Pseudamiantis tauyensis* etc.

In order to get information about the geographic (latitudinal) position suggested by the fossil molluscan fauna, several methods of quantitative analysis or graphic representation have been tried by various authors. Regarding the Omma molluscan fauna, information of the geographic (latitudinal) distribution range of Recent species along the Japan Sea coast region can be taken up from the "Check List" summarized by KURODA and HABA (1952). Such data are shown in Table 2 for each species. A frequency histogram based on the geographic (latitudinal) range of each Recent species constituting the Omma molluscan fauna is shown in Text-figure 3, compared with the similar one of the Recent molluscan fauna at Togi of Noto peninsula (37°N). In reality, however, the interpretation of these graphs is not so easy owing to the following reasons : (1) incorrect knowledge of the distribution range of Recent species ; (2) difficulty of statistical treatment of various species having different weight of importance ; (3) incompleteness of the fossil thanatocoenose etc.



Text-figure 3. Geographic (latitudinal) distribution range of the Omma molluscan fauna, compared with the Recent molluscan fauna at Togi of Noto peninsula (37°N).

Latitudinal distribution data on the living molluscan species in the Japan Sea side of Japan is largely based on the "Check List" by KURODA and HABE (1952). The numbers of species corresponding to each latitudinal interval are counted, being shown as a histogram.

Histogram A (solid line) : Abundant and common living species found in the Omma fauna.

Histogram B (broken line) : All living species found in the Omma fauna.

Histogram C (dotted line) : Recent molluscan fauna collected by N. MATSUURA at Togi of Noto peninsula (37° N), Japan.

*Bottom Character and Bathymetric Range* Most species of the Omma molluscan fauna are inhabitants on sandy and muddy bottoms; the species adapted to gravelly or rocky bottoms are: *Haliotis gigantea*, *Acmaea pallida*, *Tristichotrochus multiliratum*, *Macrophragma tokyoensis*, *Ceratostoma japonica*, *Ostrea gigas*, *Acar plicata*, *Modiolus difficilis* etc. Available information about the bottom character and the bathymetric range of each species constituting the Omma molluscan fauna is shown in Table 2. For important 14 localities around Kanazawa city, bathymetric data are tabulated in Table 5. In all localities, euneritic ( $N_1$ ) and euneritic~mesoneritic ( $N_1 \sim N_2$ ) ones are most dominant, although the species living in deeper waters are rarely found. Among 14 localities, the assemblages found in Loc. 9, 14, 16, 18, 20, 22, 25, 27, and 29 are mostly composed of euneritic species, and seem to have been more or less shallower than those in Loc. 6, 12, 31, 32 and 34. The depth of Loc. 20, 22, 25 and 29 must have been shallow as shown in Text-figure 2,



Table 5. Bathymetric distribution table of the Omma molluscan fauna from 14 localities around Kanazawa city.  
 Numerals : Number of species ; AC : Abundant and common species ; R : Rare species.

Locality	Number of Species																				Total														
	N <sub>0</sub>		N <sub>0-1</sub>		N <sub>0-4</sub>		N <sub>1</sub>		N <sub>1-2</sub>		N <sub>1-3</sub>		N <sub>1-4</sub>		N <sub>1~B</sub>		N <sub>2</sub>		N <sub>2-3</sub>		N <sub>2-4</sub>		N <sub>2~B</sub>		N <sub>3</sub>		N <sub>3-4</sub>		N <sub>3~B</sub>		N <sub>4~B</sub>		AC	R	
	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R	AC	R			
Higashi-nagaé (Loc. 6)			2	1			7	5	6	7		1	4	1	1	1	1	1	1	1	2	2	1									1	30	23	
Gohyakkokudani (Loc. 9)			2				11	12	6	7	1	1	2	4	2					2	2	1											28	28	
Yûhidera (Loc. 12)							2	6	6	3	2	1	2		2	1	1		1		3		1			1	3		1	1			24	13	
Maki (Loc. 14)				1			4	3	6	3			3		2	1		1	1		1	1											19	10	
Kakuma (Loc. 16)		2	2	2			14	4	9	4	2		4	3	2	1		1	1		2	2	1	1			1	1	2	1			40	22	
Tagami (Loc. 18)		1	3				10	6	12	4	4		3	2	2	1	1			2	3	1			1		1						41	17	
Tachi (Loc. 20)	1	1	2				9	9	12	3		1	2	3	1			1	1		1	1		1			1	2	1				31	22	
Kaminaka (Loc. 22)			1	1			9	3	8	3			2	3		1				1	2			1									22	14	
Kanegawa (Loc. 25)		1	1	1			9	5	10	6	1		4		2					1	1	2					1						30	16	
Fukuro (Loc. 27)		1	2				10	4	10	4			4		2		1				1	1						1	1				28	14	
Shimo-araya (Loc. 29)	1	1	3	1		2	12	10	11	8	1	1	5		1	1					1	4	1		1	1	1	2					39	30	
Ôkuwa (Loc. 31)			2				4	8	8	7	1	1	1	3	1		1	1		3	3	2	1			2	2	4					28	27	
Ôkuwa (Loc. 32)		1	1				4	1	6	5	1	1	2		1	1	2		1	1	1	2	1	1			1		1				22	14	
Yamashina (Loc. 34)			1	2			6	2	10	2	1		4	1	1			1	1		3	2	1		1		1	1	1	2				31	13

No : Intertidal, N<sub>1</sub> : Euneritic (~20-30 m), N<sub>2</sub> : Mesoneritic (20-30~50-60 m), N<sub>3</sub> : Subneritic (50-60~100-120 m),  
 N<sub>4</sub> : Bathyneritic (100-120~200-250 m), B : Bathyal (200-250~800-1200 m).

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APPENDIX : *Alphabetical List of Place Names*

Asagaya	朝 ヶ 屋
Asano-gawa	浅 野 川
Chôshi (-guchi)	銚 子 (口)
Dentôji	伝 燈 寺
Fukuro (-itaya)	袋 (板 屋)
Gohyakkokudani	五 百 石 谷
Higashi-nagaé	東 長 江
Kakuma	角 間
Kaminaka	上 中
Kanakusari-gawa	金 腐 川
Kanegawa	金 川
Kodatsuno-dai	小 立 野 台
Maki	牧
Mitsukôji	三 小 牛
Nagaé-gohyakkokudani	長 江 五 百 石 谷
Nodayama	野 田 山
Ôkuwa (Omma)	大 桑
Saigawa	犀 川
Shimo-araya	下 荒 屋
Tachi	館
Tagami (-honmachi)	田 上 (本町)
Teramachi-dai	寺 町 台
Utatsuyama	卯 辰 山
Yamashina	山 科
Yûhidera	夕 日 寺

PLATE I

EXPLANATION OF PLATE I

- Fig. 1. *Haliotis (Euhaliotis) gigantea* GMELIN × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70001
- Fig. 2. *Puncturella* sp. No. 1 × 2.1 Tachi (Loc. 20) GKZ 70004
- Fig. 3. *Collisella* sp. × 5/6 Ôkuwa (Loc. 31) GKZ 70006
- Fig. 4. *Lepeta* sp. × 5/3 Tachi (Loc. 20) GKZ 70008
- Fig. 5. *Machaeroplax* sp. No. 1 × 2.5 Kakuma (Loc. 16) GKZ 70009
- Fig. 6. *Turcica* sp. × 2.5 Tachi (Loc. 20) GKZ 70011
- Fig. 7. *Minolia pseudobscura* (YOKOYAMA) × 5/6 Nagaédani GKZ 70012
- Fig. 8. *Solariella* sp. × 2.5 Ôkuwa GKZ 70013
- Fig. 9. *Tristichotrochus multiliratum* (SOWERBY) × 5/6 Ôkuwa (Loc. 32) GKZ 70014
- Fig. 10. *Lirularia* sp. × 2.5 Tachi (Loc. 20) GKZ 70015
- Fig. 11. *Umboonium (Suchium) akitanum* SUZUKI × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70016
- Fig. 12. *Umboonium (Suchium) akitanum* SUZUKI × 5/6 Tachi (Loc. 20) GKZ 70017
- Fig. 13. *Starkeyna sobrina* (A. ADAMS) × 10/3 Shimo-araya (Loc. 29) GKZ 70018
- Fig. 14. *Heliacus* sp. × 10/3 Higashi-nagaé (Loc. 6) GKZ 70034
- Fig. 15. *Homalopoma amussitatum* (GOULD) × 5/3 Tachi (Loc. 20) GKZ 70019
- Fig. 16. *Cocculina* sp. × 5/4 Tachi (Loc. 20) GKZ 70021
- Fig. 17. *Putilla* sp. × 2.5 Kanegawa (Loc. 25) GKZ 70022
- Fig. 18. *Alvania (Arsenia) akibai* YOKOYAMA × 2.5 Higashi-nagaé (Loc. 6) GKZ 70023
- Fig. 19. *Alvania asura* (YOKOYAMA) × 2.5 Maki (Loc. 14) GKZ 70024
- Fig. 20. *Turritella saishuensis* YOKOYAMA × 1 Kaminaka GKZ 70025
- Fig. 21. *Turritella (Neohaustator) andenensis* OTUKA var. × 1 Fukuro-itaya GKZ 70026

