

MOLLUSCAN FAUNA OF THE MONIWA SHELL BED EXPOSED ALONG THE NATORI-GAWA IN THE VICINITY OF SENDAI, MIYAGI PREFECTURE, JAPAN

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BY

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With 3 Plates

Contents

	PAGE
I. Introduction	2
II. Locality	3
III. Fauna	3
A) Fauna of each locality	3
B) List of total forms	7
C) Numerical analysis of the fauna	9
D) Characteristic extinct species	10
IV. Palaeo-ecology	10
V. Correlation	11
VI. Climatology	13
VII. Systematic	13
A) Pelecypoda	14
B) Scaphopoda	31
C) Gastropoda	31
VIII. Summary	44
IX. Index	45

I. Introduction

The Sawoyama series,* or the older Neogene deposits in the province of Rikuzen, are well developed and quite extensive in distribution; being known to occur in the vicinity of Sendai, in the Tomiya block at the north where it is known by the name of Tomiya formation¹⁾ in the Sirasawa-Baba district at the west and in the area bordering the middle course of the river Natori at the south, and also in the Matusima-Siogama district at the northeast of the city, where it is known as the Siogama formation.²⁾

The series is roughly divisible into three beds, namely, the upper, the Sawoyama beds, middle, the Akyū beds and the lower, the Moniwa beds (see foot note of the present paper).

The lower, the Moniwa beds, is essentially marine in origin, being composed of stratified tuffaceous rocks at the upper and coarse grained sandstone and conglomerate at the lower. The size of pebbles in the conglomerate varies according to places, in certain places they are composed of huge blocks of andesitic rock.

This lower zone contains abundant fossil marine organisms, such as those of foraminifers, molluscs, brachiopods, sea urchins, cirripeds, skeletons of coral, sponge, and bryozoans, and seldom with the nest of annelids. This fossiliferous zone was already named as "The Moniwa Shell Bed."

The present paper deals exclusively with the molluscan fauna belonging to the three classes, namely, Pelecypoda, Scaphopoda and Gastropoda, collected from the said bed within a small area bordering the river Natori in the vicinity of Sendai, and is a sister paper of the previously studied Pliocene "Tatunokuti Shell Bed" (l.c.).

The fossil mollusks upon which this paper is based comprise the collection of the Saito Ho-on Kai Museum, and that of the Institute of Geology and Palaeontology, Tōhoku Imperial University, both in Sendai. The former collection was chiefly made by the present writer with the kind assistance of Messrs. K. M. HATAI and S. ITŌ during the past nine years, and the latter, though small in specific and individual number, was made by several gentlemen both present and past of the Institute.

*) Generalized stratigraphic sequence of the Neogene deposits developed in the vicinity of Sendai is as follows (NOMURA, Sci. Rep., Tōhoku Imp. Univ., ser. 2, vol. 19, no. 2, p. 236, 1938).

Quaternary		
	{	Holocene lowland deposits; sand, clay and gravel
	{	Pleistocene Aobayama beds; sand, clay and gravel
Pliocene (Sendai Umoregi series)		
Upper Umoregi beds	{	Dainenziyama shell bed
	{	Upper Umoregi bed
	{	Hirosegawa tuff
Middle Umoregi beds	{	Middle Umoregi bed
	{	Conglomerate
	{	Tatunokuti shell bed
Lower Umoregi beds	{	Lower Umoregi bed
	{	Conglomerate
Mitaki andesite and its agglomerate		
Miocene (Sawoyama series)		
Sawoyama beds	{	Cross-bedded sandstone
	{	Tuff and shale
	{	Akyū plant bed
Akyū beds	{	Akyū tuff
	{	Tuff and shale
Moniwa beds	{	Moniwa shell bed (=Akaisi shell bed)
Natorigawa andesite and its agglomerate		

1) NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 13, p. 122, 1937.

2) NOMURA, *ibid.*, no. 6, p. 193, 1935.

Before going further, I wish to express my warmest thanks to Prof. H. YABE of the Institute for his untiring encouragement and reading of this manuscript.

II. Locality

As stated above, the Moniwa shell bed occupies the lower half of the Moniwa beds. The fossil remains are especially abundant at about 10–20 meters above the underlying unconformity.

The subdivision of the Moniwa beds and the thickness of each layer as stated by H. OZAKI, 1932,¹⁾ is given in the following, in descending order:

	thickness (in m)
..... Akyū beds; massive tuff	
1. Sandy tuffite	3
2. Light brown sandy tuff	3
3. Jointy gray tuff	6
4. Tuffaceous sandstone	0.4
5. Gray massive sandy tuff containing fossil shells	6
6. Pumice bearing tuffaceous sandstone	2
7. Gray massive sandy tuff with sand pipes	5
8. Tuffaceous sandstone	0.3
9. Coarse grained sandy tuff	2
10. Greenish shale	1
11. Grayish green coarse sandstone with fossil remains	6
12. Conglomerate composed of volcanic rocks and coarse grained sandstone; fossiliferous	20
..... Natorigawa andesite and its agglomerate	

The last mentioned two layers (nos. 11 and 12) constitute the Moniwa shell bed here used.

Among a number of fossil localities that have been discovered within the region bordering the river Natori, the present specimens are from the following five localities:

1. Moniwa, Oide-mura, Natori-gun along the main course of the river Natori.
2. Minami-Akaisi, ditto.
3. Kita-Akaisi, ditto.
4. Kumanodō, Takadate-mura, ditto.
5. Goisi, Kawasaki-mura, Sibata-gun along the Goisi, a tributary of the Natori.

III. Fauna

The preservation of the fossil specimens now in question is by no means good. There are certain specimens which appear to have been worn by erosion, or crushed into pieces by wave action at the time of deposition, while others are fragile and easily fractured when separated from their compact conglomeratic matrix.

Owing to the circumstances above stated, the identification of the fossils is not easy; many forms have been left unnamed as shown in the following lists.

A) Fauna of each locality

(1) Moniwa:—In a small valley, north of the Moniwa electric power-house which stands on the left bank of the river Natori, the shell bed is excellently exposed. This is the

1) H. OZAKI, Geology of the Environs of Sendai, Graduation Thesis of the Institute of Geology and Palaeontology, Tōhoku Imperial University, Sendai, 1932 (Manuscript in Japanese).

type locality of the said bed. The lower part is composed of large andestic blocks, which upward grade into coarse sandstone and medium-sized conglomerate within about 6 meters. Abundant fossil remains of various marine organisms, such as, bryozoans, crinoid stems, corals (*Dendrophyllia* spp.), brachiopods (*Terebratulina moniwaensis* HATAI, *Coptothyris grayi* DAVIDSON), cirripeds (*Lepas* sp., *Balanus* sp.), nest of annelids, shark's teeth (*Isurus hastalis* AGASSIZ) and shells of molluscs are found. Among the animal remains just mentioned, those of the molluscs are most abundant, and arranged in various directions. The distinguished forms are the following:

Pelecypoda

1. *Nuculana moniwaensis* n. sp. Rare
2. *Pseudogrammatodon dalli* (SMITH) Rare
3. *Glycymeris* species indet. Frequent
4. *Pecten* (s.s.) *kagamianus* YOKOYAMA Frequent
5. *Pecten* (*Chlamys*) *arakawai* NOMURA Rare
6. *Pecten* (*Chlamys*) *protomollitus* NOMURA Abundant
7. *Pecten* (*Chlamys*) *notoensis* YOKOYAMA Frequent
8. *Pecten* (*Aequipecten*) *yanagawaensis* NOMURA and ZINBÔ Frequent
9. *Pecten* (*Pseudamusium*) *akihoënsis* MATSUMOTO Rare
10. *Lima* (*Limatula*) *subauriculata* MONTAGU Rare
11. *Ostrea sinensis* GMELIN Rare
12. *Crassatellites paucillus* (YOKOYAMA) Rare
13. *Lucina* species indet. Rare
14. *Cardium* (*Trachycardium* ?) *shiobarensis* YOKOYAMA Frequent
15. *Venus yokoyamai* MAKIYAMA Rare
16. *Paphia* (s.s.) *takadatensis* (MATSUMOTO) Frequent
17. *Pitar itoi* (MAKIYAMA) Rare
18. *Dosinia kaneharai* YOKOYAMA Rare
19. *Mactra* (*Spisula*) *polynyma voyi* GABB Rare
20. *Macoma* (s.s.) *tokyoensis* MAKIYAMA Rare

Scaphopoda

21. *Dentalium* cf. *weinkauffi* DUNKER Rare

Gastropoda

22. *Trochus* (s.s.) *oidensis* n. sp. Rare
23. *Polinices* (s.s.) cf. *melanostoma* (GMELIN) Rare
24. *Sinum* (s.s.) *yabei* OTUKA Rare
25. *Phalium* (*Semicassis*) cf. *japonicum* (REEVE) Rare
26. *Neptunea koromogawana* NOMURA Rare
27. *Conus moniwaensis* n. sp. Rare¹⁾

2) Minami-Akai:—At the junction of an unnamed tributary which empties into the main stream at Minami-Akai, about 2 km along the upper coarse from Moniwa, huge andestic blocks are cemented together by fossiliferous hard calcareous matter. In this locality, several molluscan specimens together with a few of *Coptothyris grayi* are found. The distinguished forms of molluscs are the following:

Pelecypoda

1. *Pseudogrammatodon dalli* (SMITH) Frequent
2. *Pecten* (*Chlamys*) *arakawai* NOMURA Rare

1) One species of Pelecypoda, *Placunomia ingens* YOKOYAMA now referred to *Pododesmus macroschismus* (*Deshayes*) was reported by MATSUMOTO from Moniwa in his paper entitled "On the Marine Fauna of Three Zones of the Upper Miocene of Natori District, Province of Rikuzen (Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 13, no. 3, 1930).

3. *Pecten (Chlamys) notoensis* YOKOYAMARare
4. *Ostrea* species indet.Rare
5. *Taras cumingi* (HANLEY)Rare
6. *Dosinia kaneharai* YOKOYAMARare
7. *Panope japonica* (A. ADAMS)Rare

Gastropoda

8. *Haliotis japonica* REEVERare
9. *Tegula (Chlorostoma) protonigerrima* n. sp.Rare
10. *Trochus* (s.s.) *oidensis* n. sp.Frequent
11. *Trochus* (s.s.) species indet.Rare
12. *Turcica preimperialis* n. sp.Rare
13. *Turbo parvuloides* n. sp.Abundant
14. *Xenophora* cf. *exuta* (REEVE)Rare
15. *Cypraea* species indet.Rare
16. *Morum macandrewi* (SOWERBY)Rare
17. *Siphonalia prespadicea* NOMURA and ZINBÔRare
18. *Babylonia* species indet.Rare
19. *Murex* species indet.Rare

(3) Kita-Akai:—In the river floor and road-side cutting near the Akyû electric car station at Kita-Akai, a short distance from the preceding locality, there are excellent exposures of conglomerate and coarse grained sandstone containing fossil marine organisms. The fossils constitute the following members: foraminifers (*Lepidocyclina polygonalis* HANZAWA, *L. japonica* YABE), sponge (*Aphrocallistes* sp.), coral (*Dendrophyllia* sp.), brachiopod (*Coptothyris grayi* DAVIDSON) and molluscs.

Of the fossil remains just mentioned, molluscs alone are predominating. The forms distinguished are given below.

Pelecypoda

1. *Arca* (s.s.) cf. *ocellata* REEVERare
2. *Pseudogrammatodon dalli* (SMITH)Frequent
3. *Glycymeris* species indet.Frequent
4. *Pecten* (s.s.) *kagamianus* YOKOYAMARare
5. *Pecten (Chlamys) arakawai* NOMURAFrequent
6. *Pecten (Chlamys) cf. kaneharai* YOKOYAMARare
7. *Pecten (Chlamys) nisataiensis* OTUKARare
8. *Pecten (Chlamys) notoensis* YOKOYAMAFrequent
9. *Pecten (Aequipecten) yanagawaensis* NOMURA and ZINBÔRare
10. *Pecten (Pseudamusium) akihoënsis* MATSUMOTOFrequent
11. *Lima (Acesta) cf. goliath* SOWERBYRare
12. *Spondylus* species indet.Rare
13. *Ostrea* species indet.Rare
14. *Taras ustus* (GOULD)Rare
15. *Lucina* species indet.Rare
16. *Chama* species indet.Rare
17. *Cardium (Trachycardium ?) shiobarensis* YOKOYAMARare
18. *Paphia* (s.s.) cf. *takadatensis* (MATSUMOTO)Rare
19. *Pitar itoi* (MAKIYAMA)Rare
20. *Dosinia nomurai* OTUKARare
21. *Dosinia kaneharai* YOKOYAMAFrequent
22. *Solen* species indet.Rare
23. *Mya* cf. *arenaria* LINNÉRare
24. *Panope japonica* (A. ADAMS)Abundant

Gastropoda

25. *Acmaea* species indet. Rare
26. *Tegula* (*Chlorostoma*) *protonigerrima* n. sp. Rare
27. *Trochus* (s.s.) *oidensis* n. sp. Rare
28. *Turcica* *preimperialis* n. sp. Rare
29. *Capulus* *natorianus* n. sp. Rare
30. *Cheilea* *yanagawaensis* NOMURA and ZINBÔ Rare
31. *Xenophora* cf. *exuta* (REEVE) Frequent
32. *Phalium* (*Doliocassis*) *yabei* NOMURA and HATAI Rare
33. *Bursa* (*Ranella*) *yabei* NOMURA and HATAI Rare
34. *Argobuccinum* (*Fusitriton*) *nipponense natorianum* n. subsp. Rare
35. *Siphonalia* *prespadicea* NOMURA and ZINBÔ Rare
36. *Siphonalia* cf. *gravitesta* NOMURA and ZINBÔ Rare
37. *Neptunea* (?) species indet. Rare
38. *Nassarius* species indet. Rare
39. *Ocenebra* (?) species indet. Rare
40. *Surculites* (*Megasurcula*) *siogamensis* NOMURA Rare

(4) Goisi:—An impure limestone layer consisting of fragments of shells of molluscs and cirripeds, about 2 meters in thickness is exposed at the river cliff, northeast, or a short distance from Goisi village, along the river Goisi. This river is a large tributary of the Natori, and meets the main stream at the Goisi electric power-house, near Kita-Akaisi, mentioned above.