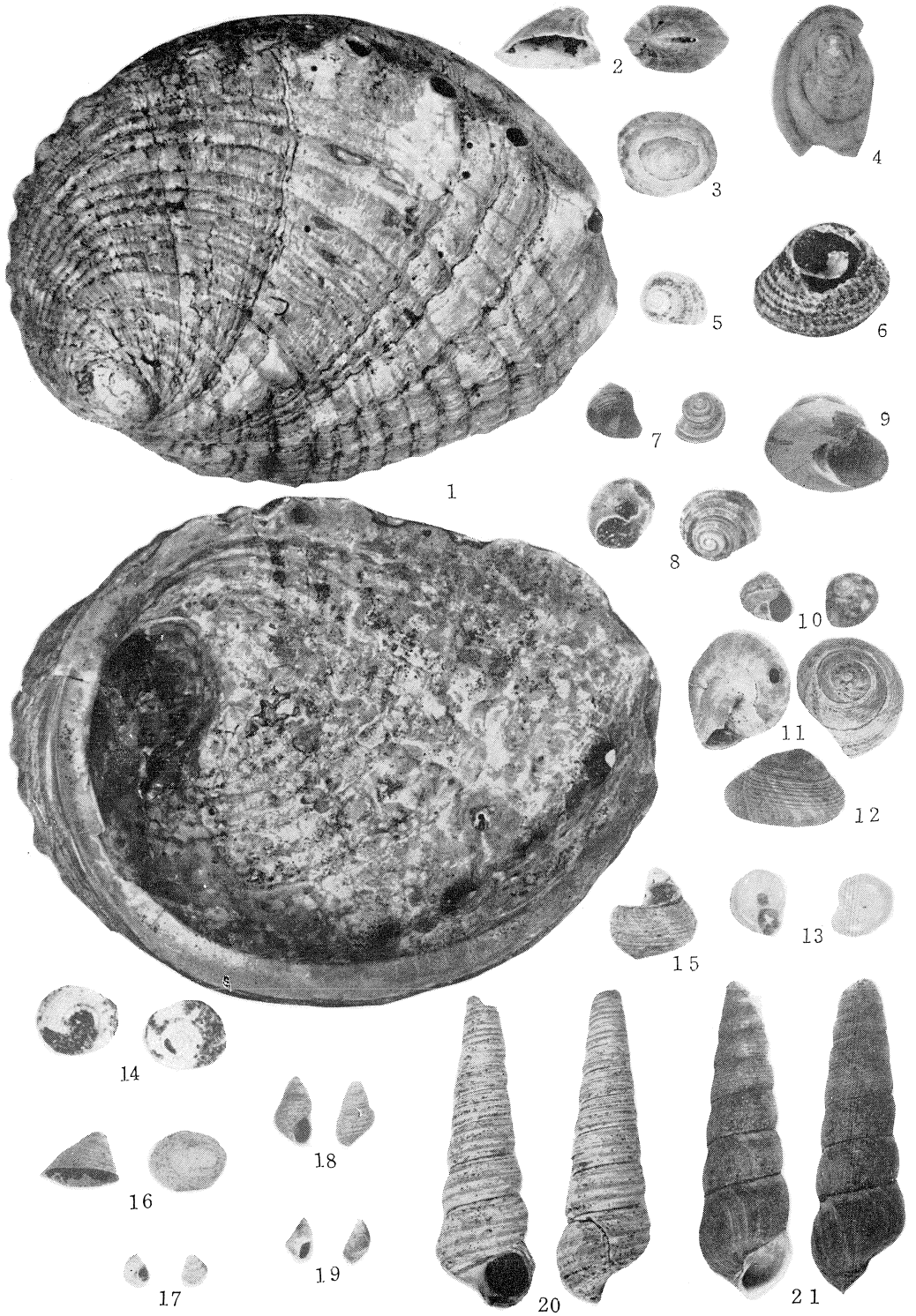




PLATE II

## EXPLANATION OF PLATE II

- Fig. 1. *Tachyrhynchus venustellus* (YOKOYAMA) × 5/3 Higashi-nagaé (Loc. 6) GKZ 70028
- Fig. 2. *Tachyrhynchus tuberculosus* (YOKOYAMA) × 5/3 Kakuma (Loc. 16) GKZ 70029
- Fig. 3. *Bittium* (*Stylidium*) *horinjiense* OINOMIKADO et IKEBE × 2.5 Nagaé-gohyakkokudani (Loc. 9) GKZ 70030
- Fig. 4. *Bittium* sp. No. 1 × 5/3 Loc. ? GKZ 70031
- Fig. 5. *Amaea* sp. × 2.5 Kanegawa (Loc. 25) GKZ 70036
- Fig. 6. *Epittonium* (*Boreoscala*) *yabei echigomum* KANEHARA × 5/6 Tachi (Loc. 20) GKZ 70038
- Fig. 7. *Nodiscala* sp. (n. sp. ?) × 2.5 Kanegawa (Loc. 25) GKZ 70035
- Fig. 8. *Balcis* sp. × 10/3 Tachi (Loc. 20) GKZ 70040
- Fig. 9. *Niso dorcas* (KURODA et HABE) var. × 5/6 Kakuma (Loc. 16) GKZ 70041
- Fig. 10. *Tugurium exutum* (REEVE) × 5/6 Ôkuwa GKZ 70051
- Fig. 11. *Menestho incisa* (YOKOYAMA) × 2.5 Higashi-nagaé (Loc. 6) GKZ 70110
- Fig. 12. *Menestho* sp. (n. sp. ?) × 2.5 Tachi (Loc. 20) GKZ 70111
- Fig. 13. *Odostomia* sp. No. 1 × 10/3 Tachi (Loc. 20) GKZ 70112
- Fig. 14. *Odostomia* sp. No. 2 × 10/3 Tachi (Loc. 20) GKZ 70113
- Fig. 15. *Odostomia* sp. No. 3 × 2.5 Tachi (Loc. 20) GKZ 70114
- Fig. 16. *Odostomia* sp. No. 4 × 2.5 Tachi (Loc. 25) GKZ 70115
- Fig. 17. *Odostomia* sp. No. 5 × 2.5 Kanegawa (Loc. 25) GKZ 70116
- Fig. 18. *Paracingulina triarata* (PILSBRY) × 10/3 Kanegawa (Loc. 25) GKZ 70117
- Fig. 19. *Leucotina* sp. No. 1 × 2.5 Nagaé-gohyakkokudani (Loc. 9) GKZ 70118
- Fig. 20. *Leucotina* sp. No. 2 × 2.5 Kakuma (Loc. 16) GKZ 70119
- Fig. 21. *Actaeopyramis* sp. × 5/6 Tachi (Loc. 20) GKZ 70120
- Fig. 22. *Turbonilla* (*Ptycheulimella*) *inscitula* YOKOYAMA × 2.5 Higashi-nagaé (Loc. 6) GKZ 70122
- Fig. 23. *Turbonilla* (*Ptycheulimella*) *inscitula* YOKOYAMA × 2.5 Higashi-nagaé (Loc. 6) GKZ 70123
- Fig. 24. *Turbonilla* (*Ptycheulimella*) sp. No. 1 × 10/3 Tachi (Loc. 20) GKZ 70124
- Fig. 25. *Turbonilla* (*Paramomula*) *paucicostulata* TOKUNAGA × 10/3 Fukuro-itaya (Loc. 27) GKZ 70126
- Fig. 26. *Turbonilla* (*Chemnitzia*) *infantula* DALL et BARTSH × 10/3 Tachi (Loc. 20) GKZ 70121
- Fig. 27. *Turbonilla* sp. × 10/3 Kanegawa (Loc. 25) GKZ 70127
- Fig. 28. *Turbonilla* (*Ptycheulimella*) sp. No. 2 × 5/4 Ôkuwa GKZ 70125
- Fig. 29. *Lunatia pila* (PILSBRY) × 5/6 Maki (Loc. 14) GKZ 70043
- Fig. 30. *Mammilla yokoyamai* MAKINO MS × 5/6 Tachi (Loc. 20) GKZ 70042
- Fig. 31. *Mammilla* sp. × 5/6 Ôkuwa (Loc. 32) GKZ 70044
- Fig. 32. *Neverita* (*Glossaulax*) *reiniana* (DUNKER) × 5/6 Ôkuwa (Loc. 31) GKZ 70045
- Fig. 33. *Neverita* (*Glossaulax*) *reiniana* (DUNKER) × 5/6 Ôkuwa (Loc. 31) GKZ 70046
- Fig. 34. *Tectonatica janthostomoides* (KURODA et HABE) × 5/6 Tachi (Loc. 20) GKZ 70047
- Fig. 35. The operculum of *Tectonatica janthostomoides* (KURODA et HABE) × 5/6 Yamashina (Loc. 34) GKZ 70048

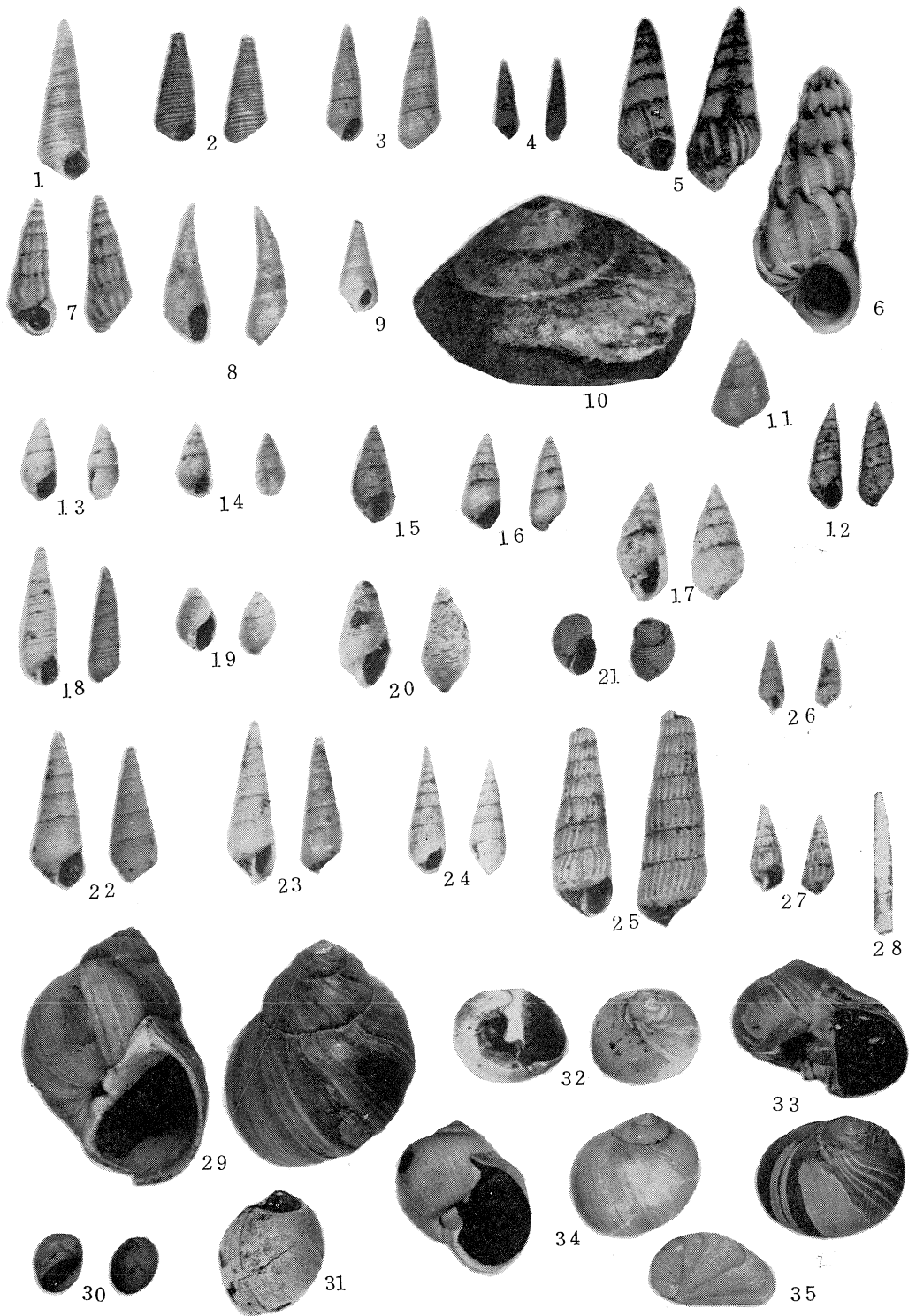


PLATE III

EXPLANATION OF PLATE III

- Fig. 1. *Semicassis minor* (KÜSTER) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70052  
Fig. 2. *Semicassis minor* (KÜSTER) × 5/6 Nagaédani GKZ 70053  
Fig. 3. *Trophonopsis kagaensis* HATAI et NISIYAMA × 5/6 Fukuro-itaya (Loc. 27) GKZ 70057  
Fig. 4. *Trophonopsis (Boreotrophon) candelabrum* (REEVE) × 5/3 Kanegawa (Loc. 25) GKZ 70058  
Fig. 5. *Trophonopsis nipponicus* (YOKOYAMA) × 10/3 Higashi-nagaé (Loc. 6) GKZ 70059  
Fig. 6. *Ceratostoma (Ocenebra) japonica* (DUNKER) × 7/6 Kaminaka (Loc. 23) GKZ 70054  
Fig. 7. *Ceratostoma (Ocenebra) japonica* (DUNKER) × 5/6 Fukuro-itaya (Loc. 27) GKZ 70055  
Fig. 8. *Ceratostoma (Ocenebra) japonica* (DUNKER) × 5/6 Tachi (Loc. 20) GKZ 70056  
Fig. 9. *Indomitrella lischkei* SMITH × 5/3 Kanegawa (Loc. 25) GKZ 70063  
Fig. 10. *Indomitrella tokyoensis* (YOKOYAMA) × 5/3 Kanegawa (Loc. 25) GKZ 70064  
Fig. 11. *Mitrella* sp. × 5/3 Tachi (Loc. 20) GKZ 70062  
Fig. 12. *Mitrella* sp. × 5/3 Tachi (Loc. 20) GKZ 70061  
Fig. 13. *Neptunea (Barbitonia) arthritica* (BERNARDI) × 5/6 Nagaé-gohyakkokudani (Loc. 9-10) GKZ 70068  
Fig. 14. *Siphonalia cassidariaeformis* (REEVE) var. × 5/6 Nagaedani GKZ 70069  
Fig. 15. *Plesiothyreus* sp. × 2.1 Shimo-araya (Loc. 29) GKZ 70020  
Fig. 16. *Siphonalia spadicea* (REEVE) × 5/6 Okuwa GKZ 70070  
Fig. 17. *Siphonalia fusoides* (REEVE) × 5/6 Loc. ? GKZ 70071  
Fig. 18. *Mitrella bicincta* (GOULD) × 5/4 Kaminaka (Loc. 22) GKZ 70060  
Fig. 19. *Malluvium otohimeae* HABE ? × 5/6 Shimo-araya (Loc. 29) GKZ 70049