Fossils of molluscs, cirriped (*Balanus* sp.) and brachiopods (*Terebratalia* sp., *Coptothyris grayi* DAVIDSON) are abundantly found in the limestone as well as upwards to the sandy tuff bed within several meters. The forms distinguished are listed below:

Pelecypoda

1. *Pseudogrammatodon dalli* (SMITH) Rare
2. *Glycymeris* species indet. Frequent
3. *Pecten* (*Chlamys*) *arakawai* NOMURA Frequent
4. *Pecten* (*Chlamys*) *nisataiensis* OTUKA Rare
5. *Pecten* (*Aequipecten*) *yanagawaensis* NOMURA and ZINBÔ Rare
6. *Anomia* *cytaeum* GRAY Rare
7. *Cardium* (*Cerastoderma* ?) *goisiense* n. sp. Rare
8. *Dosinia* cf. *kaneharai* YOKOYAMA Rare
9. *Dosinia* *nomurai* OTUKA Rare
10. *Pitar* *itoi* (MAKIYAMA) Rare
11. *Mactra* (*Spisula*) *polynyma voyi* (GABB) Rare
12. *Schizothaerus* cf. *nuttallii* (CONRAD) Rare

Gastropoda

13. *Trochus* (s.s.) *goisiensis* n. sp. Rare
14. *Turbo* species indet., Operculum Rare
15. *Crepidula* cf. *aculeata* (GMELIN) Rare
16. *Xenophora* cf. *exuta* (REEVE) Rare
17. *Siphonalia* *prespadicea* NOMURA and ZINBÔ Rare

(5) Kumanodô:—At the northern foot of the Takadate hill, a short distance west of the Kumanodô shrine, Takadate-mura, there are a number of caves in which ancient man lived. These caves are locally called "Ezo-ana." The fossil remains of bryozoans, coral (*Flabellum* sp.) brachiopods (*Coptothyris grayi* DAVIDSON, *Terebratulina crossei* DAVIDSON), sea urchin (*Echinolampas yoshiwarai* P. DE LORIOU) and molluscs are found in the vicinity of the so-called Ezo-ana. The bed is composed of fine to medium sized conglomerate, full of fossil remains, especially molluscs and one species of brachiopod, *Coptothyris grayi* (DAVIDSON). The molluscan species are:

Pelecypoda

1. *Glycymeris* species indet. Frequent
2. *Pecten* (s.s.) *kagamianus* YOKOYAMA Frequent
3. *Pecten* (*Chlamys*) *arakawai* NOMURA Rare
4. *Pecten* (*Chlamys*) *notoensis* YOKOYAMA Abundant
5. *Pecten* (*Aequipecten*) *yanagawaensis* NOMURA and ZINBÔ Rare
6. *Pecten* (*Pseudamustum*) *akihoënsis* MATSUMOTO Frequent
7. *Crassatellites paucillus* (YOKOYAMA) Frequent
8. *Ostrea* species indet. Frequent
9. *Taras cumingi* (HANLEY) Rare
10. *Venus yokoyamai* MAKIYAMA Rare
11. *Paphia* (s.s.) *takadatensis* (MATSUMOTO) Frequent
12. *Dosinia nomurai* OTUKA Rare
13. *Saxidomus* cf. *nuttalli* (CONRAD) Frequent
14. *Mactra* (?) *charischema* (MATSUMOTO) Rare
15. *Panope japonica* (A. ADAMS) Rare

Gastropoda

16. *Turcica premerialis* n. sp. Rare¹⁾

B) List of total forms

The total distinguished species and subspecies including specifically indeterminable forms are tabulated below to show the relation of the faunae of each locality.

Species	Locality ²⁾	I	II	III	IV	V	Remarks
Class Pelecypoda							
Family Nuculanidae							
1. <i>Nuculana moniwaensis</i> n. sp.		×					Extinct
Family Arcidae							
2. <i>Arca</i> (s.s.) cf. <i>ocellata</i> REEVE				×			Living ?
3. <i>Pseudogrammatodon dalli</i> (SMITH)		×	×	×	×		Living
Family Glycymeridae							
4. <i>Glycymeris</i> species indet.		×	×	×	×	×	
Family Pectinidae							
5. <i>Pecten</i> (s.s.) <i>kagamianus</i> (YOKOYAMA)		×		×		×	Extinct
6. <i>Pecten</i> (<i>Chlamys</i>) <i>arakawai</i> NOMURA		×	×	×	×	×	Extinct
7. <i>Pecten</i> (<i>Chlamys</i>) <i>kaneharai</i> YOKOYAMA				×			Extinct
8. <i>Pecten</i> (<i>Chlamys</i>) <i>protomollitus</i> NOMURA		×					Extinct
9. <i>Pecten</i> (<i>Chlamys</i>) <i>nisataiensis</i> OTUKA			×		×		Extinct
10. <i>Pecten</i> (<i>Chlamys</i>) <i>notoensis</i> YOKOYAMA		×	×	×		×	Extinct

¹⁾ MATSUMOTO (1930, l.c.) recorded the following fossils from Kumanodô; *Yoldia lischkei* SMITH, *Pectunculus yamakawai* YOKOYAMA, *Limopsis chitaniana* YOKOYAMA, *Limopsis crenata* A. ADAMS, *Diplodonta semiaspera* PHILIPPI, *Diplodonta japonica* PILSBRY, *Cardium pauperculum* YOKOYAMA, *Cyclina chinensis* (CHEMNITZ), *Meretrix* (*Callista*) *chinensis* (CHEMNITZ), *Venus rigida* GOULD, *Clementia speciosa* YOKOYAMA, *Tellina chibana* YOKOYAMA, *Psammobia oriens* DESHAYES, *Solen grandis* DUNKER, *Entodesma lago-veneris* MATSUMOTO, *Mactra charischema* MATSUMOTO, *Lutraria sieboldi* DESHAYES, *Lutraria takadatensis* MATSUMOTO, *Lima dunkeri* SMITH, *Pecten islandicus* MÜLLER, *Pecten akitanus* YOKOYAMA, *Pecten natoriensis* MATSUMOTO, *Pecten natoriensis* var. *subovalis* MATSUMOTO, *Pecten natoriensis* var. *inequilateralis* MATSUMOTO, *Pecten plicicostulatus* MATSUMOTO, *Pecten* (*Pseudamustum*) *akihoënsis* MATSUMOTO, *Velopecten survivans* MATSUMOTO, *Anomia nipponensis* YOKOYAMA, *Anomia lischkei* DAUTZENBERG and FISCHER, *Anomia lunula* YOKOYAMA, *Placunomia ingens* YOKOYAMA, *Ostrea cucullata* BORN, *Dentalium complexum* DALL, *Crepidula yokoyamai* MATSUMOTO, *Conus sieboldi* REEVE, *Balanus bisulcatus* DARWIN, *Balanus floesculus* DARWIN var. *orientalis* MATSUMOTO, *Liothyryna davidsoni* (A. ADAMS), *Terebratalia smithi* ARNOLD, *Pereudesia grayi* (DAVIDSON), *Isurus hastalis* (AGASSIZ).

Of the species mentioned by MATSUMOTO, a very few of them are represented in the present collections now under examination; this is partly due to the abundancy of specimens and partly due to the different denominations of species.

²⁾ I = Moniwa: II = Minami-Akai: III = Kita-Akai: IV = Goisi: V = Kumanodô.

Species	Locality	I	II	III	IV	V	Remarks
11. <i>Pecten (Aequipecten) yanagawaensis</i> NOMURA and ZINBÔ		×		×	×	×	Extinct
12. <i>Pecten (Pseudamusium) akihoënsis</i> MATSUMOTO		×		×		×	Extinct
13. <i>Spondylus</i> species indet.				×			
Family Limidae							
14. <i>Lima (Acesta) goliath</i> SOWERBY				×			Living?
15. <i>Lima (Limatula) subauriculata</i> (MONTAGU)		×					Living
Family Anomiidae							
16. <i>Anomia cytaeum</i> GRAY					×		Living
Family Ostreidae							
17. <i>Ostrea sinensis</i> GMELIN		×					Living
18. <i>Ostrea</i> species indet.			×	×		×	
Family Crassatellidae							
19. <i>Crassatellites paucillus</i> (YOKOYAMA)		×				×	Extinct
Family Ungulinidae							
20. <i>Taras cumingi</i> (HANLEY)			×			×	Living
21. <i>Taras ustus</i> (GOULD)				×			Living
Family Lucinidae							
22. <i>Lucina</i> species indet.		×		×			
Family Chamidae							
23. <i>Chama</i> species indet.				×			
Family Cardiidae							
24. <i>Cardium (Trachycardium ?) shiobarensis</i> YOKOYAMA		×		×			Extinct
25. <i>Cardium (Cerastoderma ?) goisiense</i> n. sp.					×		Extinct
Family Veneridae							
26. <i>Venus yokoyamai</i> MAKIYAMA		×				×	Extinct
27. <i>Dosinia nomurai</i> OTUKA				×	×	×	Extinct
28. <i>Dosinia kaneharai</i> YOKOYAMA		×	×	×	×		Extinct
29. <i>Pitar itoi</i> (MAKIYAMA)		×		×	×		Extinct
30. <i>Saxidomus</i> cf. <i>nuttallii</i> (CONRAD)						×	Living?
31. <i>Paphia</i> (s.s.) ? <i>takadatensis</i> (MATSUMOTO)		×		×		×	Extinct
Family Mactridae							
32. <i>Mactra</i> (?) <i>charischema</i> MATSUMOTO						×	Extinct
33. <i>Mactra (Spisula) polynyma voyi</i> (GABB)					×		
34. <i>Schizothaerus</i> cf. <i>nuttallii</i> (CONRAD)					×		
Family Tellinidae							
35. <i>Macoma</i> (s.s.) <i>tokyoensis</i> MAKIYAMA		×					Living
Family Solenidae							
36. <i>Solen</i> species indet.				×			
Family Hiatellidae							
37. <i>Panope</i> (s.s.) <i>japonica</i> (A. ADAMS)			×	×		×	Living
Family Myidae							
38. <i>Mya arenaria</i> LINNE				×			Living
Class Scaphopoda							
Family Dentaliidae							
39. <i>Dentalium</i> cf. <i>weinkauffi</i> DUNKER		×					Living?
Class Gastropoda							
Family Haliotidae							
40. <i>Haliotis japonica</i> REEVE			×				Living
Family Aemaedae							
41. <i>Aemaia</i> species indet.				×			
Family Trochidae							
42. <i>Trochus</i> (s.s.) <i>goisiensis</i> n. sp.					×		Extinct
43. <i>Trochus</i> (s.s.) <i>oidensis</i> n. sp.		×	×	×			Extinct
44. <i>Trochus</i> (s.s.) species indet.		×					
45. <i>Tegula (Chlorostoma) protonigerrima</i> n. sp.			×	×			Extinct
46. <i>Turcica preimperialis</i> n. sp.			×	×		×	Extinct

Species	Locality	I	II	III	IV	V	Remarks
Family Turbinidae							
47. <i>Turbo parvuloides</i> n. sp.			×				..Extinct
48. <i>Turbo</i> species indet. (Operculum)					×		
Family Hipponycidae							
49. <i>Cheilea yanagawaensis</i> NOMURA and ZINBÔ					×		
Family Capulidae							
50. <i>Capulus notorianus</i> n. sp.					×		
Family Calyptraeidae							
51. <i>Crepidula</i> cf. <i>aculeata</i> (GMELIN)						×	..Living
Family Xenophoridae							
52. <i>Xenophora</i> cf. <i>eruta</i> (REEVE)				×	×	×	..Living?
Family Naticidae							
53. <i>Polinices</i> (s.s.) cf. <i>melanostoma</i> (GMELIN)		×					..Living?
54. <i>Sinum</i> (s.s.) <i>yabei</i> OTUKA		×					..Extinct
Family Cypraeidae							
55. <i>Cypraea</i> species indet.		×					
Family Cassididae							
56. <i>Morum macandrewi</i> (SOWERBY)		×					..Living
57. <i>Phalium</i> (<i>Semicassis</i>) cf. <i>japonicum</i> (REEVE)		×					..Living?
58. <i>Phalium</i> (<i>Doliocassis</i>) <i>yabei</i> NOMURA and HATAI				×			..Extinct
Family Cymatiidae							
59. <i>Argobuccinum</i> (<i>Fusitriton</i>) <i>nipponense</i> <i>natorianum</i> n. subsp.				×			..Extinct
Family Bursidae							
60. <i>Bursa</i> (<i>Ranella</i>) <i>yabei</i> NOMURA and HATAI				×			..Extinct
Family Muricidae							
61. <i>Murex</i> species indet.			×				
62. <i>Tritonalia</i> (?) species indet.				×			
Family Buccinidae							
63. <i>Siphonalia</i> (s.s.) <i>prespadicea</i> NOMURA and ZINBÔ			×	×	×		..Extinct
64. <i>Siphonalia</i> (s.s.) cf. <i>gravitesta</i> NOMURA and ZINBÔ				×			..Extinct
65. <i>Babylonia</i> species indet.			×				
66. <i>Neptunea koromogawana</i> NOMURA		×					..Extinct
67. <i>Neptunea</i> ? species indet.				×			
Family Nassariidae							
68. <i>Nassarius</i> (<i>Hinia</i> ?) species indet.				×			
Family Turridae							
69. <i>Surculites</i> (<i>Megasurcula</i>) <i>siogamensis</i> NOMURA				×			..Extinct
Family Conidae							
70. <i>Conus moniwanus</i> n. sp.		×					..Extinct

C) Numerical analysis of the fauna

The 70 forms listed above show the following analysis, namely:

1. Number of forms of Pelecypoda	38
2. Number of forms of Scaphopoda	1
3. Number of forms of Gastropoda	21
4. Number of forms specifically determined	44
5. Number of specifically determined Pelecypoda	27
6. Number of specifically determined Scaphopoda	0
7. Number of specifically determined Gastropoda	17
8. Number of forms specifically indetermined	15
9. Number of specifically indetermined Pelecypoda	6
10. Number of specifically indetermined Scaphopoda	0
11. Number of specifically indetermined Gastropoda	9
12. Number of forms specifically questionable	11

13. Number of forms specifically questionable, but with recent affinity	10
14. Number of forms specifically questionable, but with extinct affinity	1
15. Number of extinct forms, specifically determined	33
16. Number of living forms specifically determined	11
17. Number of forms new to science	9

D) Characteristic extinct species

Excepting the new species which are described in this paper, the following ones are perhaps most important for the correlation and consideration of the probable age of the Moniwa fauna.