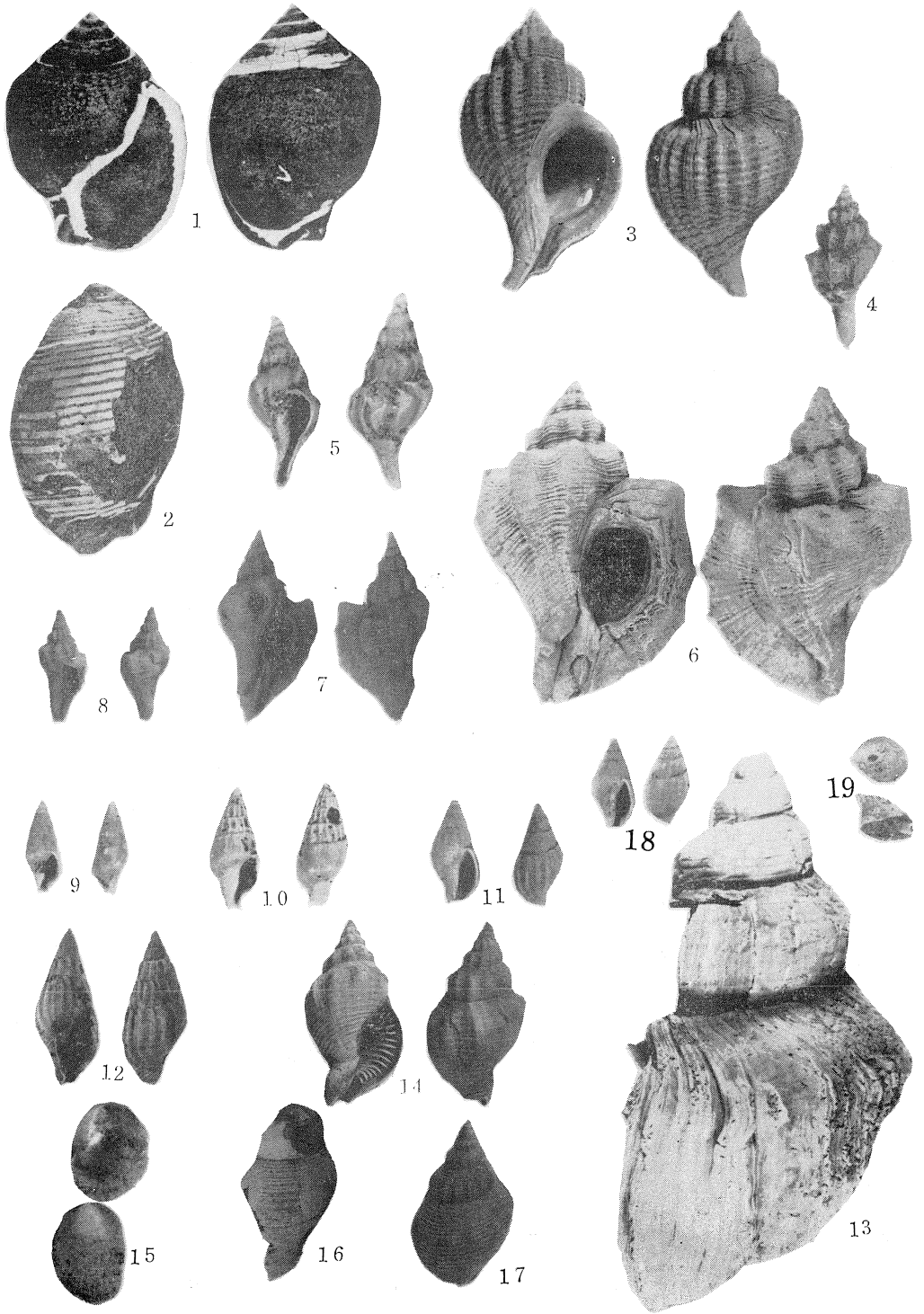


PLATE IV

EXPLANATION OF PLATE IV

- Fig. 1. *Searlesia japonica* YOKOYAMA × 5/6 Tachi (Loc. 20) GKZ 70073  
Fig. 2. *Babylonia elata* (YOKOYAMA) × 5/6 Sué GKZ 70074  
Fig. 3. *Plicifusus ozawai* (YOKOYAMA) × 5/6 Higashi-nagaé (Loc. 6) GKZ 70075  
Fig. 4. *Plicifusus ozawai* (YOKOYAMA) × 5/6 Higashi-nagaé (Loc. 6) GKZ 70076  
Fig. 5. *Ootomella* sp. (n. sp. ?) × 5/4 Kakuma (Loc. 16) GKZ 70077  
Fig. 6. *Nassarius (Zeuxis) caelatus* (A. ADAMS) × 5/6 Higashi-nagaé (Loc. 6) GKZ 70065  
Fig. 7. *Tritia luteola* (E. A. SMITH) var. × 5/3 Tachi (Loc. 20) GKZ 70066  
Fig. 8. *Tritia luteola* (E. A. SMITH) var. × 5/3 Tachi (Loc. 20) GKZ 70067  
Fig. 9. *Fusinus perplexus* (A. ADAMS) × 5/6 Ôkuwa (Loc. 31) GKZ 70078  
Fig. 10. *Olivella spretoides* YOKOYAMA × 5/3 Kanegawa (Loc. 25) GKZ 70079  
Fig. 11. *Oliva mustelina* LAMARCK × 5/4 Ôkuwa (Loc. 31) GKZ 70080  
Fig. 12. *Fulgoraria masudae* HAYASAKA × 5/6 Maki (Loc. 14) GKZ 70081  
Fig. 13. *Fulgoraria masudae* HAYASAKA × 5/6 Loc. ? GKZ 70082  
Fig. 14. *Cancellaria (Merica) kobayashii* (YOKOYAMA) × 5/6 Tachi (Loc. 20) GKZ 70083  
Fig. 15. *Sydaphera spengleriana* (DESHAYES) × 5/6 Nagaédani GKZ 70085  
Fig. 16. *Sydaphera spengleriana* (DESHAYES) × 5/6 Ôkuwa (Loc. 31) GKZ 70086  
Fig. 17. *Admete murayamai* (YOKOYAMA) × 5/6 Tachi (Loc. 20) GKZ 70087  
Fig. 18. *Admete* sp. × 5/3 Higashi-Nagaé (Loc. 6) GKZ 70088  
Fig. 19. *Narona (Solatia) nodulifera* (SOWERBY) × 5/6 Tachi (Loc. 20) GKZ 70089  
Fig. 20. *Bittium* sp. No. 2 × 5/3 Yamashina (Loc. 34) GKZ 70032  
Fig. 21. *Macrophragma tokyoensis* (PILSBRY) × 5/3 Shimo-araya (Loc. 29) GKZ 70027  
Fig. 22. *Cancellaria japonica lischkei* (YOKOYAMA) × 5/6 Tagami-honmachi (Loc. 18) GKZ 70084



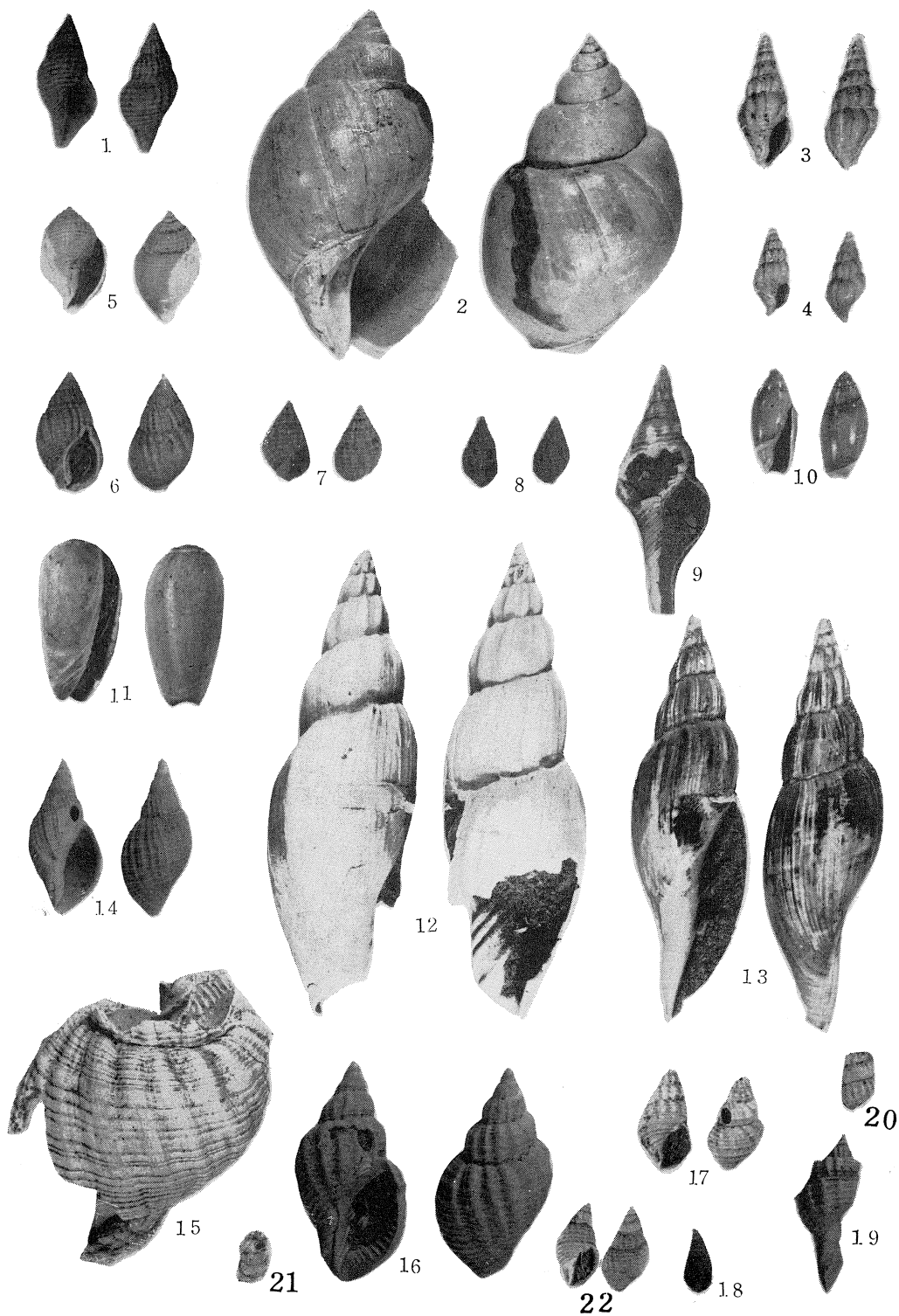


PLATE V

EXPLANATION OF PLATE V

- Fig. 1. *Antiplanes contraria* (YOKOYAMA) × 5/4 Tachi (Loc. 20) GKZ 70091  
 Fig. 2. *Rectiplanes sanctaioammis* (SMITH) × 5/4 Okuwa GKZ 70092  
 Fig. 3. *Paradrillia inconstans* (SMITH) × 5/3 Higashi-nagaé (Loc. 6) GKZ 70093  
 Fig. 4. *Paradrillia dainichiensis* (YOKOYAMA) × 5/3 Loc. ? GKZ 70094  
 Fig. 5. *Inquisitor* sp. × 5/3 Kanegawa (Loc. 25) GKZ 70095  
 Fig. 6. *Suavodrillia declivis* (v. MARTENS) × 5/4 Kanegawa (Loc. 25) GKZ 70096  
 Fig. 7. *Tomopleula* sp. × 5/3 Higashi-nagaé (Loc. 6) GKZ 70097  
 Fig. 8. *Propebela (Turritoma) yokoyamai* ONOYAMA × 2.1 Hihashi-nagaé (Loc. 6) GKZ 70098  
 Fig. 9. *Propebela (Turritoma) turricula candida* (YOKOYAMA) × 5/3 Okuwa GKZ 70099  
 Fig. 10. *Ophiodermella ogurana* (YOKOYAMA) × 5/6 Nagaédani GKZ 70100  
 Fig. 11. *Granotoma dissoluta* (YOKOYAMA) × 5/3 Shimo-araya (Loc. 29) GKZ 70102  
 Fig. 12. *Ophiodermella miyatensis* (YOKOYAMA) × 5/6 Okuwa GKZ 70101  
 Fig. 13. *Guraleus tabatensis* (TOKUNAGA) × 2.5 Loc. ? GKZ 70103  
 Fig. 14. *Guraleus* sp. ? × 2.5 Tachi (Loc. 20) GKZ 70104  
 Fig. 15. *Pseudoetrema fortilirata* (E. A. SMITH) × 2.5 Kanegawa (Loc. 25) GKZ 70105  
 Fig. 16. *Nannodriella* sp. (n. sp. ?) × 2.5 Higashi-nagaé (Loc. 6) GKZ 70106  
 Fig. 17. *Oenopota kagana* (YOKOYAMA) 5/6 Fukuro-itaya GKZ 70107  
 Fig. 18. *Oenopota* sp. ? × 5/6 Fukuro-itaya (Loc. 27) GKZ 70108  
 Fig. 19. *Terebra lischkeana* DUNKER × 5/4 Fukuro-itaya (Loc. 27) GKZ 70109  
 Fig. 20. *Pupa* sp. × 2.5 Okuwa GKZ 70128  
 Fig. 21. *Ringicula (Ringiculina) doliaris* GOULD × 2.5 Tachi (Loc. 20) GKZ 70129  
 Fig. 22. *Ringicula (Ringiculina) doliaris* GOULD × 2.5 Tachi (Loc. 20) GKZ 70130  
 Fig. 23. *Ringicula (Ringiculina) yokoyamai* TAKEYAMA × 2.5 Tachi (Loc. 20) GKZ 70131  
 Fig. 24. *Epitonium (Depressiscala) auritum* (SOWERBY) × 2.5 Shimo-araya (Loc. 29) GKZ 70037  
 Fig. 25. *Coleophysis (Sulcoretusa) minima* (YAMAKAWA) × 10/3 Tachi (Loc. 20) GKZ 70132  
 Fig. 26. *Rhizorus tokunagai* (MAKIYAMA) × 2.5 Tachi (Loc. 20) GKZ 70134  
 Fig. 27. *Adamnestia japonica* (A. ADAMS) × 2.5 Higashi-nagaé (Loc. 6) GKZ 70135  
 Fig. 28. *Decorifer insignis* (PILSBRY) × 10/3 Tachi (Loc. 20) GKZ 70136  
 Fig. 29. *Decorifer* sp. × 2.5 Kakuna (Loc. 16) GKZ 70137  
 Fig. 30. *Cavolina longirostris* (BLAINVILLE) × 2.9 Kanegawa (Loc. 25) GKZ 70139  
 Fig. 31. *Philine argentata* GOULD × 2.5 Fukuro-itaya (Loc. 27) GKZ 70138  
 Fig. 32. *Machaeroplax* sp. No. 2 × 2.9 Higashi-nagaé (Loc. 6) GKZ 70010  
 Fig. 33. *Acmaea (Niveotectura) pallida* (GOULD) × 5/6 Shimo-araya (Loc. 29) GKZ 70007  
 Fig. 34. *Crepipatella lingulata* (GOULD) × 2.5 Shimo-araya (Loc. 29) GKZ 70050

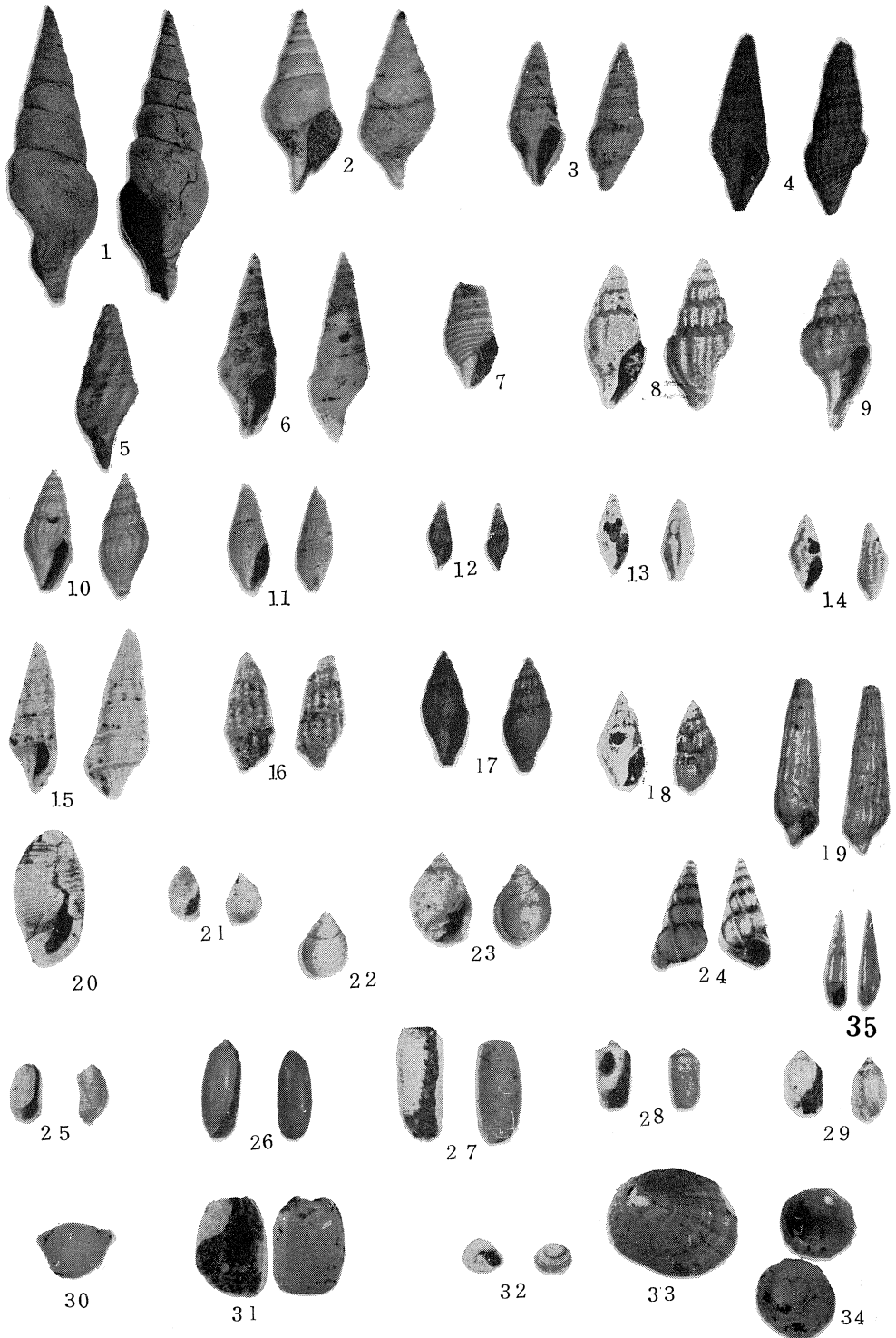


PLATE VI

EXPLANATION OF PLATE VI

- Fig. 1. *Puncturella nobilis* A. ADAMS × 2.5 Shimo-araya (Loc. 29) GKZ 70002  
Fig. 2. *Puncturella fastigiata* A. ADAMS × 2.5 Shimo-araya (Loc. 29) GKZ 70003  
Fig. 3. *Puncturella* sp. No. 2 × 2.5 Shimo-araya (Loc. 29) GKZ 70005  
Fig. 4. *Bittium* sp. No. 3 × 2.5 Shimo-araya (Loc. 29) GKZ 70033  
Fig. 5. *Nassaria* sp. (n. sp. ?) × 5/6 Shimo-araya (Loc. 29) GKZ 70072  
Fig. 6. *Pyrrunculus phialus* (A. ADAMS) × 2.5 Tagami-honmachi (Loc. 18) GKZ 70133  
Fig. 7. *Cypraeolina cotamago* (YOKOYAMA) × 2.5 Tagami-honmachi (Loc. 18) GKZ 70090  
Fig. 8. *Cavolina uncinata* (d'ORBIGNY) × 5/4 Tagami-honmachi (Loc. 18) GKZ 70140  
Fig. 9. *Acar plicata* (DILLWYN) × 5/4 Shimo-araya (Loc. 29) GKZ 70156  
Fig. 10. *Acar* sp. × 5/4 Shimo-araya (Loc. 29) GKZ 70158  
Fig. 11. *Acar* sp. × 5/4 Shimo-araya (Loc. 29) GKZ 70157  
Fig. 12. *Pseudogrammatodon dalli* (SMISH) × 5/4 Shimo-araya (Loc. 29) GKZ 70159  
Fig. 13. *Limopsis (Pectunculina) crenata* A. ADAMS × 1.4 Ôkuwa (Loc. 31) GKZ 70165  
Fig. 14. *Limopsis obliqua* A. ADAMS × 1.4 Higashi-nagaé (Loc. 6) GKZ 70166  
Fig. 15. *Aspalima (Nippolimopsis) decussata* (A. ADAMS) × 2.5 Shimo-araya (Loc. 29) GKZ 70167  
Fig. 16. *Glycymeris yessoensis* (SOWERBY) × 5/6 Nagaédani GKZ 70163  
Fig. 17. *Glycymeris nipponicus* (YOKOYAMA) × 5/6 Ôkuwa GKZ 70164  
Fig. 18. *Modiolus difficilis* KURODA et HABE × 5/6 Kakuma (Loc. 16) GKZ 70172  
Fig. 19. *Modiolus (Modiolusia) sirahensis* (JOUSSEAUME) var. × 5/4 Kaminaka GKZ 70173  
Fig. 20. *Chlamys cosibensis* (YOKOYAMA) × 5/6 Nagaédani GKZ 70177  
Fig. 21. *Chlamys nipponensis* KURODA × 1.1 Ôkuwa GKZ 70174  
Fig. 22. *Chlamys nipponensis* KURODA × 1.1 Ôkuwa GKZ 70175  
Fig. 23. *Chlamys swiftii* (BERNARDI) × 1.1 Yamashina GKZ 70176  
Fig. 24. *Pillucina* sp. × 2.5 Shimo-araya (Loc. 29) GKZ 70213

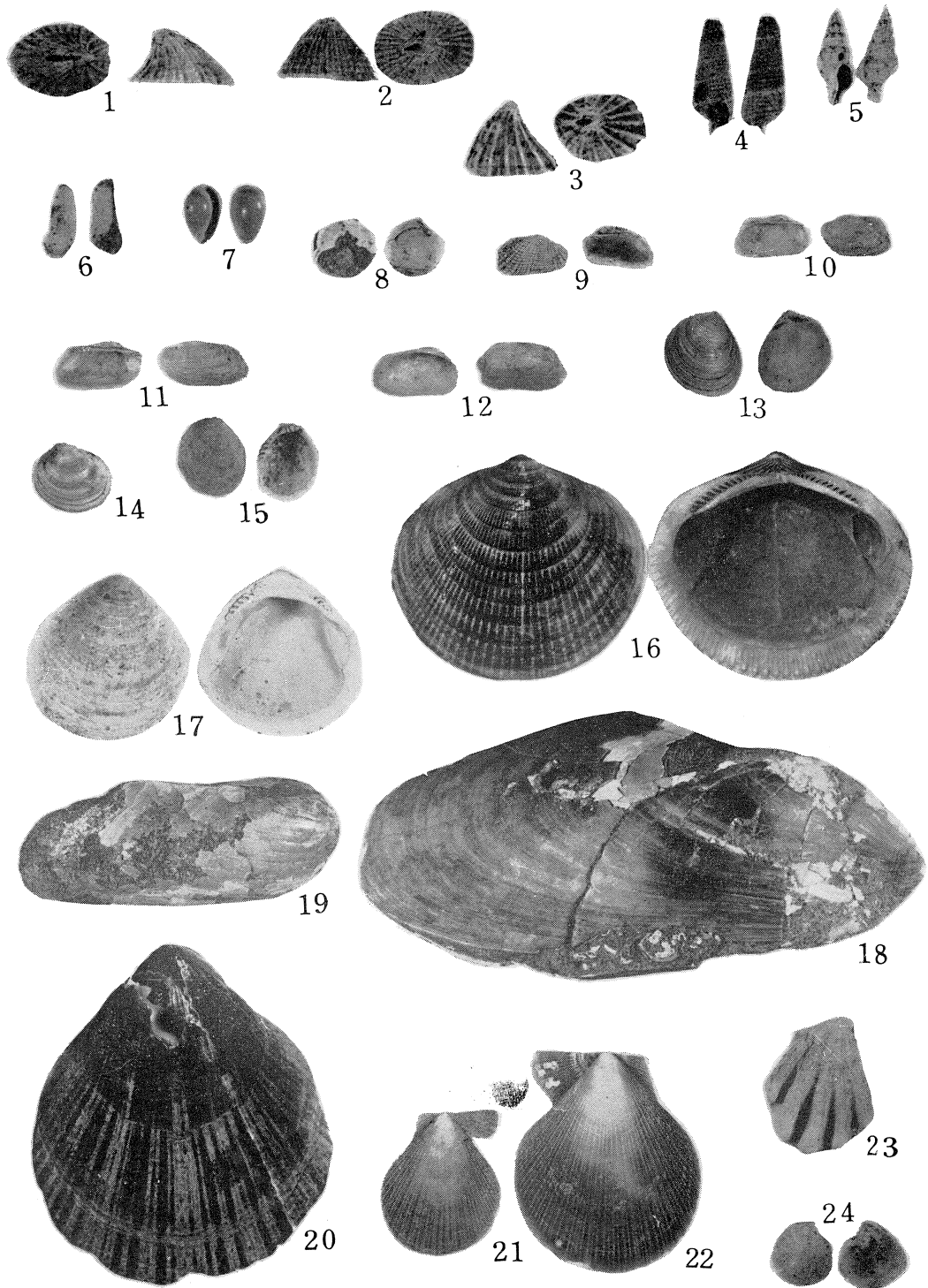


PLATE VII



EXPLANATION OF PLATE VII

- Fig. 1. *Dentalium (Dentale) weinkauffi* DUNKER × 1 Nagaé-gohyakkokudani (Loc. 9) GKZ 70141
- Fig. 2. *Antalis rhabdotum* (PILSBRY) × 1 Nagaédani GKZ 70142
- Fig. 3. *Entalinopsis nivosum* (KURODA et KIKUCHI) × 10/3 Ôkuwa (Loc. 31) GKZ 70143
- Fig. 4. *Entalinopsis nivosum* (KURODA et KIKUCHI) × 10/3 Higashi-nagaé (Loc. 6) GKZ 70144
- Fig. 5. *Ennucula tenuis* (MONTAGU) × 2.5 Nagaé-gohyakkokudani (Loc. 9) GKZ 70145
- Fig. 6. *Ennucula niponica* (SMITH) var. × 5/4 Nagaédani GKZ 70146
- Fig. 7. *Acila (Truncacila) insignis* (GOULD) × 1.1 Kanegawa (Loc. 25) GKZ 70147
- Fig. 8. *Acila divaricata* (HINDS) × 5/6 Ôkuwa GKZ 7014
- Fig. 9. *Nuculana robai* (KURODA) × 5/4 Ôkuwa GKZ 70149
- Fig. 10. *Nuculana (Thestyleda) yokoyamai* KURODA × 5/4 Higashi-nagaé (Loc. 6) GKZ 70150
- Fig. 11. *Yoldia (Cnesterium) notabilis* YOKOYAMA × 5/6 Kakuma (Loc. 16) GKZ 70153
- Fig. 12. *Yoldia (Cnesterium) excavata* DALL × 5/6 Maki (Loc. 14) GKZ 70154
- Fig. 13. *Saccella sematensis* (SUZUKI et ISIZUKA) × 5/4 Ôkuwa (Loc. 31) GKZ 70151
- Fig. 14. *Saccella gordonis* (YOKOYAMA) × 5/4 Ôkuwa (Loc. 31) GKZ 70152
- Fig. 15. *Arca miyatensis* OYAMA × 5/6 Tachi (Loc. 20) GKZ 70155
- Fig. 16. *Anadara amacula* (YOKOYAMA) × 5/6 Ôkuwa GKZ 70160
- Fig. 17. *Anadara amacula* (YOKOYAMA) × 5/6 Fukuro-itaya GKZ 70161
- Fig. 18. *Crenella* sp. No. 1 × 5/6 Loc. ? GKZ 70170
- Fig. 19. *Anadara (Scapharca) satowi ommaensis* OTUKA × 5/6 Nagaédani GKZ 70162