- 1) *Pecten (s.s.) kagamianus* YOKOYAMA
- 2) *Pecten (Chlamys) arakawai* NOMURA
- 3) *Pecten (Chlamys) kaneharai* YOKOYAMA
- 4) *Pecten (Chlamys) protomollitus* NOMURA
- 5) *Pecten (Chlamys) nisataiensis* OTUKA
- 6) *Pecten (Chlamys) notoensis* YOKOYAMA
- 7) *Pecten (Aequipecten) yanagawaensis* NOMURA and ZINBÔ
- 8) *Crassatellites pauxillus* (YOKOYAMA)
- 9) *Cardium (Trachycardium ?) shiobarensis* YOKOYAMA
- 10) *Dosinia nomurai* OTUKA
- 11) *Dosinia kaneharai* YOKOYAMA
- 12) *Pitar itoi* (MAKIYAMA)
- 13) *Cheilea yanagawaensis* NOMURA and ZINBÔ
- 14) *Sinum yabei* OTUKA
- 15) *Phalium (Doliocassis) yabei* NOMURA and HATAI
- 16) *Argobuccinum nipponense* NOMURA and ZINBÔ
- 17) *Bursa yabei* NOMURA and HATAI
- 18) *Siphonalia prespadicea* NOMURA and ZINBÔ
- 19) *Siphonalia gravitesta* NOMURA and ZINBÔ
- 20) *Neptunea koromogawana* NOMURA
- 21) *Surculites (Megasurcula) siogamensis* NOMURA

Another extinct form, *Pecten (Pseudamusium) akihoënsis* MATSUMOTO, which was first described from Kumanodô of the present region is of particular interest, owing to its large form and rather wide distribution within the Tôhoku region.

IV. Palaeo-ecology

The fauna is essentially composed of the members of rocky shore inhabitants, such as, *Anomia*, *Ostrea*, *Spondylus*, *Chama*, *Haliotis*, *Acmaea*, *Trochus*, *Tegula*, *Turbo*, *Capulus*, *Crepidula* and many others. There are no typical brackish-water types, such as *Cerithium*, *Batillaria*, *Anadara* and *Cyclina* etc. A few sand and mud-loving forms, such as, *Macoma*, *Solen*, *Mactra*, *Mya* and *Dentalium* which are intermingled in the fauna may be exotic, as they were most probably transported from some near place.

The faunal assemblage just mentioned is in good harmony with the geologic evidence shown by the Moniwa shell bed which consists of huge andesitic conglomerate at the base and medium-sized conglomerate and coarse grained sandstone at the upper as stated in Part II. Another interesting feature is that the fauna is decidedly southern in aspect, being represented by many species now living far south of the present region, or extinct species whose nearest allies are now found in southern waters.

V. Correlation

From the faunal and stratigraphic relations, the Moniwa shell bed may be correlated with the following:

(1) The Huzina series, particularly its lower part (Kimati bed) in the environs of the Lake Sinzi, Simane prefecture. This is the type locality of *Pecten kagamianus* YOKOYAMA¹⁾. The detailed stratigraphic sequence of the said district was recently reported by TOMITA and SAKAE.²⁾ The Neogene of Izumo now in question was stated by YOKOYAMA to be the Lower Pliocene, but is now referred to the Lower Miocene (two fold division) by TOMITA and SAKAE.

(2) The Nanao bed of Noto, Isikawa prefecture, the type locality of *Pecten notoensis* YOKOYAMA, which is there associated with *Pecten kagamianus* and some others. YOKOYAMA defined the bed as Pliocene,³⁾ while OTUKA⁴⁾ refer it to the Middle Miocene.

It is here noticed that almost all the Neogene formations defined by YOKOYAMA as "the Lower Pliocene" are now referred by the Japanese workers to the Miocene.

(3) The Neogene of the Titibu basin, Saitama prefecture (Musasi province), the type locality of *Crassatellites pauxillus* (YOKOYAMA). The Moniwa shell bed may be nearly similar in age to the Yokoze bed, or Takasino bed of C. HAYAKAWA.⁵⁾ According to HAYAKAWA, these beds occupy the upper part of the Titibu Miocene. The Tertiary formation developed in the Titibu basin,⁶⁾ is now considered by the present writer as ranging from the Middle to Lower Miocene, or older.

(4) Fossil zones II and III of N. KANEHARA, at Siobara, Totigi prefecture (Simotuke province), cited by YOKOYAMA.⁷⁾ This is the type locality of *Pecten kaneharai* YOKOYAMA, *Dosinia kaneharai* YOKOYAMA and *Cardium shiobarensense* YOKOYAMA. H. HIINO⁸⁾ recently studied the stratigraphy of the area just mentioned, and a part of his Miocene Kanomatazawa series certainly corresponds to the Moniwa shell beds. Siobara is one of the typical Miocene (possibly Middle to Lower Miocene) fossil localities in Japan.

(5) The Tanagura bed developed in the environs of the town Tanagura, Hukusima prefecture (Iwaki province). This is the type locality of *Bursa yabei* NOMURA and HATAI associated with *Dosinia kaneharai* YOKOYAMA, *Pecten akihoënsis* MATSUMOTO, *Pecten kaneharai* YOKOYAMA, and *Cardium shiobarensense* YOKOYAMA. YOKOYAMA⁹⁾ correlated the bed with the Siobara. From the result of study on the fossil mollusca from the Tanagura bed, NOMURA and HATAI¹⁰⁾ reached the conclusion that it is Middle Miocene by a three fold division.

(6) The Yanagawa bed at Yanagawa and its neighbourhood, Hukusima prefecture (Iwaki province). This is the type locality of *Pecten (Aequipecten) yanagawaensis* NOMURA and ZINBÔ, *Cheilea yanagawaensis* NOMURA and ZINBÔ, *Argobuccinum nipponense* NOMURA and ZINBÔ, *Phalium yabei* NOMURA and HATAI, *Siphonalia prespadicea* NOMURA and ZINBÔ, *Siphonalia gravitesta* NOMURA and ZINBÔ, and the characteristic fossils in association are, *Pecten kugami-*

1) YOKOYAMA, Jap. Jour. Geol. Geogr., vol. 2, no. 1, 1923.

2) TOMITA and SAKAE, Jour. Geol. Soc. Jap., vol. 44, no. 525, p. 482, 1937; *ibid.*, vol. 45, no. 537, p. 530, 1938 (in Japanese).

3) YOKOYAMA, Imp. Geol. Surv. Jap., Rep. no. 104, 1924.

4) OTUKA, Bull. Earthq. Res. Inst., Tokyo Imp. Univ., vol. 13, pt. 4, 1935; *ibid.*, vol. 14, pt. 3, 1936.

5) HAYAKAWA, Jour. Geol. Soc., Tokyo, vol. 37, no. 440, p. 185, 1930 (in Japanese).

6) YOKOYAMA, Jour. Fac. Sci., Tokyo Imp. Univ., sec. 2, vol. 1, pt. 3, 1925.

7) YOKOYAMA, Jour. Fac. Sci., Tokyo Imp. Univ., sec. 2, vol. 1, pt. 4, 1926.

8) NIINO, Jour. Geol. Soc., Tokyo, vol. 40, no. 479, 1933 (in Japanese).

9) YOKOYAMA, Jour. Fac. Sci., Tokyo Imp. Univ., sec. 2, vol. 3, pt. 4, 1931.

10) NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, 1936.

anus YOKOYAMA, *Dosinia kaneharai* YOKOYAMA and *Pecten notoensis* YOKOYAMA. The Moniwa fauna is most related to this fauna.¹⁾

(7) The Siogama shell bed, Siogama, Miyagi prefecture (Rikuzen province),²⁾ the type locality of *Surculites (Megasurcula) siogamensis* NOMURA and the Koromogawa shell bed³⁾ near Hiraizumi, Iwate prefecture (Rikutyû province), the type locality of *Neptunea koromogawana* NOMURA are referred also to the Miocene in age but the two localities mentioned above occupy a somewhat higher stratigraphic position than that of the Moniwa.

(8) The Tate bed, the lower part of the Lower Kadonosawa series of OTUKA developed in the vicinity of Hukuoka, Iwate prefecture (Mutu province). This is the type locality of *Pecten nisataiensis* OTUKA, *Dosinia nomurai* OTUKA, and *Sinum yabei* OTUKA. OTUKA refers the Kadonosawa to the Middle Miocene.⁴⁾

(9) The lower part of the Oirase series in the Nisi-Tugaru district, Aomori prefecture (Mutu province). This is the type locality of *Pecten arakawai* NOMURA and *Pecten protomollitus* NOMURA; the writer previously ascribed the bed to the upper or middle part of the Lower Miocene⁵⁾ by a two fold division.

(10) The lower part of the Meisen series, cited by MAKIYAMA.⁶⁾ The Meisen Miocene is a thick complex found in the environs of Meisen, North Kankyôdô, Tyôsen (Korea). *Pitar itoi* MAKIYAMA which is found in the Moniwa was first described from the Kantindô formation in the Meisen series at Kantin. At first this formation was regarded by MAKIYAMA as the Lower Miocene and later changed to the Middle Miocene. However the associated fauna as well as the stratigraphic position of the Kantindô does not seem to correspond exactly to the Moniwa which is rather related to the underlying Heiroku conglomerate, judging from the climatologic evidence afforded by the fauna. According to MAKIYAMA, the Kantin fauna is of cold water type, while that of the Heiroku is represented by the warm-water forms. The Moniwa fauna is also of warm-water type as shown in the next part.

Speaking climatologically, the Moniwa fauna may roughly correspond to the fauna containing either *Vicarya*, or *Miogyssina-Operculina* in Japan. *Vicarya* and *Miogyssina-Operculina* are the Malayan elements, which extended north into Japan during older Neogene time. The geologic range of *Vicarya* as stated by YABE and HATAI⁷⁾ is: "From the standard of the Japanese Neogene now adopted by the writers it is to be noticed that *Vicarya* with all of its species is restricted to the Japanese Miocene, and especially to the middle part in a three-fold division, and to the lower part in the two-fold classification."

In the sense of a large-scale chronologic classification my opinion is the same as that of the two authors just mentioned. However the upper horizon from which *Vicarya* is found appears to indicate a somewhat higher stratigraphic horizon than the Moniwa shell bed by the occurrence of *Vicarya callosa yokoyamai* TAKAYAMA from the upper shell bed of Siogama which is now believed to belong to a horizon younger than the Moniwa shell bed. This fact, however, needs further confirmation.

Consequently the age of the Moniwa shell bed can be roughly referred to the upper part of the Lower Miocene by the two fold classification, in spite of various opinions.

1) NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 6, 1935; *ibid.*, no. 10, 1936.

2) NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, 1935.

3) NOMURA, *ibid.*, no. 13, 1937.

4) OTUKA, Bull. Earthq. Res. Inst., Tokyo Imp. Univ., vol. 12, pt. 3, 1934.

5) NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, 1935.

6) MAKIYAMA, Mem. Coll. Sci., Kyoto Imp. Univ., ser. B. vol. 11, no. 3, 1926; *ibid.*, vol. 11, no. 4, art. 8, 1936.

7) YABE and HATAI, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 19, no. 2, 1938.

VI. Climatology

The Moniwa fauna, as stated above, is of a warm-water aspect; being represented by the following forms: (1) *Spondylus*, (2) *Ostrea sinensis* SOWERBY, (3) *Chama*, (4) *Haliotis japonica* REEVE, (5) *Trochus*, (6) *Tegula (Chlorostoma) protonigerrima* n. sp. (closely allied to *T. nigerrima*, a warm-water form), (7) *Turbo parvuloides* n. sp. (closely allied to *T. parvulus* GMELIN, a tropical species), (8) *Cheilea*, (9) *Xenophora* cf. *exuta* (REEVE), (10) *Polinices* cf. *melanostoma* (GMELIN), (11) *Sinum*, (12) *Cypraea*, (13) *Morum macandrewi* (SOWERBY), (14) *Phalium (Semicassis)* cf. *japonicum* (REEVE), (15) *Bursa*, (16) *Babylonia*, (17) *Murex*, and (18) *Conus*.

These forms point to a decidedly warm climate, as warm as those which at present flourish in the southern Kwantô region, a distance of about 4° degrees latitude southward, or further south of the present region. With the exception of few northern forms, namely *Mactra (Spisula) polynyma voyi* (GABB), two different forms of *Neptunea*, and *Argobuccinum nipponense natorianum* n. subsp., which resembles *A. oregonense* (REDFIELD). However it is not surprising since *M. polynyma voyi* and *A. oregonense* are found living in the seas adjacent to the region now in question, or rarely found more south in certain depths. Hence the presence of the above two forms in the fauna is considered at the present as having no bearing on the climate. The deep water shells are generally persistent, having a longer geologic range than those found in shallow water or the littoral zone.

Comparing the present fauna with that of the Pliocene Tatunokuti shell-bed which was described by me in a recent number of this series I find considerable difference in the climatic conditions of the two faunae, the latter being decidedly cool. MATSUMOTO¹⁾ already recognised the warm nature of the Moniwa fauna and states "Does the warmer feature of the third zone²⁾ and the neutral condition of the first³⁾ represent a piece of a linear climate change? The writer does not think so. The change might have been cyclic, and the warmer feature of the third zone might have been preceded by a colder phase."

The interchanges of the climatic condition as evidenced by the molluscan fossils during the Neogene period have been repeatedly explained by various workers, but the cause of it remains in question. The pole shifting is one of the hypothesis to explain the climatic changes during the past ages, but this is not fully proved. The distributions of molluscs along the coast of Japan are, however, essentially controlled by oceanic currents, the warm current "Kuro-siwo and the cold current Oyasiwo" at the present day.

VII. Systematic

In this part the description of 6 new species and 1 new subspecies together with remarks on several previously known species as well as specifically indeterminable forms are dealt with. The species are arranged according to THIELE's classification in his *Handbuch der systematischen Weichtierkunde*, 1931, except for the gastropods which are preceded by the pelecypods.

A few references are given under each species, as almost all the known species have been repeatedly enumerated by various Japanese workers.

1) MATSUMOTO, 1930, 1. c.
2) Second and third zones of MATSUMOTO (1930, 1. c.) correspond to the Moniwa shell bed of the present memoir.
3) First zone of MATSUMOTO (1930, 1. c.) appears to be a higher horizon than the Moniwa shell bed.

A. Class **Pelecypoda**Family **Nuculanidae**Genus **Nuculana** LINK, 1807

Genotype—*Arca rostrata* CHEMINITZ = *Nuculana pennula* MÜLLER; Recent, northern seas of Europe.

The species of *Nuculana* have a wide geographical distribution in the present seas, but *Nuculana* (s.s.) generally inhabits in the cold waters, either of northern seas, or of deep water of various regions.

Only a single new species of the genus is found in the Moniwa fauna.

***Nuculana moniwaensis* n. sp.**

Pl. I (I), Fig. 14.

Shell like the typical *Nuculana* in outline, medium in size, moderately convex, transversely elongated, inequilateral; rounded anteriorly, with a somewhat rostrate beak posteriorly; scarcely raised umbo located at anterior third of shell; anterior dorsal slope short, more or less convex; posterior about twice as long as anterior, slightly concave with subtruncate end; ventral margin apparently evenly arched, but more abrupt anteriorly. Surface with two obtuse ridges extending from beak to upper and lower corners of posterior margin; sculpture and internal characters unknown. Length 24, height 13.7, depth of a left valve 3.5 mm (holotype).

Only a single cast of the interior of the valve of this species is represented in the collection. The general characters of the species appear to be somewhat related to "*Leda*" *robai* KURODA¹⁾ on one hand, and to "*Leda*" *pennula* YOKOYAMA²⁾ on the other, but the two latter forms are more elongated transversely than the present species.

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 2569.³⁾

Range:—Known only from the type locality.

Family **Arcidae**Genus **Arca** LINNÉ, 1788

Genotype:—*Arca noae* LINNÉ; Recent Mediterranean Sea.

The present distribution of *Arca* s.s. is mostly confined to the tropic seas. In Japan, one species of *Arca* s.s., *A. boucardi* JOUSSEAU (= *A. kobeltiana* PILSBRY) extends into northern Japan; it is found attached by means of the byssus to rocks, or is often concealed in holes of rocks.

One questionable specimen is represented in the Moniwa fauna.

1) KURODA, The Venus, vol. 1, no. 3, appendix p. 9, figs. 6,7, 1929.

2) YOKOYAMA, Jour. Coll. Sci., Tokyo Imp. Univ., vol. 45, art. 7, p. 9, pl. 2, figs. 7-9, 1925.

3) Register number of the specimen in the collection of the Saito Ho-on Kai Museum, abbreviated S. H. M., Coll. Reg. No. Register number of the specimen in the collection of the Institute of Geology and Palaeontology, Tôhoku Imperial University, abbreviated G. I. S. Coll., Reg. No.

***Arca* (s.s.) cf. *ocellata* REEVE**

One mould specimen of a right valve measuring about 36 mm in length. Whether it belongs to *A. ocellata* REEVE, or to *A. boucardi* JOUSSEAUME is at present doubtful, hence the naming is provisional.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 19885.

Genus *Pseudogrammatodon* ARKELL, 1930

Genotype:—*Arca* (*Macrodon*) *dalli* SMITH; Recent, off Kôbe, Japan.

A few species of the genus are known to live in the world. They are rather deep water inhabitants; *P. dalli* is found living in Japan from shallow littoral waters to considerable depths on the continental shelf.

For the generic discussion of the genus *Pseudogrammatodon*, the reader is referred to the papers of ARKELL, 1930¹⁾ and REINHART, 1935.²⁾

***Pseudogrammatodon dalli* (SMITH)**

Arca (*Macrodon*) *dalli* SMITH, Challenger Rep. Zool., vol. 13, p. 269, pl. 17, figs. 10–10b, 1885.

Pseudogrammatodon dalli (SMITH), NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 5, p. 4, pl. 2, figs. 14a, 14b, 1935; *ibid.*, no. 10, p. 119, pl. 13, fig. 9, 1936.

Parallelodon obliquatus YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 39, art. 6, p. 170, pl. 18, figs. 9–11, 1920.

Cucularia dalli obliquata (YOKOYAMA), KURODA, The Venus, vol. 1, no. 6, appendix p. 27, text-figs. 41, 42, 1929.

Several specimens, some of them are large and rather well preserved. This is one of the persistent species found in the Japanese Neogene.

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 2560. Kita-Akaisi, S. H. M. Coll., Reg. No. 2600. Minami-Akaisi, S. H. M. Coll. Reg. No. 19878. Goisi, S. H. M. Coll., Reg. No. 19914.

Range:—Recent (Northern to Western Honsyû, and Tyôsen), and dates back to the Miocene.

Genus *Glycymeris* DA COSTA, 1778

Genotype:—*Glycymeris orbicularis* DA COSTA = *Arca glycymeris* LINNÉ; Recent, European seas.

Most of the species of *Glycymeris* enjoy clear water along sandy, rocky or gravelly beaches, and are common in tropic, subtropic and temperate seas.

In Japan, *G. yessoensis* SOWERBY alone lives in cold water ranging from Tisima to Western Honsyû, from shallow water to about 200 m.

The Moniwa fauna is represented by specifically indeterminable specimens.

***Glycymeris* species indet.**

Pl. II (II), Fig. 20

Several examples. They are mostly found as casts of the interior of the valves, hence specific determination is impossible. So far as the outline of the specimens are con-

1) ARKELL, Ceol. Mag. London, vol. 67, no. 793, 1930.

2) REINHART, Bull. Mus. d'Hist. nat. Belgique, vol. 11, no. 13, 1935.

cerned, they appear to be separable into the following three, namely *G. yessoensis* SOWERBY, *G. rotunda* DUNKER and *G. derelicta* YOKOYAMA. The last mentioned type is most frequent and mainly distinguished from the other two by having higher and more prominent beaks. The crenulation of the internal margin as suggested by the cast is very fine and numerous, and is perhaps one of its characteristic features. *G. derelicta* is abundant in the Yanagawa shell bed at Yanagawa, Hukusima prefecture. The figured specimen is a cast from Moniwa; it resembles *G. derelicta* YOKOYAMA.

Occurrence:—Moniwa, S. H. M. Coll., No. 2574; G. I. S. Coll. Reg. No. 23720. Kita-Akai, S. H. M. Coll., Reg. No. 2584. Goisi, S. H. M. Coll., No. 19918. Kumanodô, S. H. M. Coll., Reg. No. 2614.

Family Pectinidae

Genus *Pecten* MÜLLER, 1776

Genotype:—*Ostrea maxima* LINNÉ; Recent, European seas.

Pectens are most characteristic in the Moniwa fauna, being represented by the following subgenera; *Pecten*, s.s., *Chlamys* (BOLTEN) RÖDING, 1798, *Aequipecten* FISCHER, 1886, and *Pseudamusium* MÖRCH, 1853.

The living Pectens have a world-wide distribution, but *Pecten* s.s. and *Aequipecten* flourish in warm and temperate waters, *Pseudamusium* is known to live in shallow to deep water, and *Chlamys* prefers temperate and northern cold waters.

Of the subgenera mentioned, *Chlamys* has the largest number of species in the Moniwa fauna. Living species of *Chlamys* often anchor themselves by means of a byssus to rocks, and conceal themselves in rock crevices.

Pecten (s.s.) *kagamianus* YOKOYAMA

Pl. II (II), Fig. 15

Pecten kagamianus YOKOYAMA, Jap. Jour. Geol. Geogr., vol. 2, no. 1, p. 8, pl. 1, fig. 1, 1923.

Pecten (*Patinopecten*?) *kagamianus* YOKOYAMA, Imp. Geol. Surv. Jap., Rep. no. 104, p. 2, pls. 1, 2, 1929.

Pecten (*Vola*?) *kagamianus* YOKOYAMA, NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 162, 1935; *ibid.*, no. 10, pl. 20, fig. 3, 1936.

Pecten permirus YOKOYAMA, Jour. Geol. Soc. Tokyo, vol. 33, English part p. 9, pl. 2, 1926.

Pecten plicicostulatus MATSUMOTO, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 13, no. 3, p. 105, pl. 40, fig. 15, 1930.

Specimens frequent, but badly fractured in most cases. The figured large left valve from Kumanodô is characterized as: subcircular or nearly orbicular in outline, moderately thick, much compressed, weakly convex at central part of disc. Surface marked by about 16 radial ribs narrower than their interspaces; each ribs carry a few longitudinal striae on their backs, rounded on top, sharper at umbonal region. Intercostal spaces broad, smooth and rather shallow. Ears subequal in size, and radially sculptured by a few riblets.

In general, the radial ribs are weak and hardly raised at the lateral extremities of the valve, but towards the centre they increase in strength and become prominent. This specimen measures more than 100 mm in height and length; it is almost similar in size with the type.

For further notes on *P. kagamianus*, the reader is referred to the paper entitled "A Note on *Pecten kagamianus* YOKOYAMA" by K. M. HATAI, 1938.¹⁾

1) HATAI, Bull. Biogeogr. Soc. Jap., vol. 8, no. 6, 1938.

This species appears to belong to the typical *Pecten*, as it closely resembles *P. maximus* LINNÉ in both form and sculpture. The mould specimen of this species is hardly distinguishable from *P. kimurai* YOKOYAMA.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2609; G. I. S. Coll., No. 49942. Moniwa, S. H. M. Coll., Reg. Nos. 2572, 2575; G. I. S. Coll., Reg. No. 49943. Kumanodô, S. H. M. Coll., Reg. No. 5589.

Range:—Known only from the Miocene.

***Pecten (Chlamys) arakawai* NOMURA**

Pl. II (II), Figs. 1, 2, 3

Pecten (Pecten) arakawai NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 40, pl. 4, figs. 1, 2, 1935.

Specimens of this species are not rare. Although the large specimens are generally imperfect its characteristic features are easily seen. This species has been recorded only from the *Operculina-Miogyopsina* bed at Tanozawa, Nisi-Tugaru district, Aomori prefecture.

Occurrence.—Goisi, S. H. M. Coll., Reg. No. 19922. Minami-Akai, S. H. M. Coll., Reg. No. 19876. Kita-Akai, G. I. S. Coll., Reg. No. 16079; S. H. M. Coll., Reg. Nos. 2604, 2605. Moniwa, S. H. M. Coll., Reg. No. 2581. Kumanodô, S. H. M. Coll., Reg. Nos. 2591, 2629.

Range:—Known only from the Miocene.

***Pecten (Chlamys) protomollitus* NOMURA**

Pl. II (II), Figs. 7, 8, 9

Pecten (Pecten) protomollitus NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 41, pl. 6, fig. 3, 1935.

This species is abundant at Moniwa, but was not collected from the other localities of this beds. All of the specimens are imperfect owing to the thin and fragile test.

The shell is decidedly circular in outline, compressed and with numerous, fine, dichotomous radial riblets on both valves.

Pecten sp., figured by YOKOYAMA from the Nanao bed of Noto¹⁾ is somewhat related, but is much larger though it has a thin test and fine radial sculpture as in the present species.

Some of the Moniwa specimens measure (in mm):

	Length and height	Depth	
No. 1)	62	ca. 8	(left valve)
No. 2)	49	ca. 5	(,,)
No. 3)	45	ca. 5	(,,)
No. 4)	43	ca. 5	(,,)
No. 5)	40	ca. 4	(right valve)

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 2580; G. I. S. Coll., Reg. Nos. 23716, 49928.