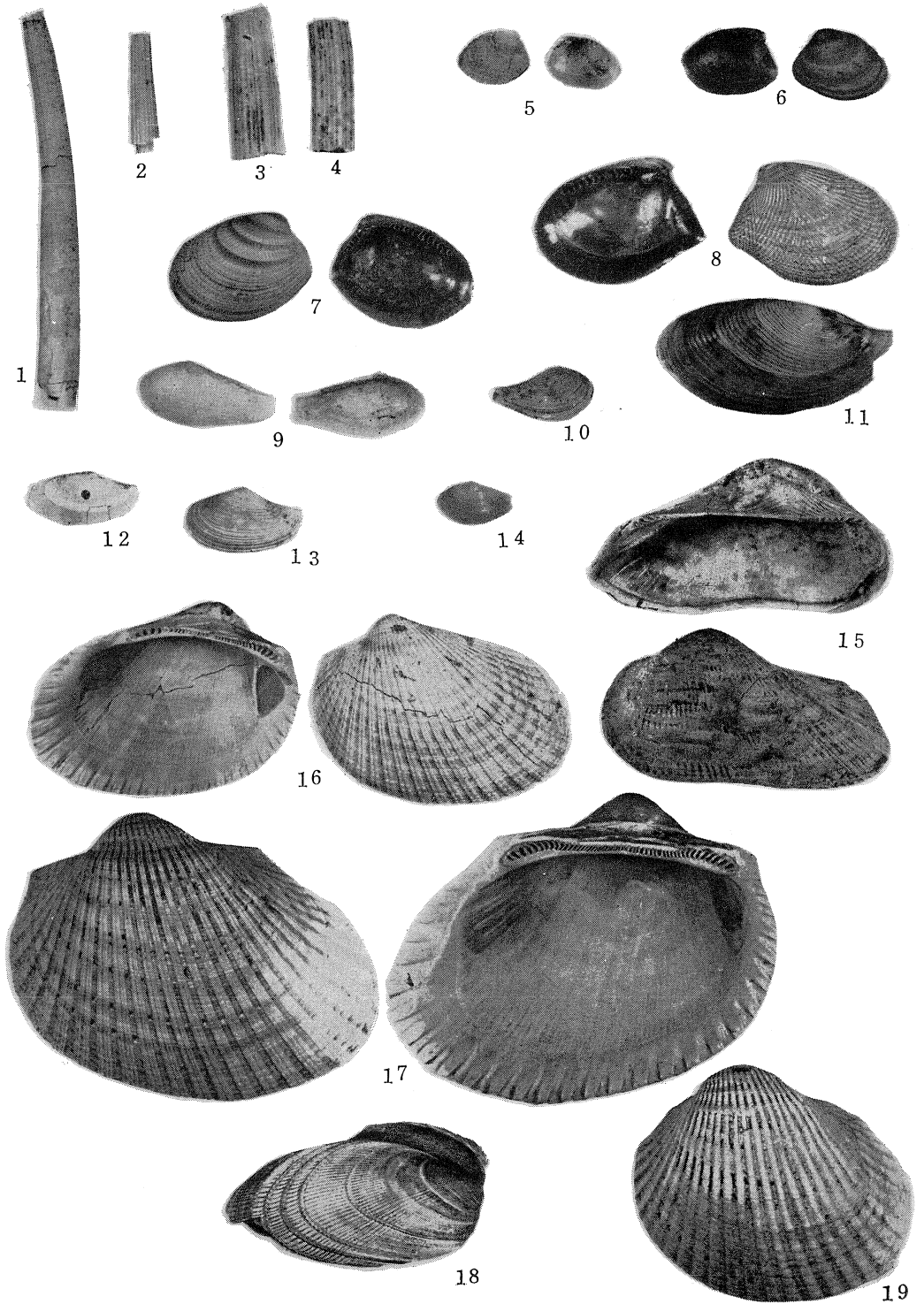


PLATE VIII

EXPLANATION OF PLATE VIII

- Fig. 1. *Pecten (Notovola) albicans* (SCHRÖTER) × 5/6 Tagami-honmachi (Loc. 18) GKZ 70178  
Fig. 2. *Pecten (Notovola) albicans* (SCHRÖTER) × 5/6 Tagami-honmachi (Loc. 18) GKZ 70179  
Fig. 3. *Pecten (Notovola) albicans* (SCHRÖTER) × 5/4 Kanegawa (Loc. 25) GKZ 70180  
Fig. 4. *Peten (Notovola) albicans* (SCHRÖTER) × 1.4 Kanegawa (Loc. 25) GKZ 70181  
Fig. 5. *Pecten (Notovola) puncticulatus* DUNKER var. × 5/6 Okuwa GKZ 70182  
Fig. 6. *Palinopecten kurosawensis* (YOKOYAMA) × 5/6 Tachi (Loc. 20) GKZ 70188  
Fig. 7. *Anomia cytaeum* GRAY × 1 Tachi (Loc. 20) GKZ 70193  
Fig. 8. *Astarte (Tridonta) borealis* (SCHUMACHER) × 1.1 Loc. ? GKZ 70198  
Fig. 9. *Astarte (Tridonta) borealis* (SCHUMACHER) ? × 1.1 Yūhidera (Loc. 12) GKZ 70199  
Fig. 10. *Astarte (Tridonta) bennetti* DALL × 2.5 Higashi-nagae (Loc. 6) GKZ 70200

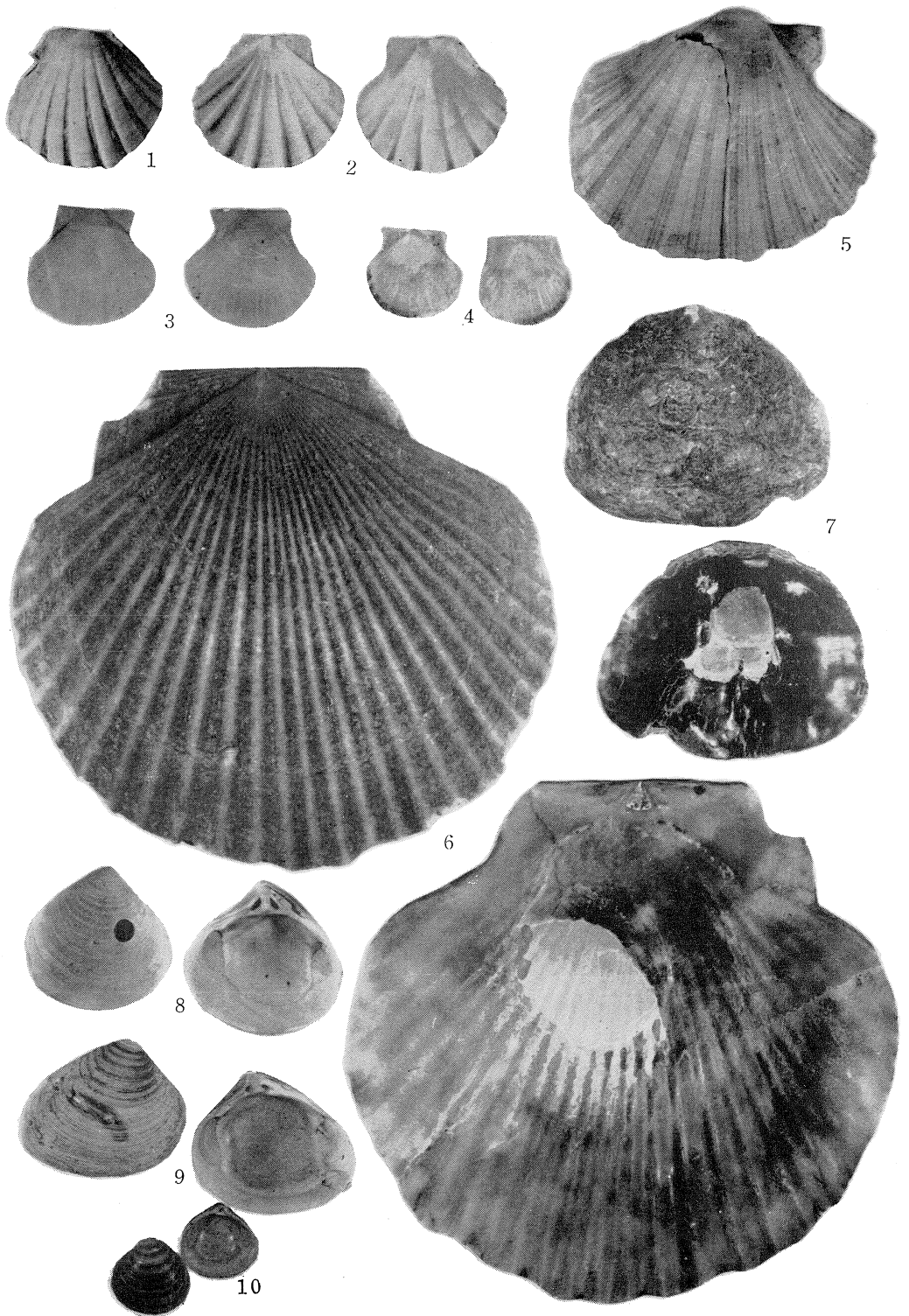


PLATE IX

EXPLANATION OF PLATE IX

- Fig. 1. *Patinopecten tokyoensis hokurikuensis* AKIYAMA × 5/6 Nagaédani GKZ 70185  
Fig. 2. *Patinopecten tokyoensis hokurikuensis* AKIYAMA × 5/6 Nagaédani GKZ 70186  
Fig. 3. *Patinopecten kurosawensis* (YOKOYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9)  
GKZ 70187  
Fig. 4. *Limatula kurodai* OYAMA × 10/3 Kakuma (Loc. 16) GKZ 70189

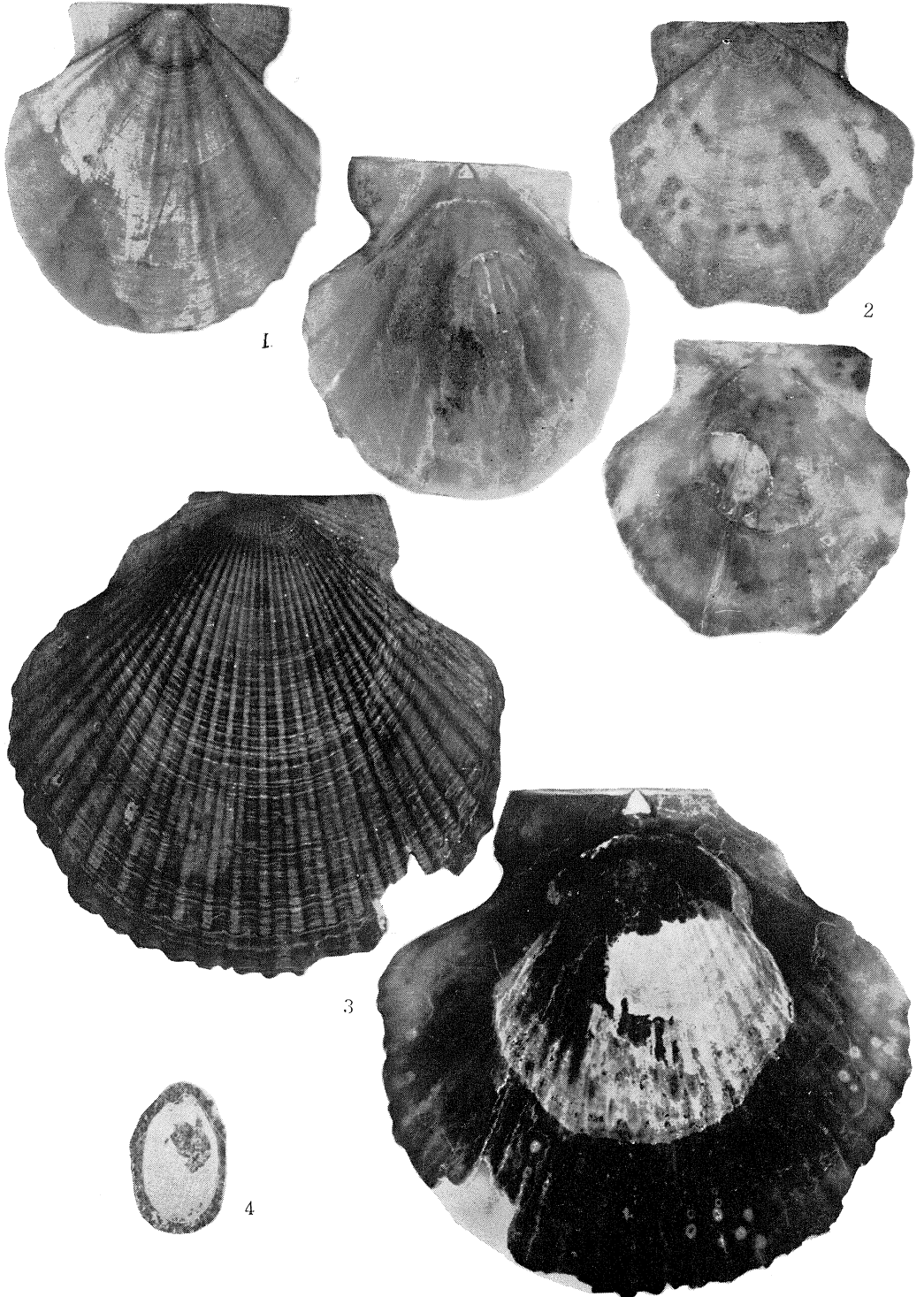




PLATE X

EXPLANATION OF PLATE X

Fig. 1. *Patinopecten yessoensis* (JAY) × 5/6 Nagaédani GKZ 70183

Fig. 2. *Monia umbonata* (GOULD) × 5/6 Kakuma (Loc. 16) GKZ 70194

Fig. 3. *Monia umbonata* (GOULD) × 1 Higashi-nagae (Loc. 6) GKZ 70195

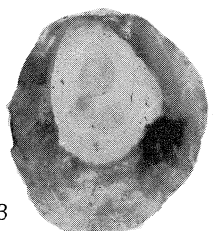
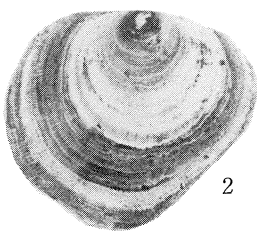


PLATE XI

EXPLANATION OF PLATE XI

- Fig. 1. *Patinopecten yessoensis* (JAY) × 5/6 Nagaédani GKZ 70183
- Fig. 2. *Venericardia* (*Megacardia*) *kiiensis cipangoana* YOKOYAMA × 1 Kakuma (Loc. 16) GKZ 70201
- Fig. 3. *Venericardia* (*Cyclocardia*) *ferruginea* CLESSIN × 1 Nagaédani GKZ 70202
- Fig. 4. *Venericardia* (*Cyclocardia*) *ferruginea* CLESSIN × 1 Nagaédani GKZ 70203
- Fig. 5. *Lima sowerbyi nipponica* OYAMA × 5/6 Shimo-araya (Loc. 29) GKZ 70190
- Fig. 6. *Venericardia* (*Miodontiscus*) *prolongata nakamurai* (YOKOYAMA) × 5/3 Higashi-nagae (Loc. 6) GKZ 70204
- Fig. 7. *Mantellum hakodatense* (TOKUNAGA) × 5/6 Shimo-araya (Loc. 29) GKZ 70192
- Fig. 8. *Joannisiella cumingi* (HANLEY) × 5/6 Okuwa (Loc. 32) GKZ 70205
- Fig. 9. *Felaniella usta* (GOULD) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70206