Range:—Known only from the Miocene.

1) YOKOYAMA, Imp. Geol. Surv. Jap., Rep. no. 104, p. 6, pl. 6, figs. 3, 4, 1929.

***Pecten (Chlamys) nisataiensis* (OTUKA)**

Pl. II (II), Figs. 5, 6

Chlamys islandicus nisataiensis OTUKA, Bull. Earthq. Res. Inst., Imp. Univ., Tokyo, vol. 12, pt. 3, p. 612, pl. 47, fig. 26, 1934.

This is a rather small, subcircular, compressed and thin shelled species having many, rather low, flattened dichotomous radial riblets, which are separated by nearly equal, or slightly narrower interspaces.

Although all the specimens at hand lack their ears, they can be identified with the species by the characteristic ornamentation.

Fig. 5 in the plate measures 33.5 mm in length and carries about 30 radial riblets, while fig. 6 attains 34 mm in length and has 35 radial riblets. The number of riblets and size of the former specimen are nearly similar to the type described by OTUKA from the Miocene Lower Kadonosawa series at Nisatai, Ninohe district, Iwate prefecture.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19925. Kita-Akai, G. I. S. Coll., Reg. No. 16207.

Range:—Known only from the Miocene.

Pecten (Chlamys) kaneharai* YOKOYAMAPecten kaneharai* YOKOYAMA, Jour. Fac. Sci., Tokyo Imp. Univ., sec. 2, vol. 1, pt. 4, p. 135, pl. 18, fig. 1; pl. 19, figs. 1, 2, 5-7, 1926; *ibid.*, vol. 3, pt. 4, p. 203, pl. 13, 1931.*Pecten (Chlamys) kaneharai* YOKOYAMA, NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no 13, p. 127, pl. 18, figs. 1, 2, 1937.

A few fractured specimens of moderate size.

The characteristic features of the species are the scaly radial ribs, which are divided into three parts by two longitudinal furrows. Of the three parts of ribs, the middle one is broader and higher than the other two.

P. kaneharai figured by the present writer and HATAI¹⁾ from the Tanagura beds at Tanagura, Hukushima prefecture, is more related to *P. ingeniosus* YOKOYAMA, than to *P. kaneharai*. *P. ingeniosus* was first established by YOKOYAMA²⁾ on specimens from Noto province (Nanao bed) under the name of *P. (Chlamys) hastatus* var. *ingeniosus*, later it was listed by KURODA³⁾ as a subspecies of *P. farreri*, a species now living in Chinese waters.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 4444; G. I. S. Coll., Reg. No. 49932.

Range:—Known only from the Miocene.

***Pecten (Chlamys) notoensis* YOKOYAMA**

Pl. I (I), Figs. 4-7

Pecten notoensis YOKOYAMA, Imp. Geol. Surv. Jap., Rep. no. 104, p. 4, pls. 3, 4, 5, 1929.*Pecten (Pecten) notoensis* YOKOYAMA, NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 161, pl. 15, fig. 27, 1935; NOMURA *ibid.*, p. 209, 1935.

P. natoriensis MATSUMOTO, and its two varieties, *subovalis* and *inequilateralis* described from Kumanodô⁴⁾ are synonymous as stated in my previous works, cited above.

1) NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 119, pl. 13, figs. 3, 4, 1936.
 2) YOKOYAMA, Imp. Geol. Surv. Jap., Rep. no. 104, p. 5, pl. 6, fig. 2, 1929.
 3) KURODA, The Venus, vol. 3, no. 2, appendix p. 92, 1932.
 4) MATSUMOTO, I. c., pp. 104, 105, pl. 40, figs. 10, 11, 12, 13, 14, 1930.

There are numerous well preserved specimens of this species in the collection, some of them give the following measurements (in mm) :

Right valve			Left valve		
Height	Length	Depth	Height	Length	Depth
67	63	14.5	70.5	70.5	19.5
62.5	62.5	16	68	68	22
50	46.5	15	65	63	22.5
49	48.5	13	54	ca. 53.5	17.5
47	46	14	53	49	13
45	43	9.5	49	48	13
42.5	39	11.5	48.5	49	10
41	37.5	7	40.5	44	flat.
39	37	9	35	35	flat.

At the time when this species was first described, YOKOYAMA compared it with his *P. turpiculus* from the Pliocene of Sinano,¹⁾ while MATSUMOTO stated that his *P. natoriensis* "appears to stand near *P. cosibensis* YOKOYAMA²⁾ as to be nearly ancestral to it." Both *P. turpiculus* and *P. cosibensis* are closely related to *P. swiftii* BERNARD, a species found from Northern Japan and the Okhotsk Sea. But the present shell differs from *P. swiftii* in having a rounder disc, smaller ears, with shallower notch, and by the greater number of radial ribs which branch, or appear in the interspaces.

The geniculate nature at a short distance below the beak, or at the upper one-third of disc is perhaps one of the characteristic features of this species; by this nature, the young shells are nearly flat as shown in the above measurements.

Occurrence.—Moniwa, S. H. M. Coll., Reg. No. 2576; G. I. S. Coll., Reg. No. 49923. Kita-Akai, S. H. M. Coll., Reg. No. 2615; G. I. S. Coll., Reg. Nos. 16075, 16078, 49921. Minami-Akai, S. H. M. Coll., Reg. No. 19887. Kumanodô, S. H. M. Coll., Reg. No. 2624.

Range:—Known only from the Miocene.

Notes:—At Noto, the type locality of this species it has been reported to occur in association with another interesting scallop, named *P. (Chlamys) crassivenius* YOKOYAMA. *P. crassivenius* is found at Tunaki, a short distance north of Moniwa. The bed at Tunaki in which *P. crassivenius* was found is a rather loosely consolidated brownish sandstone and is believed at present to occupy a higher horizon than the typical Moniwa bed. At Tunaki, *P. crassivenius* is associated with *Epitonium*, *Neptunea* and some other molluscs. This faunal zone will be treated at another opportunity. In this occasion *P. crassivenius* and *Epitonium* sp. are figured in the accompanying plate.

Pecten (Aequipecten) yanagawaensis NOMURA and ZINBÔ

Pl. I (I), Figs. 10-13

Pecten (Aequipecten) yanagawaensis NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 339, pl. 2, figs. 2a, 2b, 1936.

1) YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 1, p. 18, pl. 2, fig. 4, 1925.

2) YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 39, art. 6, p. 156, pl. 13, figs. 7, 8, 1920.

This small scallop resembles *P. vesiculosus* DUNKER of our seas in outline, but has a greater number of radial ribs.

The type locality of this species is the Miocene Yanagawa shell beds at Yanagawa, Hukusima prefecture. This is the second record of its occurrence.

Specimens from Moniwa are frequent and rather well preserved.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 2606; G. I. S. Coll., Reg. No. 25275. Goisi, S. H. M. Coll., No. 19908. Moniwa, S. H. M. Coll., Reg. No. 2577.

Range:—Known only from the Miocene.

Pecten (Pseudamusium) akihoënsis MATSUMOTO

Pl. I (I), Figs. 2, 3; Pl. II (II), Fig. 4

Pecten (Pseudamusium) akihoënsis SAGA (MS) MATSUMOTO, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 13, no. 3, p. 106, pl. 40, figs. 7, 8, 1930; NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 121, pl. 16, fig. 12, 1936; *ibid.*, vol. 13, p. 131, pl. 20, figs. 2, 3, 1937.

This species has the characteristic features of *Pseudamusium* in every respect, but is much larger than the usual types. The dimensions (in mm) of some specimens collected from Kita-Akai are given below:

Right valve			Left valve		
Height	Length	Depth	Height	Length	Depth
70	68	?	51	48	4
55	?	5.5	45	?	4
39	35	5.5	32.5	30	?

Occurrence:—Kita-Akai, G. I. S. Coll., Reg. Nos. 16077, 49924. S. H. M. Coll., Reg. No. 2565. Moniwa, S. H. M. Coll., Reg. No. 2579. Kumanodô, S. H. M. Coll., Reg. No. 2630.

Range:—Known only from the Miocene.

Genus *Spondylus* LINNÉ, 1758

Genotype:—*Spondylus gaederopus* LINNÉ; Recent, Mediterranean Sea.

Spondylus is known to live in warm water ranging from the littoral zone to considerable depths. They are usually found adhering to rocks and corals. Fossil occurrence of the genus in Japan is rather rare. Most of the species from the Japanese Neogene are likely to be identified as *S. cruentus* LISCHKE.

The specimen from Moniwa is too poor for specific identification.

Spondylus species indet.

A single fractured upper valve of considerable convexity. It has fine radial riblets all over the surface like *S. candidus* LAMARCK, and measures 45 mm in height.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 6515.

Family **Limidae**

Genus **Lima** CUVIÉR, 1798

Genotype:—*Ostrea lima* LINNÉ = *Lima squamosa* LAMARCK; Recent, Indo-Pacific.

Living species of *Lima* are world-wide in distribution; they take to either a swimming or sessile life.

The Moniwa fauna contains two subgenera, *Limatula* S. V. WOOD, 1839 and *Acesta*, H. and A. ADAMS, 1858, which are known in Japan at present to live in rather deep water.

Lima (Limatula) subauriculata (MONTAGU)

Lima subauriculata MONTAGU, YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 39, art. 6, p. 150, pl. 12, fig. 10, 1920.

A single valve of this widely distributed species is found in the collection.

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 2561.

Range:—Recent (Northern Pacific and Atlantic), and dates back to the Miocene.

Lima (Acesta) cf. goliath SOWERBY

A fragment of a large *Lima* apparently with nearly smooth surface and resembling both *L. goliath* SOWERBY and *L. goliath yagenensis* OTUKA¹⁾.

According to OTUKA, the latter subspecies is restricted to the Miocene in age, and is found from the Titibu district, Ina district, Sinzi district besides Eastern Aomori.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 2596.

Family **Anomiidae**

Genus **Anomia** LINNÉ, 1758

Genotype:—*Anomia ephippium* LINNÉ; Recent, European seas.

The present distribution of *Anomia* is world-wide. Although predominating in tropic and subtropic faunas, it also occurs in the temperate faunas, and ranges from the littoral zone to considerable depths. All the species lead a sessile life, being attached by means of a plug to rocks and other substratum.

The genus is poorly represented in the Moniwa fauna.

Anomia cytaeum GRAY

Pl. II (II), Fig. 14

Anomia cytaeum GRAY, NOMURA, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 19, no. 2, p. 251, pl. 35, fig. 7, 1938.

Only a circular, thin, compressed upper valve is represented in the collection. This form may perhaps be typical.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19909.

1) OTUKA, Jour. Geol. Soc. Jap., vol. 46, no. 544, p. 27, 1939.

Range:—Recent (Hokkaidô to Taiwan; Tyôsen and China), and dates back to the Miocen.

Family Ostreidae

Genus *Ostrea* LINNÉ, 1758

Genotype:—*Ostrea edulis* LINNÉ; Recent, European seas.

This genus leads a sessile life, adhering to rocks and other substratum, and is very variable in outline according to the habitat.

The present distribution of *Ostrea* is in the tropic and temperate seas.

In the Moniwa fauna, specimens of the genus are by no means rare, but are mostly ill-preserved.

Ostrea sinensis Gmelin

Pl. I (I), Figs. 1a, 1b

Ostrea sinensis GMELIN, SOWERBY in REEVE, Conch. Icon., vol. 18, *Ostrea*, sp. 5, 1870.

The single right, or upper valve of this species in the collection may be characterized as follows. Shell medium size, solid, slightly convex, ovate in outline, nearly as high as long, or more or less higher. Surface ornamented by irregularly disposed concentric lamellae and a few radiating low waves. Beak small with a short and shallow ligamental cavity. Both sides of cavity with numerous, fine crenulations, which are elsewhere gently undulated. Muscular impression oval in outline, distinct, placed somewhat anteriorly to center, sculptured by many concentric lines. Height 82, length 77, depth 13 mm.

The specimen appears to have slightly less marked radial plications than the normal living types, but this slight difference may be regarded as variation. The specimen figured by KURODA¹⁾ is close to the present fossil.

O. sinensis is not known to live in Northern Japan, it is decidedly a warm water form.

Occurrence:—Moniwa, G. I. S. Coll., Reg. No. 23717.

Range:—Recent (Kyûsyû and Ryûkyû), and dates back to the Miocene.

Ostrea species indet.

There are a number of ill-preserved small specimens of *Ostrea* in the Moniwa fauna. Some of them are questionably referred to *O. rosacea* DESHAYES, which occurs both fossil and Recent in Japan.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 2618. Kita-Akai, S. H. M. Coll., Reg. No. 2589. Minami-Akai, S. H. M. Coll., Reg. No. 19886.

Family Crassatellitidae

Genus *Crassatellites* KRUEGER, 1823

Genotype:—*Crassatellites sinuatus* KRUEGER = *Crassatella gibbosula* LAMARCK; Eocene fossil, Paris Basin.

1) KURODA, The Venus, vol. 2, no. 3, appendix p. 50, text-fig. 57, 1930.

Living species of the genus are abundant in warm waters ranging from the littoral zone to considerable depths, and a few species are known to live in Japan.

Only a single species of the genus is represented in the Moniwa fauna.

***Crassatellites pauxillus* (YOKOYAMA)**

Pl. I (I), Fgs. 8, 9

Crassatella pauxilla YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 3, p. 122, pl. 15, figs. 8-10, 1925.

Several internal casts exhibiting the characteristic features of the named species are found in the collection. The approximate dimensions of the specimen (fig. 9) are: height 23.5, length 30, depth 8 mm, which is somewhat larger than the types described by YOKOYAMA from the Miocene of Titibu, Musasi province. Since the hinge as well as the interior characters of the species are not known, the generic reference is provisional. Not rare, especially at Kumanodô.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 2616. Moniwa, S. H. M. Coll., Reg. No. 19951.

Range:—Known only from the Miocene.

Family **Ungulinidae**

Genus ***Taras*** RISSO, 1826

Genotype:—*Taras antiquatus* RISSO; Pliocene (or Pleistocene), Trinité, Riviera.

The present distribution of *Taras* is almost world-wide, ranging from shallow water to considerable depths on the continental shelf. The Moniwa fauna is represented by two sections *Felaniella* DALL, 1899 and *Joannisiella* DALL, 1895.

This genus is better known as *Diplodonta*.

***Taras cumingi* (HANLEY)**

Taras cumingi (HANLEY), NOMURA, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 19, no. 2, p. 253, pl. 35, fig. 13, 1938.

A few specimens.

This belongs to *Joannisiella*. More or less precise accounts are given in my work cited above.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19889. Kumanodô, S. H. M. Coll., Reg. No. 2621.

Range:—Recent (Northern Honsyû to Kyûsyû), and dates back to the Miocene.

***Taras ustus* (GOULD)**

Mysia (Felania) usta GOULD, Otia Conch., p. 170, 1862.

Mysia pacifica TOKUNAGA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 21, art. 2, p. 53, 1906.

Diplodonta usta (GOULD), YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 39, art. 6, p. 130, pl. 9, figs. 14-16, 1920.

Taras (Felaniella) ustus (GOULD), NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 124, pl. 15, fig. 3, 1936.

Very rare; only two specimens are found in the collection.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2593.

Range:—Recent (Tisima, Hokkaidô to Central Honsyû), and dates back to the Miocene.

Family Codakiidae

Genus *Lucina* BRUGUIÈRE, 1797

Genotype:—*Venus pensylvanica* LINNÉ; Recent, West Indies.

The living species of *Lucina*, also known as *Phacoides*, are most common in warm water, ranging from the sandy littoral zone to considerable depths. *Lucina (Lucinoma) acutilineata* CONRAD is a well known species, frequently found in the Neogene deposits of Japan, and consists "the *Thyasira-Lucina* Fauna" of YABE.

In the Moniwa fauna, this genus is poorly represented.

Lucina species indet.

Small, compressed moulds, resembling young forms of *L. acutilineata*.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2607. Moniwa, G. I. S. Coll., Reg. No. 49949.

Family Chamidae

Genus *Chama* LINNÉ, 1758

Genotype:—*Chama lazarus* LINNÉ; Recent, Indian Ocean.

Living species of *Chama* are almost restricted to the tropical seas, they have heavy shells and are found among coral reefs. Fossil species in the Neogene deposits of Japan are rare, but occur frequently in the Raised coral reef formation of Ryûkyû and Taiwan.

It is poorly represented in the Moniwa fauna.

Chama species indet.

Only a single, considerably large and heavy, flat valve resembling *C. semipurpurata* LISCHKE and *C. dunkeri* LISCHKE, both living in our warmer seas.

Occurrence:—Kita-Akai, G. I. S. Coll., Reg. No. 11203.

Family Cardiidae

Genus *Cardium* LINNÉ, 1758

Genotype:—*Cardium costatum* LINNÉ; Recent, Indo-Pacific.

Cardium, as a whole, have a long geologic range and are world-wide in present distribution.

The Moniwa fauna is represented by two questionable subgenera, *Trachycardium* MÖRCH, 1853 and *Cerastoderma* MÖRCH, 1853. Living species of *Trachycardium* are most abundant in the tropic and subtropic seas, while *Cerastoderma* extends into the Arctic seas.

***Cardium (Trachycardium?) shiobarensis* YOKOYAMA**

Pl. II (II), Fig. 19

Cardium shiobarensis YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 4, p. 134, pl. 20, figs. 2-5, 1926.*Cardium (Trachycardium) shiobarensis* YOKOYAMA, NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 125, pl. 15, fig. 4, 1936.

Frequent, especially at Moniwa, but are mostly smaller than the type.

The figured specimen in this paper is similar to figure 3 of YOKOYAMA in outline. *C. pauperculum* YOKOYAMA which is figured by YOKOYAMA from the Miocene of Titibu¹⁾ is perhaps the same. The typical *C. pauperculum* YOKOYAMA is a *Serripes*.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2583; G. I. S. Coll., Reg. No. 16073. Moniwa, S. H. M. Coll., Reg. No. 2572.

Range:—Known only from the Miocene.

***Cardium (Cerastoderma?) goisiense* n. sp.**

Pl. III (III), Fig. 23

Shell of medium size, ovate-trigonal in outline, rather thin, moderately inflated, sub-equilateral, anterior side slightly shorter than posterior; anterior and ventral margin evenly arched; posterior margin lost, but may have been more sharply rounded than anterior; dorsal margins straightish, slightly unequally descending from beak, anterior a little shorter than posterior. Beaks small, pointed, considerably incurved. Surface sculptured by about forty round-topped, radial ribs, separated by shallow interspaces, which are apparently narrower than ribs. Ribs obliterated and water worn on both sides of disc. Surface also marked by several, rather distinct, more or less periodic concentric undulations, no fine incremental lines observed. Hinge as well as interior surface inaccessible. Approximate dimensions are: height 50, length 55, depth of valve 17 mm.

The specimen has the posterior area bounded by a ridge running from beak to the posterior corner. This characteristic seems to be due to subsequent pressure. If this be the true characteristic feature, then the subgeneric position of the species should be changed to *Nemocardium*. *Cardium (Cerastoderma) shinjiense* YOKOYAMA²⁾ from the Miocene of Izumo may be compared with the present species, but is rounder.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19913.

Range:—Known only from the type locality.

Family Veneriidae**Genus *Venus* LINNÉ, 1758**Genotype:—*Venus verrucosa* LINNÉ; Recent, European seas.

Living species of the genus are universal in geographic distribution, but *Venus* s.s., is frequent in the tropic and subtropic waters, ranging from the shallow sandy shore to considerable depths.

1) YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 3, p. 121, pl. 14, figs. 12, 13, 1923, not *C. pauperculum* YOKOYAMA in Jap. Jour. Geol. Geogr., vol. 2, no. 1, p. 6, pl. 1, fig. 2, 1923.

2) YOKOYAMA, Jap. Jour. Geol. Geogr., vol. 2, no. 1, p. 7, pl. 2, fig. 6, 1923.

The genus is divided into many subgenera. The Moniwa specimens are not typical members of the genus.

Venus yokoyamai MAKIYAMA

Venus (Chione) yokoyamai MAKIYAMA, NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 126, pl. 14, figs. 3, 4, 1936.

A few ill-preserved specimens, less convex than the usual types.

The species is related to *Mercenaria* SCHUMACHER, 1817 on one hand, and to *Chione*, MEGERLE VON MÜHLFELD, 1811 on the other.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 2622. Moniwa, S. H. M. Coll., Reg. No. 19399. Goisi, S. H. M. Coll., Reg. No. 19943.

Range:—Known from the Miocene and Pliocene.

Genus *Dosinia* SCOPOLI, 1777

Genotype:—*Dosinia africana* GRAY; Recent, coast of Africa.

The genus *Dosinia* is known to have an extensive geographic range, but is more frequent in tropic than in cool water faunas. They live mostly in shallow water.

The Moniwa fauna is represented by two species of different specific group.

Dosinia kaneharai YOKOYAMA

Pl. I (I), Figs. 15, 16

Dosinia kaneharai YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 4, p. 133, pl. 17, figs. 1-5, pl. 18, fig. 2, 1926. NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 5, p. 83, pl. 3, figs. 6-8, 1935. NOMURA and HATAI, *ibid.*, vol. 10, p. 128, pl. 14, fig. 2, 1936; *ibid.* vol. 13, p. 137, 1937.

Quite frequent.

This species is the type of *Kaneharaiia* MAKIYAMA.¹⁾

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2598; G. I. S. Coll., Reg. No. 16071. Minami-Akai, S. H. M. Coll., Reg. No. 19883. Moniwa, S. H. M. Coll., Reg. No. 2577. Goisi, G. I. S. Coll. Reg. No. 50144.

Range:—Known only from the Miocene.

Dosinia nomurai OTUKA

Dosinia japonica nomurai OTUKA, Bull. Earthq. Res. Inst., Imp. Univ., Tokyo, vol. 12, pt. 3, p. 618, pl. 48, fig. 54, 1934.

Dosinia nomurai OTUKA, NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 217, pl. 17, fig. 2, 1935; NOMURA and HATAI, *ibid.*, no. 13, p. 136, pl. 19, fig. 6, 1937.

A few imperfect specimens are questionably referred to the named species.

Dosinia troscheli of YOKOYAMA (not LISCHKE)²⁾ from Siobara, Simotuke province may prove to be the present species.

1) MAKIYAMA, Mem. Coll. Sci., Kyoto Imp. Univ., ser. B, vol. 11, no. 4, art. 8, p. 213, 1936.

2) YOKOYAMA, Jour. Fac. Sci., Imp. Univ., Tokyo, sec. 2, vol. 1, pt. 4, p. 133, pl. 16, fig. 1b, 1926.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19924. Kita-Akaisi, S. H. M. Coll., Reg. No. 19935. Kumanodô, S. H. M. Coll., Reg. No. 19937.

Range:—Known only from the Miocene.

Genus *Pitar* ROEMER, 1857

Genotype:—*Venus tumens* GMELIN; Recent, west coast of Africa.

Pitar s.s. is a small shell living mostly in tropic seas, but is sometimes found in warm-temperate waters in considerable depths.

The species found in the Moniwa fauna is not of the typical group as it has a larger size and rougher surface ornamentation.

Pitar itoi (MAKIYAMA)

Pl. III (III), Fig. 22

Pitaria itoi MAKIYAMA, Mem. Coll. Sci., Kyoto Imp. Univ., ser. B, vol. 2, art. 8, p. 159, pl. 13, fig. 7, 1926.
Pitar itoi MAKIYAMA, *ibid.*, vol. 10, no. 2, art. 6, p. 214, pl. 5, fig. 12, 1936. NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 128, pl. 15, fig. 8, 1936; *ibid.*, no. 13, p. 135, pl. 18, fig. 4, 1937.

A few ill-preserved specimens.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 6517. Moniwa, S. H. M. Coll., Reg. No. 2601. Goisi, S. H. M. Coll., Reg. No. 19919.

Range:—Known only from the Miocene.

Genus *Saxidomus* CONRAD, 1937

Genotype:—*Saxidomus nuttalli* CONRAD; Recent, west coast of North America.

Saxidomus is a genus which contains but a few species, of which all are mostly restricted to warm-temperate waters of the Northern Pacific region. They generally inhabit along shallow sandy beaches.

Questionable specimens are represented by moulds of the interior valve in the Moniwa fauna.

Saxidomus cf. nuttalli CONRAD

Pl. III (III), Fig. 21

The outline of the shells refer them to the named species; the Japanese *S. purpuratus* SOWERBY is a color variety of the American species.

The specimens are larger and transversely more elongated than *Pitar itoi* MAKIYAMA, cited above.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 2617.

Genus *Paphia* (BOLTEN) RÖDING, 1798

Genotype:—*Paphia ala-papilionis* (BOLTEN) RÖDING; Recent, Indian Ocean.

The present distribution of *Paphia* is rather wide, but *Paphia* s.s. is restricted to the Indian Ocean from where it ranges to the warmer part of Japan. *P. undulata* (BORN) which

occurs in Siogama bay, Miyagi prefecture is perhaps the northernmost limit of distribution of the typical *Paphia*.

In the Moniwa fauna, this genus is represented by questionable mould specimens.

***Paphia* (s.s.)? *takadatensis* (MATSUMOTO)**

Pl. III, (III), Figs. 1, 2, 3

Lutraria takadatensis MATSUMOTO, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 13, no. 3, p. 103, pl. 40, fig. 2, 1930.

?*Lutraria sieboldii* MATSUMOTO, ibid., p. 103, pl. 40, fig. 3, 1930 (not DESHAYES).

Very frequent, but all are mould specimens.

The outline of the specimens is nearly identical with a certain small-sized *Paphia*. A similar mould was recorded by YOKOYAMA¹⁾ from the Pliocene of Sukegawa, Ibaragi prefecture under the name of "*Tapes*" *undulata* BORN.

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 2578; G. I. S. Coll., Reg. No. 16012. Kumanodô, S. H. M. Coll., Reg. No. 2612. Kita-Akai, S. H. M. Coll., Reg. No. 2608.

Range:—Known only from the present district.

Family Mactridae

Genus *Mactra* LINNÉ, 1767

Genotype:—*Cardium stultorum* LINNÉ; Recent, European seas.

Many species are known of the genus *Mactra* since the late Mesozoic time. The present distribution is almost universal, but they are apparently most abundant in the tropic seas. They mostly burrow in sand at shallow depths. *M. (Spisula) polynyma voyi* (GABB), and *M. (Spisula) sachalinensis* SCHRENCK, are the cold water inhabitants; these are found in the present fauna of Japan.

Two species of the genus are distinguished in the Moniwa fauna.

***Mactra* (?) *charischema* MATSUMOTO**

Pl. II (II), Fig. 21

Mactra charischema MATSUMOTO, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 13, no. 3, p. 105, pl. 29, figs. 16, 17, 1930.

Mactra charischema was first described by MATSUMOTO on specimens collected from Kumanodô; it resembles *M. veneriformis* "DESHAYES" according to that author.