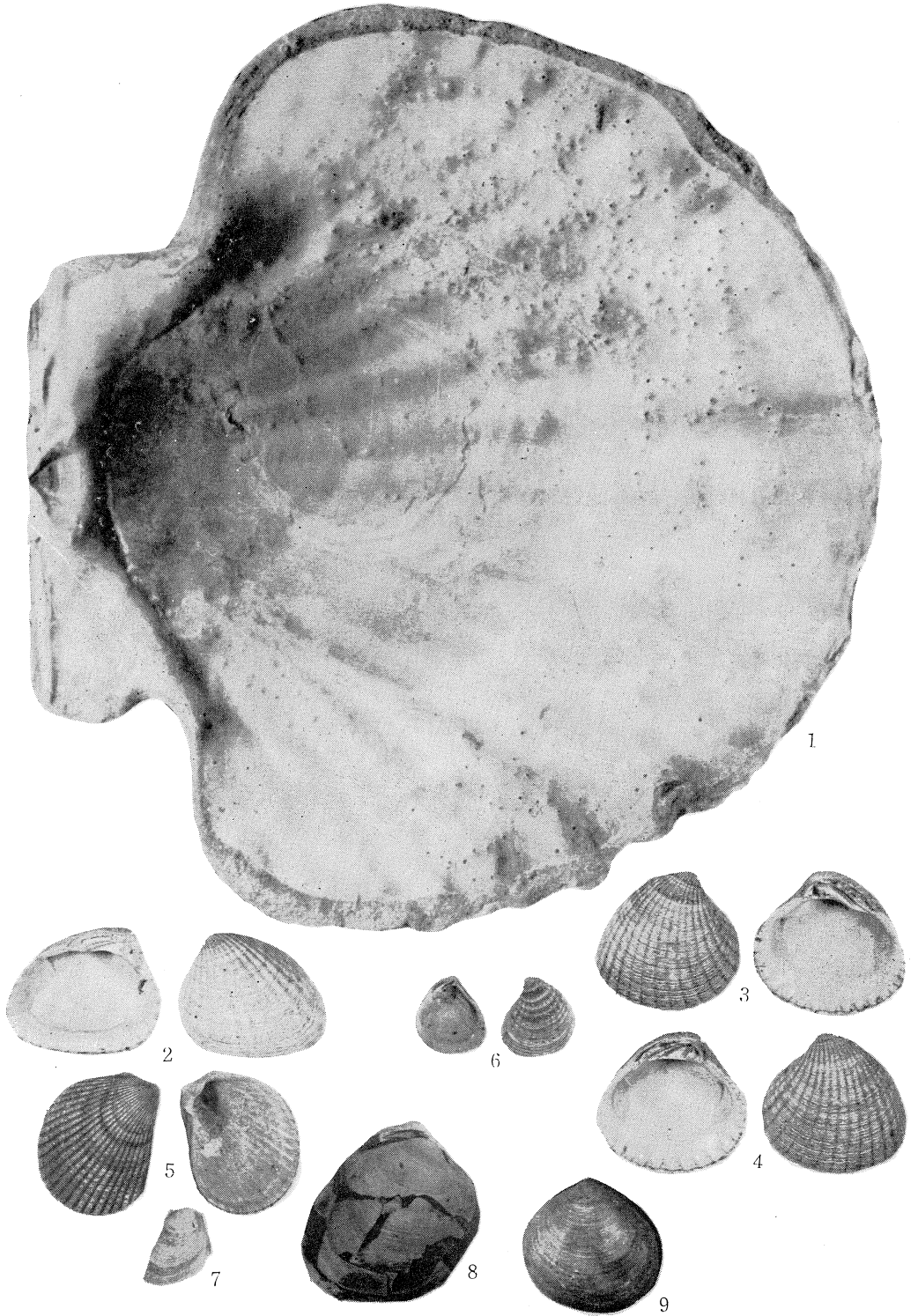


PLATE XII

EXPLANATION OF PLATE XII

Fig. 1. *Patinopecten yessoensis* (JAY) × 5/6 Nagaédani GKZ 70184

Fig. 2. *Ostrea* (*Crassostrea*) *gigas* THUNBERG × 5/6 Kanegawa (Loc 25) GKZ 70196

Fig. 3. *Notostrea musashiana* (YOKOYAMA) × 5/6 Kakuma (Loc. 16) GKZ 70197



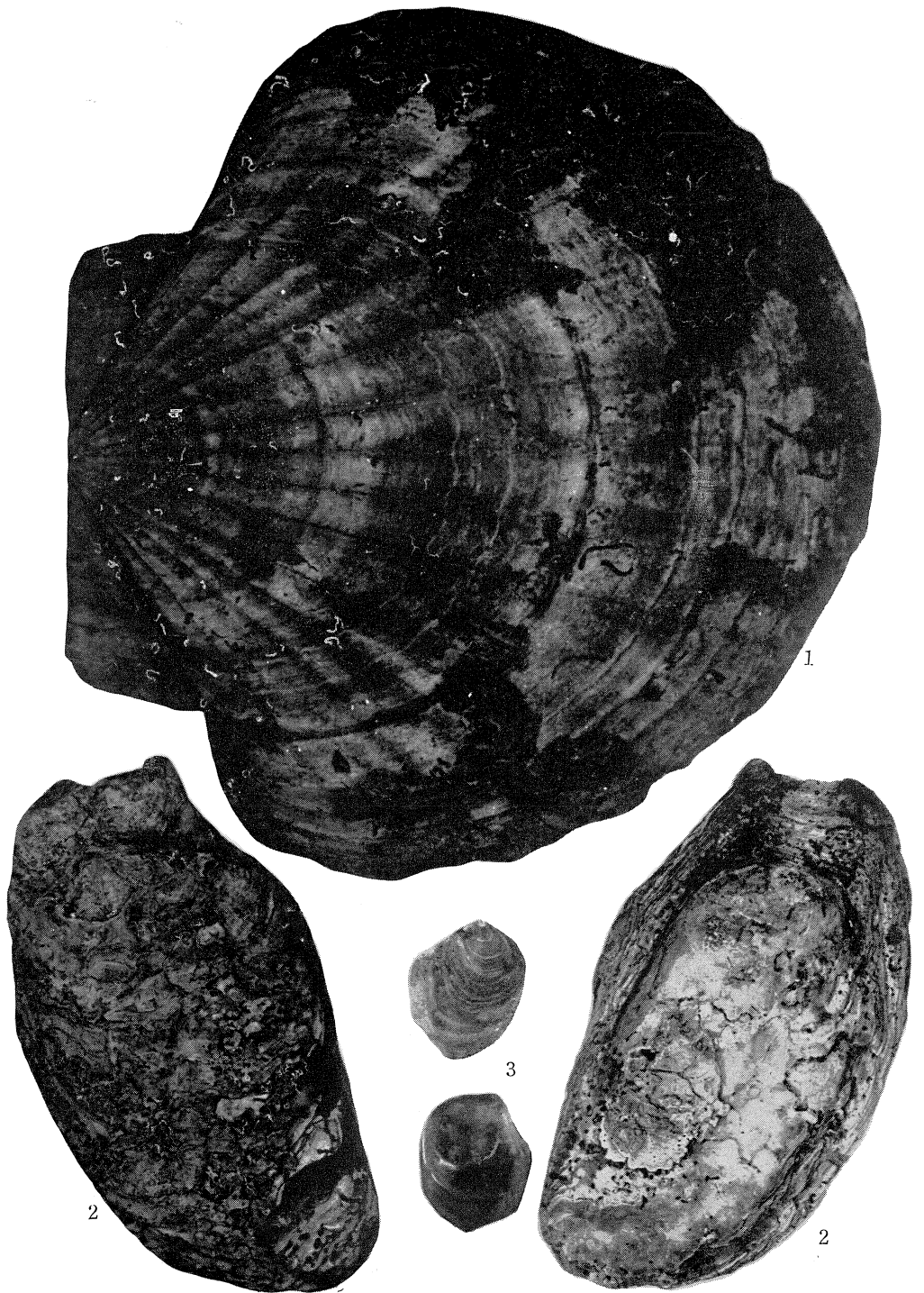


PLATE XIII

EXPLANATION OF PLATE XIII

- Fig. 1. *Patinopecten yessoensis* (JAY) × 5/6 Nagaédani GKZ 70184  
Fig. 2. *Thyasira tokunagai* KURODA et HABE × 5/3 Kakuma (Loc. 16) GKZ 70208  
Fig. 3. *Pillucina (Wallucina) lamyi* (CHAVAN) × 5/3 Shimo-araya (Loc. 29) GKZ 70214  
Fig. 4. *Axinopsida subquadrata* (A. ADAMS) × 2.5 Tachi (Loc. 20) GKZ 70209  
Fig. 5. *Lucinoma annulata* (REEVE) × 1 Shimo-araya (Loc. 29) GKZ 70210  
Fig. 6. *Alucinoma crassiuscula* (YOKOYAMA) × 1.1 Ôkuwa (Loc. 31) GKZ 70211  
Fig. 7. *Alucinoma* sp. ? × 5/3 Tachi (Loc. 20) GKZ 70212  
Fig. 8. *Bellucina civica* (YOKOYAMA) × 2.5 Ôkuwa (Loc. 31) GKZ 70215  
Fig. 9. *Nemocardium (Keenaea) samarangae* (MAKIYAMA) × 7/6 Dentôji (Loc. 12) GKZ 70216  
Fig. 10. *Clinocardium shinjiense* (YOKOYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9)  
GKZ 70217  
Fig. 11. *Clinocardium fastosum* (YOKOYAMA) × 5/6 Maki (Loc. 13) GKZ 70218  
Fig. 12. *Fulvia* sp. × 2.1 Kanegawa (Loc. 25) GKZ 70219



PLATE XIV

EXPLANATION OF PLATE XIV

- Fig. 1. *Pitar* (*Costellipitar*) *chordata* (RÖMER) ? × 1.5 Nagaé-gohyakkokudani (Loc. 9)  
GKZ 70220
- Fig. 2. *Callista chinensis* (HOLTEN) var. × 5/6 Okuwa (Loc. 31) GKZ 70221
- Fig. 3. *Mercenaria simpsoni* (GOULD) × 5/6 Kanegawa (Loc. 25) GKZ 70225
- Fig. 4. *Mercenaria simpsoni* (GOULD) × 5/6 Nagaedani GKZ 70226
- Fig. 5. *Mercenaria yokoyamai* (MAKIYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70227
- Fig. 6. *Mercenaria yokoyamai* (MAKIYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70228
- Fig. 7. *Mercenaria yokoyamai* (MAKIYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70229
- Fig. 8. *Veremolpa* sp. × 5/4 Nagaé-gohyakkokudani (Loc. 9) GKZ 70230
- Fig. 9. *Veremolpa* sp. × 5/4 Nagaé-gohyakkokudani (Loc. 9) GKZ 70231
- Fig. 10. *Liocyma aniwana* DALL × 5/6 Okuwa (Loc. 32) GKZ 70239
- Fig. 11. *Liocyma* sp. × 5/4 Maki (Loc. 14) GKZ 70240
- Fig. 12. *Gemma* sp. ? × 2.5 Kanegawa (Loc. 25) GKZ 70241

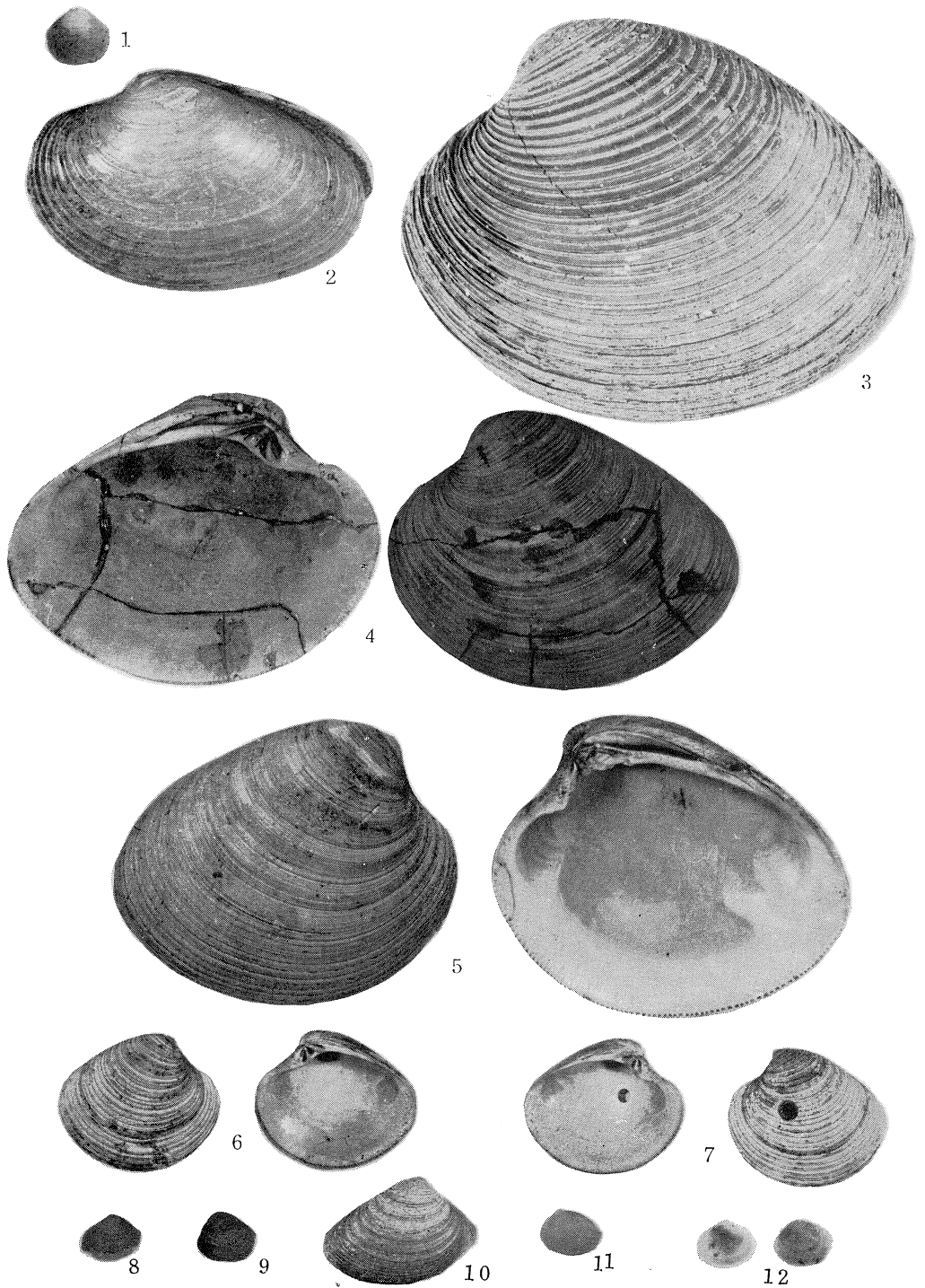


PLATE XV



EXPLANATION OF PLATE XV

- Fig. 1. *Dosinia (Dosinella) angulosa* (PHILIPPI) × 5/6 Nagaédani GKZ 70223  
Fig. 2. *Dosinia (Phacosoma) japonica* (REEVE) × 5/6 Nagaédani GKZ 70224  
Fig. 3. *Callithaca (Protocallithaca) adamsi* (REEVE) × 5/6 Nagaé-gohyakkokudani (Loc. 9)  
GKZ 70232  
Fig. 4. *Callithaca (Protocallithaca) adamsi* (REEVE) × 5/6 Nagaédani GKZ 70233  
Fig. 5. *Callithaca (Protocallithaca) adamsi* (REEVE) var. × 5/6 Nagaédani GKZ 70234  
Fig. 6. *Paphia amabilis* (PHILIPPI) × 5/6 Nagaédani GKZ 70242