A single specimen collected from the type locality is a cast of a left valve; its accurate generic determination needs further investigation due to the hinge character being unknown both in the type and topotype specimens.

Occurrence:—Kumanodô, S. H. M. Coll., Reg. No. 19936.

Range:—Known only from the type locality.

1) YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 45, art. 5, p. 22, pl. 5, fig. 1, 1925.

***Mactra (Spisula) polynyma voyi* (GABB)**

Pl. I (I), Fig. 17

Mactra (Spisula) polynyma voyi (GABB), NOMURA, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 19, no. 2, p. 265, 1938.

Two mould specimens of this species are represented in the present collection. The outline of these shells more resemble the variety *alaskana* than the typical *voyi*.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19911. Moniwa, S. H. M. Coll., Reg. No. 2562.

Range:—Recent (Northern Japan; Arctic Ocean to Puget Sound, North America), and dates back to the Miocene.

Genus ***Schizothaerus*** CONRAD, 1853Genotype:—*Schizothaerus nuttallii* (CONRAD); Recent North Pacific.

A single species of the genus is known to live on the coast of both Japan and America within the northern Pacific region.

The occurrence of this species in the Moniwa fauna is perhaps due to transportation from a near place by currents seeing that the shell is known to live deeply burried in muddy, or fine sandy bottoms at very shallow depths.

***Schizothaerus cf. nuttallii* (CONRAD)**

Pl. III (III), Fig. 24

Compare with:

Lutraria (Crytodon) nuttallii CONRAD, Jour. Acad. Nat. Sci. Phila., vol. 7, p. 235, pl. 18, fig. 1, 1937.*Tresus nuttallii* (CONRAD), YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, vol. 40, art. 1, p. 133, pl. 8, fig. 8, 1922.

This is the first record of its occurrence from the Miocene of Japan. According to Grant and Gale, *S. nuttallii* bears many synonyms such as: *Lutraria* (or *Tresus*) *maxima* MID-DENDORFF, *Lutraria inflata* DUNKER, *Lutraria* (or *Schizothaerus*) *capax* GOULD, *Spisula longa* DALL, *Schizothaerus cf. pajaroanus* DICKERSON (not CONRAD) and *Mactra nasuta* of Pacific coast collectors (not GOULD).

Two mould specimens in the collection, the larger one measures about 100 mm in length (figured). The mould has many concentric undulations which are the impressions of the external sculpture.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19923.

Range:—Recent (Kyûsyû, Honsyû and Hokkaidô, Japan; Alaska to Lower California, North America), and dates back to the Miocene.

Family **Tellinidae**Genus ***Macoma*** LEACH, 1819

Genotype:—*Macoma tenera* LEACH = *Tellina calcarea* GEMLIN; Recent, northern Pacific and Atlantic; also boreal seas.

The present distribution of *Macoma* is almost universal but *Macoma* s.s. is rather frequent in the temperate and boreal faunas. They live mostly burried in fine sand or mud in shallow depths.

This genus is very scanty in the Moniwa fauna.

***Macoma* (s.s.) *tokyoensis* MAKIYAMA**

Macoma tokyoensis MAKIYAMA, NOMURA, Sci. Rep., Tôhoku Imp. Univ., ser 2, vol. 19, no. 2, p. 263, 1938.

A single mould specimen.

Occurrence:—Moniwa, S. H. M. Coll., Reg. No. 32728.

Range:—Recent (Hokkaidô to Kyûsyû, Japan; also Indo-Pacific), and dates back to the Miocene.

Family Solenidae

Genus *Solen* LINNÉ, 1758

Genotype:—*Solen vaginus* LINNÉ; Recent, European seas.

Species of *Solen* decidedly take to a burrowing habit in warm water. In Japan, *S. krusensterni* SCHRENCK is the cold water type.

In the Moniwa fauna, the genus is poorly represented.

***Solen* species indet.**

An imperfect mould, only about one-third of the total length of the shell is found. This is considered to be an exotic form by its ecologic character.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 2588.

Family Hiatellidae

Genus *Panope* MÉNARD, 1807

Genotype:—*Panope aldrovandi* MÉNARD = *Panope glycymeris* (BORN); Recent, Mediterranean Sea.

Panope is a fine sand or mud burrower. The few living species which have a universal distribution, are mostly found in the northern hemisphere.

Only a single species of *Panope* s.s. is known to occur in Japan both fossil and Recent. Specimens are abundant in the Moniwa fauna.

***Panope* (s.s.) *japonica* (A. ADAMS)**

Panope japonica (A. ADAMS), NOMURA, Sci. Rep., Tôhoku Imp. Univ., ser. 2, vol. 19, no. 2, p. 268, pl. 36, figs. 7a, 7b, 1938.

All of the specimens are invariably smaller than the Pliocene Tatunokuti specimens with somewhat different aspect in outline.

Occurrence:—Minami-Akaisi, S. H. M. Coll., Reg. No. 19894 (b). Kita-Akaisi, S. H. M. Coll., Reg. No. 2134; G. I. S. Coll., Reg. Nos. 16094, 49966.

Range:—Recent (Hokkaidô to Western Honsyû), and dates back to the Miocene, or Oligocene.

Family Myidae

Genus Mya LINNÉ, 1758

Genotype:—*Mya truncata* LINNÉ; Recent, boreal seas down to North Pacific and Atlantic.

Myas are found in all temperate and cold waters. The species generally lives in fine sand or mud as those of *Panope*.

Only a questionable specimen is represented in the Moniwa fauna.

***Mya* cf. *arenaria* LINNÉ**

A mould resembling the named species. This species has a wide geographic distribution along the coasts of both northern Pacific and Atlantic.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2595.

B. Class Scaphopoda

Family Dentaliidae

Genus Dentalium LINNÉ, 1758

Genotype:—*Dentalium elephantinum* LINNÉ; Recent, Philippine Islands.

Most members of *Dentalium* live in shallow water, but a few small-sized species extend into deep water.

The present distribution of the genus is almost world-wide. Very often they burrow in fine sand and mud.

The Moniwa fauna contains but a few, rather large-sized specimens.

***Dentalium* cf. *weinkauffi* DUNKER**

The size and curvature of the present specimens resemble *D. weinkauffi* DUNKER, which is a common species in Japan.

Occurrence:—Moniwa S. H. M. Coll., Reg. No. 2558.

C. Class Gastropoda

Family Haliotidae

Genus Haliotis LINNÉ, 1758

Genotype:—*Haliotis asinina* LINNÉ; Recent, Oriental seas.

The species of *Haliotis* are shallow water inhabitants being found on rocky shores. The present distribution of the genus is wide, ranging from the tropic to temperate waters. *H. kamtschathkana* JONAS extends into cold water. It is interesting to know that no species have been recorded from the east coast of North America.

The Moniwa fauna has a single species represented by a single specimen.

***Haliotis japonica* REEVE**

PL. III (III), Fig. 25

Haliotis japonica REEVE, HIRASE, Coll. Jap. Shells, Illust. nat. Colours, p. 33, pl. 60, fig. 1, (+ *H. diversicolor* REEVE), 1934.

A small mould measuring about 30 mm in longer diameter and 20 mm in shorter diameter. The surface is provided with the impressions of numerous fine, curved threads. The number of perforations is unknown.

This is the first record of the occurrence of this species from the Tertiary deposits of Japan.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19893.

Range:—Recent (Central Honsyû and southward to China Sea), and dates back to the time represented by the Moniwa fauna.

Family **Acmaeidae**

Genus ***Acmaea*** ESCHSCHOLTZ, 1830

Genotype:—*Acmaea mitra* ESCHSCHOLTZ; Recent, west coast of North America.

Most *Acmaea* are shallow water forms which adhere to rocks or other rigid substances. The present distribution is universal, ranging from tropic to Arctic waters. The genus is also known as *Patelloida*; it is poorly represented in the Moniwa fauna.

***Acmaea* species indet.**

Two specimens, and apparently belonging to different species are found. One is larger and higher than the other. Unfortunately the specimens are represented by imperfect moulds.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2582.

Family **Trochidae**

Genus ***Tegula*** LESSON, 1834

Genotype:—*Tegula elegans* LESSON = *Trochus pellis-serpentis* WOOD; Recent, western tropic America.

The living species of *Tegula* s.s. are known only from the west coast of Central America where they range to the Gulf of California, but the members of the subgenus *Chlorostoma* SWAINSON, 1840 are widely distributed along the Pacific borders of both America and Japan, and also in the Indo-Pacific. They are generally found crawling on rocks, or conceal themselves in the crevices. No species is represented in the present Atlantic faunas.

The specimens of the genus in the Moniwa shell bed are by no means rare.

***Tegula (Chlorostoma) protonigerrima* n. sp.**

PL. III (III), Figs. 15, 16

Shell considerably large, depressed conical, widely umbilicated; test solid. Whorls about 6, impressed at suture, narrowly shouldered at summit, obliquely ribbed axially between

sutures; ribs rather small, about 40–50 in number on last whorl, regularly arranged, usually simple, but rarely dichotomous, separated by somewhat narrower interspaces; ribs and interspaces crossed by numerous, rather marked revolving striae making surface corrugated. Periphery of last whorl bluntly angulated; base flat, smooth except for growth lines. Aperture transversely elongated, oblique; columella short, stout with a strong rounded tooth in middle, and an obsolete one at base. Umbilicus wide. Height 24.5, diameter 28.5 mm (type, fig. 16).

There are few imperfect specimens in the collection. The largest attains more than 40 mm in diameter (fig. 15).

This species is characterized by the low conic outline having many slender, oblique, axial ribs and the wide umbilicus at base. It resembles *Tegula argyrostoma* (GMELIN), and *Tegula nigerrima* (GMELIN) from Japan, but it is distinguished from the former by having a lower shell, flatter base and more angular periphery with a wide umbilicus; from *T. nigerrima* which is closer allied to the present species, by the shell which is larger, lower, and the umbilicus appears to be wider.

Occurrence:—Kita-Akaisi, G. I. S. Coll., Reg. No. 16201; S. H. M. Coll., Reg. No. 19884. Minami-Akaisi, S. H. M. Coll., Reg. No. 19884.

Range:—Known only from the present region.

Genus *Trochus* LINNÉ, 1758

Genotype:—*Trochus maculatus* LINNÉ; Recent, Indian Ocean ranging to Japan.

This genus is at present largely distributed in the Old World. No species have been reported from the Neogene or Quarternary deposits of the Pacific coast of North America. GRANT and GALE, 1931).

The species lives on shallow rocky beaches in tropic and subtropic waters, a very few species range to temperate water. This tropic genus is represented in the Moniwa fauna by many specimens.

Trochus goisiensis n. sp.

Pl. III (III), Fig. 17

Shell small, typically trochoid, anterior part of later whorls somewhat bulging, periphery of last whorl bluntly angulated; base, and nuclear whorls lost. Surface marked by many, almost vertical, or more or less oblique axial ribs, some of which dichotomose anteriorly; interspaces are much narrower than ribs. Suture impressed, well marked. Height ca. 22, diameter ca. 23 mm.

Although an imperfect specimen is represented in the collection, it is of interest to note that it resembles somewhat *T. incrassatus* LAMARCK which ranges from southern Japan to the Indo-Pacific.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19907.

Range:—Known only from the type locality.

Trochus (s.s.) *oidensis* n. sp.

Pl. III (III), Figs. 19a, 19b

Shell of moderate size, with few whorls, low-conic; outline nearly straight, or slightly convex, apparently more or less bulging below; sutures slightly impressed, rather indistinct.

Apical whorls missing in type specimen; whorls with many, oblique axial ribs crossed by 4-5 spiral grooves giving surface granular appearance; interspaces rather irregular in width, but as a whole, nearly equal to ribs. Periphery of last whorl sharply angulated; base flattened, marked by about 7 spiral ridges. Umbilicus wide; aperture and columella fractured. Height (preserved portion) 28.5, diameter 40 mm (holotype).

There are several paratype specimens in the collection. One of them is somewhat larger than the type, but the surface sculpture is worn away, a smaller specimen has the basal sculpture rather coarsely beaded.

Compared with the preceding, this species is larger, less higher with the surface sculpture beaded. *T. maculatus* LINNÉ is also related to the present species, but the former is higher with somewhat different sculpture.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19875 (a). Moniwa, S. H. M. Coll., Reg. No. 2557. Kita-Akai, S. H. M. Coll. Reg. No. 2586.

Range:—Known only from the present region.

Trochus (s.s.) species indet.

There is another type of *Trochus*, which is represented by two imperfect specimens.

The shell is apparently similar to *T. oidensis* n. sp., mentioned above in sculpture, but the whorls are slightly lower in height, and the lateral outline is decidedly concave, instead of being more or less convex as in that species. The base of the present specimens is also concave.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19875 (b).

Genus *Turcica* H. and A. ADAMS, 1854

Genotype:—*Turcica monilifera* A. ADAMS; Recent, Moreton Bay, Australia.

The present distribution of *Turcica* is restricted to the Pacific border of Australia, North America and Japan, and is known as a warm water form. *T. imperialis* A. ADAMS is a Japanese living species ranging from the littoral zone to considerable depths on the continental shelf.

The Moniwa fauna is represented by a single new species related to *T. imperialis*.

Turcica preimperialis n. sp.

Pl. III (III), Figs. 20a, 20b

Shell closely resembling *Turcica imperialis* A. ADAMS; moderate in size, more or less ovate-conical (apical whorls missing), with convex whorls and strongly marked, deep sutures. Surface sculpture consisting of 5, beaded spiral cords between sutures. Periphery rounded, base convex, having 6 prominent cords which are apparently beaded like space between sutures. Umbilicus closed. Test thin. Aperture filled with matrix. Height of preserved portion 44, diameter 32 mm.