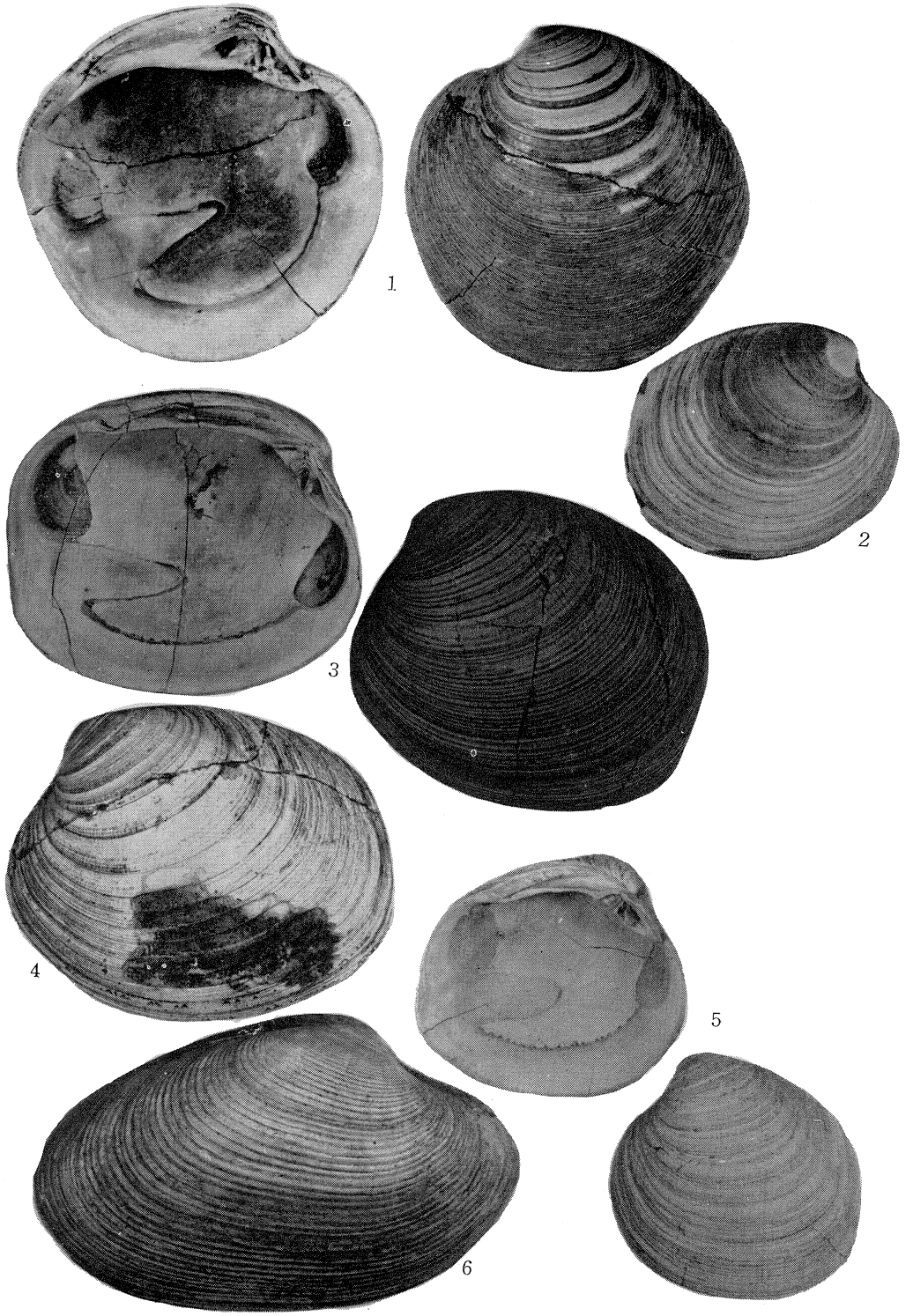


PLATE XVI

EXPLANATION OF PLATE XVI

- Fig. 1. *Pseudamiantis tauyensis* (YOKOYAMA) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70235
- Fig. 2. *Pseudamiantis tauyensis* (YOKOYAMA) × 5/6 Nagaédani GKZ 70236
- Fig. 3. *Pseudamiantis tauyensis* (YOKOYAMA) × 5/6 Nagaédani GKZ 70237
- Fig. 4. *Pseudamiantis* sp. (n. sp. ?) × 5/6 Kakuma (Loc. 16) GKZ 70238
- Fig. 5. *Clementia vatheletti* MABILLE × 5/6 Loc. ? GKZ 70243
- Fig. 6. *Clementia vatheletti* MABILLE × 5/6 Loc. ? GKZ 70244

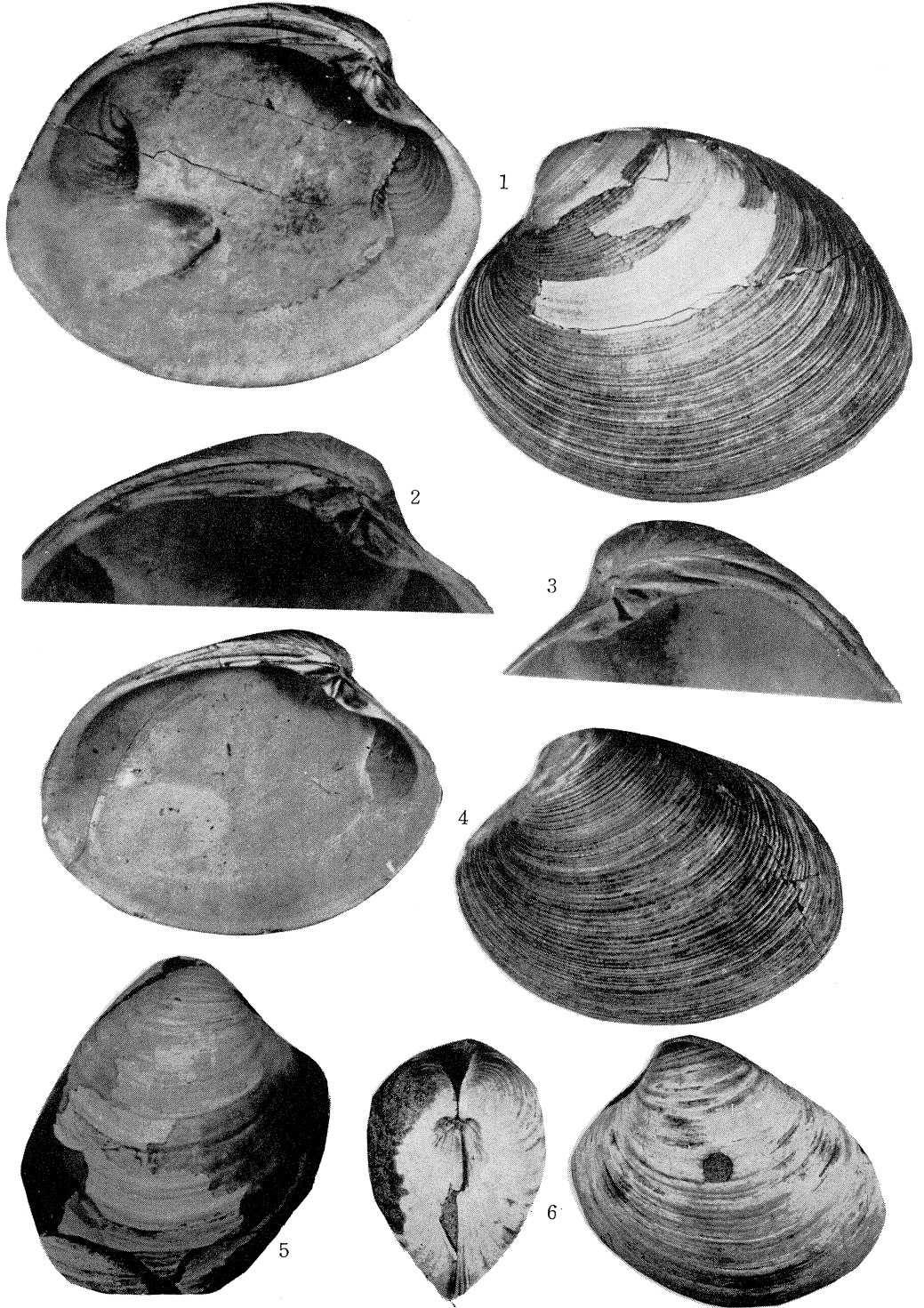


PLATE XVII

EXPLANATION OF PLATE XVII

- Fig. 1. *Spisula* sp. × 5/6 Ôkuwa (Loc. 31) GKZ 70246  
Fig. 2. *Mactra* sp. × 5/6 Ôkuwa (Loc. 31) GKZ 70247  
Fig. 3. *Spisula* (*Mactromeris*) *voyi* (GABB) × 5/6 Tachi (Loc. 20) GKZ 70245  
Fig. 4. *Macoma calcarea* (GMELIN) × 5/6 Nagaédani GKZ 70248  
Fig. 5. *Macoma calcarea* (GMELIN) × 5/6 Kakuma (Loc. 16) GKZ 70249  
Fig. 6. *Macoma middendorffi* DALL × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70252  
Fig. 7. *Macoma calcarea* (GMELIN) × 5/6 Yamashina (Loc. 34) GKZ 70251  
Fig. 8. *Macoma* sp. No. 2 × 1.5 Ôkuwa (Loc. 31) GKZ 70259  
Fig. 9. *Macoma calcarea* (GMELIN) × 1.1 Yamashina (Loc. 34) GKZ 70250  
Fig. 10. *Macoma* (*Rexithaerus*) *sectior* OYAMA × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ  
70256  
Fig. 11. *Macoma* (*Rexithaerus*) *sectior* OYAMA × 5/6 Nagaédani GKZ 70257  
Fig. 12. *Macoma nipponica* (TOKUNAGA) × 1.1 Ôkuwa (Loc. 31) GKZ 70254  
Fig. 13. *Macoma* sp. No. 1 × 5/6 Kanegawa (Loc. 25) GKZ 70258

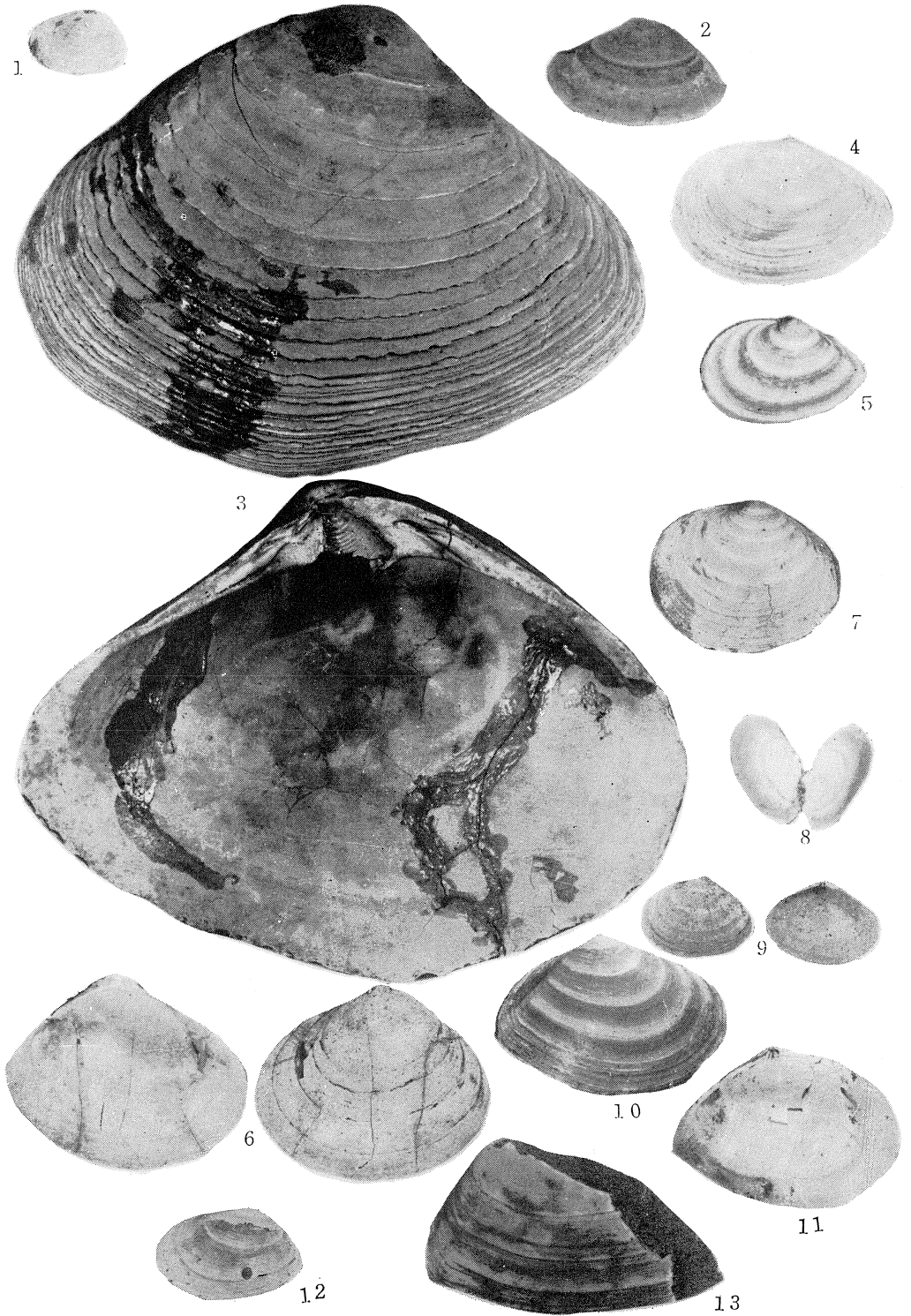




PLATE XVIII

EXPLANATION OF PLATE XVIII

- Fig. 1. *Heteromacoma yantaiensis* (CROSSE et DEBEAUX) × 5/6 Nagaédani GKZ 70260  
Fig. 2. *Macoma anser* OYAMA × 5/6 Nagaédani GKZ 70255  
Fig. 3. *Fabulina nitidula* (DUNKER) × 1.1 Ôkuwa GKZ 70261  
Fig. 4. *Lima sowerbyi nipponica* OYAMA × 5/6 Shimo-araya (Loc. 29) GKZ 70191  
Fig. 5. *Macoma praetexta* (v. MARTENS) × 5/6 Tagami-honmachi (Loc. 18) GKZ 70253  
Fig. 6. *Peronidia lutea* (WOOD) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70262  
Fig. 7. *Siliqua pulchella* (DUNKER) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70263  
Fig. 8. *Siliqua alta* (BRODERIP et SOWERBY) × 1 Loc. ? GKZ 70264  
Fig. 9. *Solen krusensternii* SCHRENCK × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70265  
Fig. 10. *Hiatella orientalis* (YOKOYAMA) × 2.1 Kakuma (Loc. 16) GKZ 70266  
Fig. 11. *Panope japonica* A. ADAMS × 5/6 Kakuma (Loc. 16) GKZ 70267  
Fig. 12. *Panope japonica* A. ADAMS × 5/6 Tachi (Loc. 20) GKZ 70268

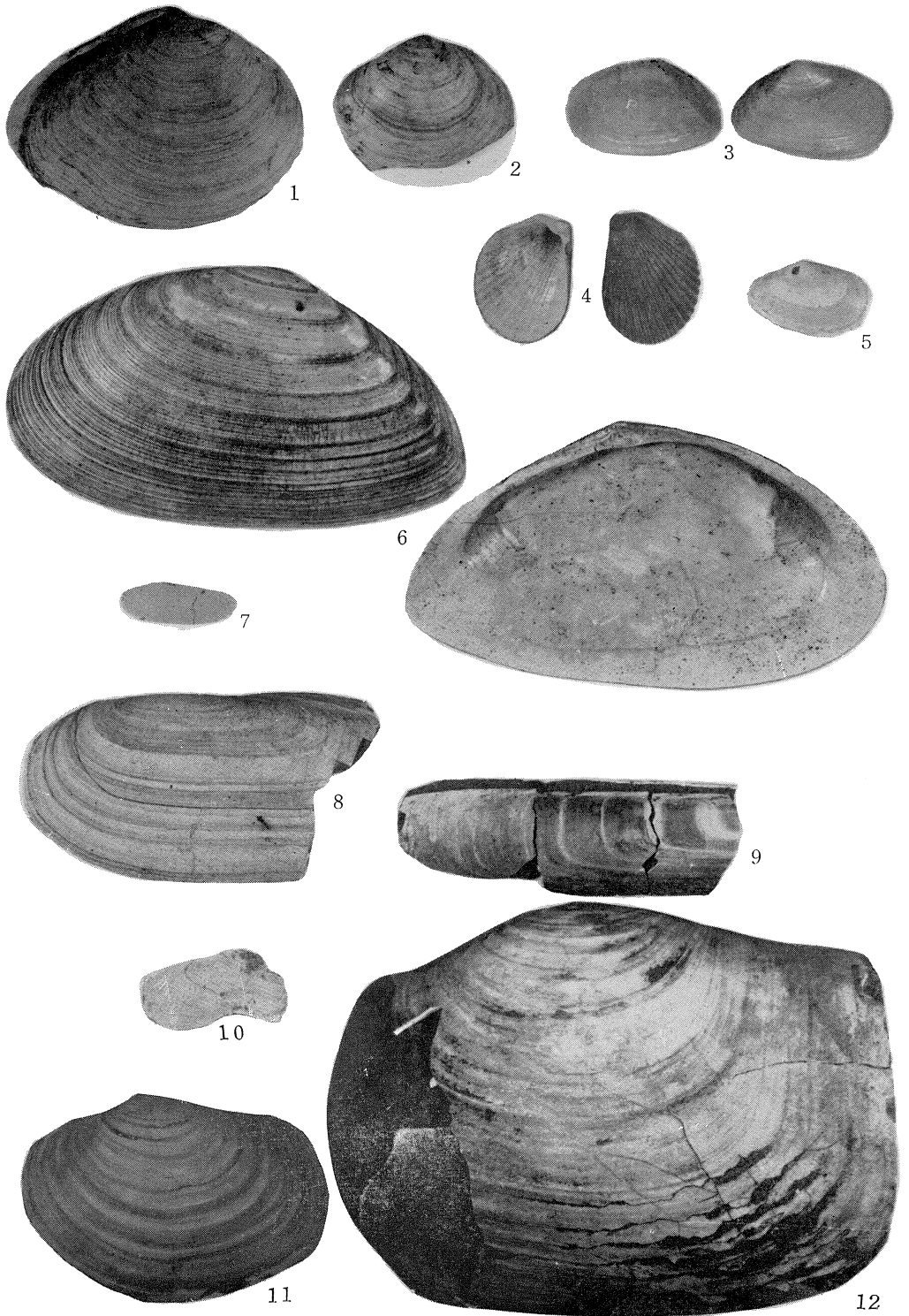


PLATE XIX

EXPLANATION OF PLATE XIX

- Fig. 1. *Cryptomya bussoensis* YOKOYAMA × 1.1 Maki (Loc. 14) GKZ 70270  
Fig. 2. *Mya (Arenomya) japonica* JAY × 5/6 Kakuma (Loc. 16) GKZ 70271  
Fig. 3. *Mya (Arenomya) japonica* JAY × 5/6 Nagaédani GKZ 70272  
Fig. 4. *Mya cuneiformis* (BÖHM) × 5/6 Tachi (Loc. 20) GKZ 70273  
Fig. 5. *Myadora japonica* HABE × 5/4 Fukuro-itaya (Loc. 28) GKZ 70277  
Fig. 6. *Myadora japonica* HABE × 5/4 Maki (Loc. 14) GKZ 70278  
Fig. 7. *Myadora japonica* HABE × 5/4 Tachi (Loc. 20) GKZ 70279  
Fig. 8. *Myadora japonica* HABE × 5/4 Higashi-nagaé (Loc. 6) GKZ 70280  
Fig. 9. *Pandora pulchella* YOKOYAMA × 5/6 Higashi-nagaé GKZ 70274  
Fig. 10. *Pandora pulchella* YOKOYAMA × 5/6 Higashi-nagaé GKZ 70275  
Fig. 11. *Pandora (Kimmerlia) pseudobilirata* NOMURA et HATAI × 5/6 Kakuma (Loc. 16) GKZ 70276  
Fig. 12. *Thracia kakumana* (YOKOYAMA) × 5/6 Maki (Loc. 14) GKZ 70281  
Fig. 13. *Cuspidaria* sp. (n. sp. ?) × 2.5 Kanegawa (Loc. 25) GKZ 70282  
Fig. 14. *Saxidomus purpuratus* (SOWERBY) × 5/6 Shimo-araya (Loc. 29) GKZ 70222  
Fig. 15. *Joannisiella cumingi* (HANLEY) × 5/6 Yamashina (Loc. 34) GKZ 70206  
Fig. 16. *Cardiomya gouldiana septentrionalis* (KURODA) × 5/4 Tagami-honmachi (Loc. 18) GKZ 70283  
Fig. 17. *Solamen diaphana* (DALL) × 5/6 Nagaé-gohyakkokudani (Loc. 9) GKZ 70169  
Fig. 18. *Crenella* sp. No. 2 (n. sp. ?) × 2.5 Kakuma (Loc. 16) GKZ 70171  
Fig. 19. *Solamen diaphana* (DALL) × 5/6 Ôkuwa GKZ 70168  
Fig. 20. *Anisocorbula modesta* (GOULD) × 5/6 Shimo-araya (Loc. 29) GKZ 70269

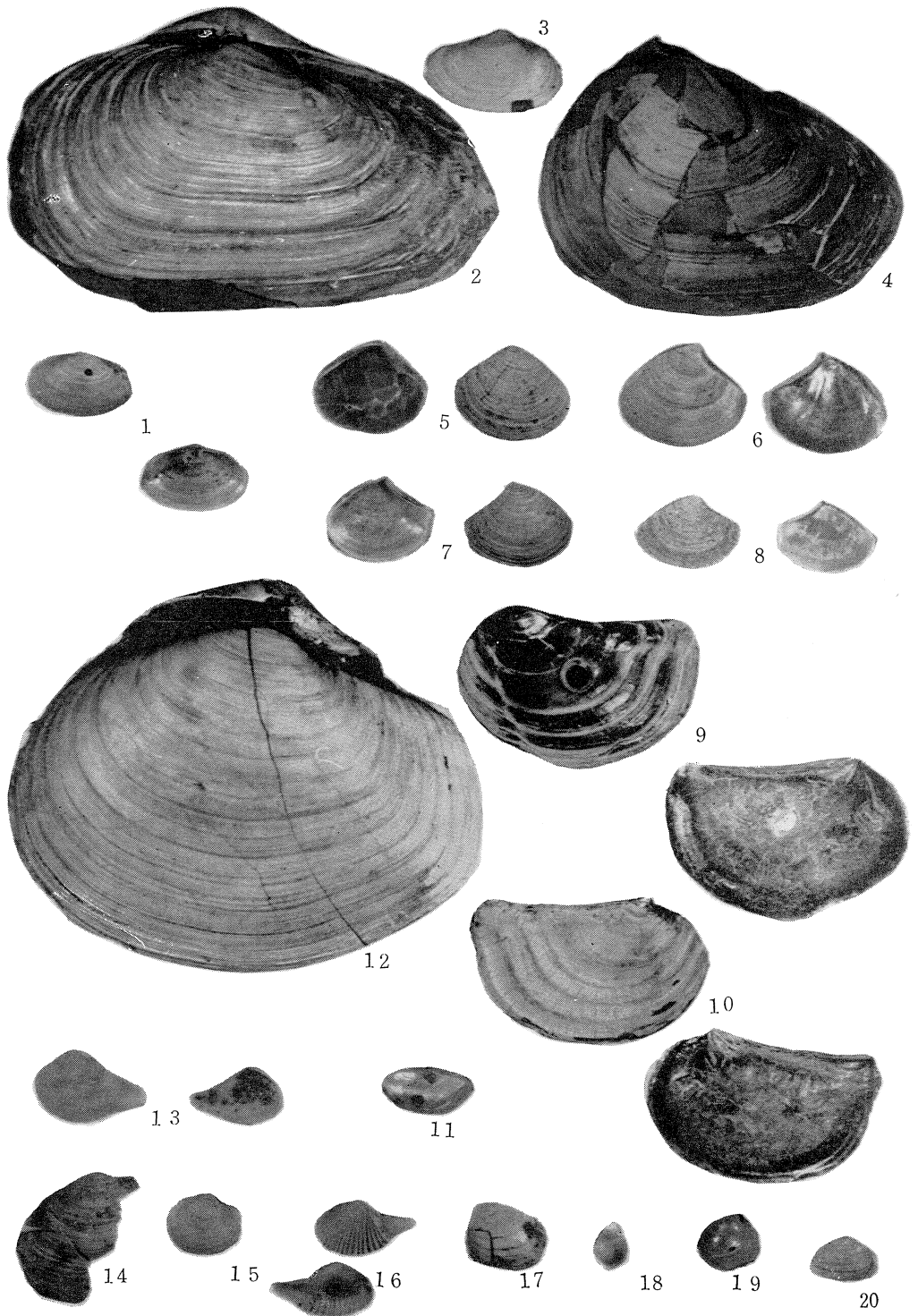


PLATE XX

## EXPLANATION OF PLATE XX

Fig. 1. White tuff layer inserted in the lower part of the Omma sandstone formation.  
A road-cutting at Yūhidera.

Fig. 2~6. Example of the exposure of shell beds in the Pliocene Omma sandstone formation  
around Kanazawa city.

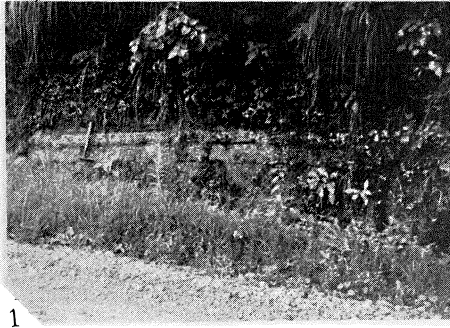
Fig. 2. Gosho (Loc. 4)

Fig. 3 and 4. Nagaé-gohyakkokudani (Loc. 9)

Fig. 5. Tagami-honmachi (Loc. 18). Crowded shells of *Turritella saishuensis* YOKOYAMA.

Fig. 6. Kanegawa (Loc. 25). Mostly closed valves of *Glycymeris yessoensis* (SOWERBY).





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