Four ill-preserved specimens were examined. The largest specimen which comes from Minami-Akai is chosen for the type and figured.

The species differs from *T. imperialis* A. ADAMS by having somewhat stouter revolving cords, and slightly more convex base. The spiral cords on the base of the present species are broader and fewer than *T. imperialis*.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19881, Kita-Akai, S. H. M. Coll., Reg. No. 19927. Kumanodô, S. H. M. Coll., Reg. No. 12035.

Range:—Known only from the present region.

Family Turbinidae

Genus *Turbo* LINNÉ, 1758

Genotype:—*Turbo petholatus* LINNÉ; Recent, Indo-Pacific, ranging to Japan.

Living species of *Turbo* are widely distributed in warm seas, but *Turbo* s.s. occurs principally in tropic Asia and Australia, ranging to Japan on the north and to New Zealand on the south. They inhabit among rocks and coral reefs in shallow depths.

This tropic genus is represented in the Moniwa fauna by many specimens.

Turbo parvuloides n. sp.

Pl. III (III), Figs. 12a, 12b

Shell rather small, ovate-conic as in the usual *Turbo*, apparently not umbilicated; test thin. Whorls about 5, or more in number (apical whorls missing in all specimens), rounded, marked by many spiral threads or striae which are not spinose, but somewhat beaded, 2 or 3 finer intermediate striae appear between coarser ones. Base convex, similarly sculptured like space between sutures but spirals appear to become somewhat coarser near umbilical region. Numerous very fine growth lines also present all over surface. Aperture large. Height of preserved portion 43, diameter 30.2 mm (type).

Specimens are numerous, but all are ill-preserved.

The type is not the largest specimen in the collection; the largest, but imperfect specimen measures about 40 mm in diameter.

This species resembles *Turbo parvulus* PHILIPPI from the warmer regions of Japan in outline and size, but differs from the latter by having finer and more numerous revolving threads upon the surface.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19877.

Range:—Known only from the type locality.

Turbo species indet.

Pl. III (III), Figs. 13, 14

The collection contains two specimens of operculum belonging to the genus *Turbo*. They are circular in outline, flat inside and convex outside with about 4 volutions. The nucleus is placed somewhat lateral. The approximate dimensions are: diameter 14 mm (fig. 13); diameter 13.5 mm and convexity ca. 5 mm (fig. 14).

Whether they belong to the preceding species, or to that of the another species is at present in question.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19915.

Family Hipponycidae

Genus *Cheilea* MODEER, 1793

Genotype:—*Patella equestris* LINNÉ; Recent, Indo-Pacific, and ranging to southern Japan, also Cape Hatteras to Florida and West Indies.

Few living species of the genus *Cheilea* are known to occur in tropic to warm waters in shallow depths. The type species has an extraordinarily extensive geographic range as stated above.

A single specimen referred to the genus is represented in the Moniwa fauna.

Cheilea yanagawaensis NOMURA and ZINBÔ

Cheilea yanagawaensis NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 189, pl. 15, fig. 7, 1935.

A specimen, almost identical with the type which comes from the Miocene Yanagawa shell beds at Yanagawa, Hukusima prefecture.

The interior characteristics are not known in the type, hence, the generic reference is questionable, but the outline and sculpture are related to *C. equestris*.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2602.

Range:—Known only from the Miocene.

Family Capulidae

Genus *Capulus* MONTFORT, 1810

Genotype:—*Patella ungarica* LINNÉ; Recent, European seas.

The present distribution of *Capulus* is world-wide. Most of the species are sedentary in shallow water. Few species are known to live in Japan.

A new species of the genus is in the present collection.

Capulus natorianus n. sp.

Pl. III (III), Fig. 18

Shell of moderate size, ovate-trigonal (?), or somewhat fan-shaped, strongly inflated, most convex part lies more or less above middle. Apex prominent, much produced from posterior end of subcircular aperture. Nuclear whorls loosely dextral coiled. Surface sculpture unknown (internal cast), but has numerous, fine impressions of crenulation along ventral border. Length ca. 19, width, ca. 21, convexity ca. 11 mm.

A single ill-preserved specimen is questionably referable to the present genus.

The character of the ventral crenulation and laterally broadened aperture is quite distinct from the known *Capulus* in Japan.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 19933.

Range:—Known only from the type locality.

Family **Calyptraeidae**Genus ***Crepidula*** LAMARCK, 1799

Genotype:—*Patella fornicata* LINNÉ Recent, east coast of North America.

Living species of *Crepidula* are almost universal in distribution, but are most abundant in tropic faunas. They adhere to rocks and shells in shallow depths where sea waves wash with great violence.

Crepidula* cf. *aculeata (GMELIN)

An imperfect mould resembling *C. aculeata* which lives in the warmer part of Japan, and elsewhere in tropic and warm-temperate waters.

Occurrence:—Goisi, S. H. M. Coll., Reg. No. 19917 (a).

Family **Xenophoridae**Genus ***Xenophora*** FISCHER de WALDHEIM, 1807

Genotype:—*Trochus conchyliophorus* BORN; Recent, West Indies.

The present distribution of the genus is in tropic and warm-temperate waters. No living or fossil species have been recorded from northeast Honsyû, Japan; the occurrence from the Moniwa bed is perhaps the first.

The species of *Xenophora* possess a peculiar habit, being armed with foreign substances and inhabit rather deep water.

Xenophora* cf. *exuta (REEVE)

Pl. III (III), Fig. 10

Very frequent at Kita-Akaisi.

The specimens here examined are closely related to *X. exuta* (REEVE), a warm water inhabitant ranging from Central Honsyû to Ogasawara-zima (Bonin Islands), and also the China Sea. But the exact comparison is impossible due the ill-preservation of the specimens. All the fossils before me are found as mould showing faintly the external sculpture and lack the peripheral undulation. Exact determination is left until better specimens are obtained.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 2590; G. I. S. Coll., Reg. No. 16066. Goisi, S. H. M. Coll., Reg. No. 19917.

Family **Naticidae**Genus ***Polinices*** MONTFORT, 1810

Genotype:—*Polinices albus* MONTFORT = *Natica mammilaris* LAMARCK = *Natica brunnea* LINK; Recent, West Indies.

The genus as a whole, is universal in present distribution, but most species of *Polinices* s.s. are represented in tropic faunas.

The Moniwa specimens appear to belong to the typical *Polinices*.

***Polinices* (s.s.) cf. *melanostoma* (GMELIN)**

Two small specimens having rather narrow shell with pointed spire are found. They resemble *P. melanostoma* (GMELIN) and *P. simiae* (DESHAYES) from the warmer part of Japan and further south. The umbilicus of the present specimens appear more related to the former than to the latter.

Occurrence:—Moriwa, S. H. M. Coll., Reg. No. 2568.

Genus *Sinum* (BOLTEN) RÖDING, 1758

Genotype:—*Helix haliotoides* LINNÉ; Recent, type locality unknown.

Sinum, or better known as *Sigaretus*, is a tropic genus, but a few species range into the warm-temperate water. They live on muddy, or fine sandy bottoms in very shallow depths. *Eunaticina*, a subgenus of *Sinum* ranges from the littoral zone to considerable depths in Japan.

A single specimen of the genus is in the present collection.

***Sinum* (s.s.) *yabei* OTUKA**

Sinum yabei OTUKA, Bull. Earthq. Res. Inst., Tokyo Imp. Univ., vol. 12, pt. 3, p. 627, pl. 49, figs. 44, 45, 1934.
NOMURA and HATAI Saito Ho-on Kai Mus. Res. Bull., no. 10, p. 145, pl. 17, figs. 2, 10, 1936.

Rather well preserved specimens somewhat smaller than the type.

Occurrence:—Moriwa, S. H. M. Coll., Reg. No. 6922.

Range:—Known only from the Miocene.

Family *Cypraeidae***Genus *Cypraea* LINNÉ, 1758**

Genotype:—*Cypraea tigris* LINNÉ; Recent, Indo-Pacific, and ranging to southern Japan.

Living species of *Cypraea* have a wide distribution in all warm seas, but are most abundant in the Indo-Pacific region. They live on coral reefs and rocky shores at low water.

The Moriwa fauna has three imperfect indeterminable specimens.

***Cypraea* species indet.**

Pl. III (III), Figs. 4, 5, 6

All specimens are found as mould. The largest attains more than 35 mm in height, while one of the smaller ones measures 26 mm in height. Whether the specimens can be separated into different species, or belong to one and the same species is at present uncertain. However, they are invariably ovate, with swollen outline, teeth rather marked on both sides of lips, and the spire is raised as can be seen in the young individuals of certain species of the genus. Be the specific determination as it may, it is worthy to note that this tropic genus occurs from the present region.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19892.

Family Cassididae

Genus *Morum* (BOLTEN) RÖDING, 1798

Genotype:—*Morum purpureum* GMELIN = *Strombus oniscus* LINNÉ; Recent, West Indies.

Morum is also known as *Oniscia* or *Lambidium*. The genus occurs commonly in warm waters. Few living species of the genus are known from the Indo-Pacific and West Indies.

The Moniwa fauna contains a single specimen of this interesting genus.

Morum macandrewi (G. B. SOWERBY)

Pl. III (III), Figs. 7a, 7b

Oniscia macandrewi G. B. SOWERBY, PILSBRY, Cat. Mar. Moll. Jap., p. 49, pl. 2, fig. 3, 1895.

Morum macandrewi (Sowerby), HIRASE, Coll. Jap. Shells etc., p. 67, pl. 98, fig. 1, 1934.

The outline and impression of outer sculpture of the specimen are almost identical with the named species. Fig. 7a is a mould representing a part of the terminal varix of the outer lip.

PILSBRY's specimens measured: Alt. 45, diam. 29, alt. of aperture 26 mm; Alt. 36, diam. 24, alt. of aperture 30 mm. The present mould specimen measures 38.5 mm in height.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19891.

Range:—Recent (warmer part of Japan), and dates back to the age represented by the Moniwa fauna.

Genus *Phalium* LINK, 1807

Genotype:—*Buccium glaucum* LINNÉ; Recent, Philippine, and ranging to southern Japan.

Living species of *Phalium* including the subgenus *Semicassis* are abundant in tropical seas, but several extend into warm-temperate water. Only one species of *Phalium*, *P. (Semicassis) strigatum* (GMELIN) is rarely found in the warmer part of the Tōhoku region. They mostly live on sandy bottoms at low water.

Two species belonging to different subgenera are distinguished in the Moniwa fauna.

Phalium (Semicassis) cf. japonicum (REEVE)

A single, small specimen of *Phalium* which is almost identical with the named species.

P. japonicum is now living along the Pacific coast of Japan ranging from southern Kwantō, Central Japan to Southern Japan and the China seas; it is decidedly a warm water form.

Occurrence:—Moniwa, G. I. S. Coll., Reg. No. 23743.

Phalium (Doliocassis) yabei NOMURA and HATAI

Phalium yabei NOMURA and HATAI, Jap. Jour. Geol. Geogr., vol. 11, nos. 1-2, p. 52, pl. 8, figs. 2, 4, 5, 8, 8a, 1933.

One specimen of a mould is examined in the present fauna.

At the time when this species was established, we thought that the beds in which *P. yabei* was found, belonged to the Lower Pliocene, or somewhat older, but now it is certain that it should be referred to the Miocene.

Occurrence:—Kita-Akai, G. I. S. Coll., Reg. No. 25274.

Range:—Known only from the Miocene.

Family Cymatiidae

Genus *Argobuccium* BRUGUIÈRE, 1792

Genotype:—*Ranella veillum* BRODERIP (?); Recent, Chile.

The genus appears to contain certain different forms, having a wide geographic distribution. The subgenus *Fusitriton*, which is represented in the Moniwa fauna inhabits the cold-temperate waters.

Argobuccium (Fusitriton) nipponense natorianum n. subsp.

Pl. III (III), Figs. 8a, 8b.

Compare with:

Ranella (Priene) nipponensis NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 181, pl. 15, fig. 34, 1935.

Shell rather small, fusiform, with 6 or more whorls. Preserved whorls 4, marked by axial ribs and spiral cords, their intersecting points nodose. Last whorl with about 22 rounded, obliquely flexuose ribs separated by more or less wider interspaces in breadth; 2 strong varices, one on outer surface of outer lip and other placed diametrically opposite to former. Spiral cords about 10 on last whorl, in addition to few finer ones on base; generally separated by wide interspaces provided with 1 to 3 fine interstitial spiral threads. Base abruptly contracted; canal short and recurved. Inner side of aperture filled with matrix. Height (preserved portion) ca. 45, diameter 24.5 mm.

An imperfect specimen from the present region may be compared with *A. (Fusitriton) nipponense* (NOMURA and ZINBÔ) from the Miocene Yanagawa beds at Yanagawa in the Hukusima basin, but the former differs from the latter by having a smaller shell with more slender and more oblique radial ribs.

Difference between this and *A. (Fusitriton) oregonense* (REDFIELD) is also very slight, and it is scarcely distinguished by having less prominent and more number of axial ribs in the present form.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 19928.

Range:—Known only from the type locality.

Family Bursidae

Genus *Bursa* (BOLTEN) RÖDING, 1798

Genotype:—*Bursa monitata* (BOLTEN) RÖDING = *Murex bufonus* GMELIN; Recent, Indo-Pacific.

The species of the genus are universal in the tropic seas, the majority inhabit rocky places and on coral reefs.

It is interesting to note that this tropic form occurs from the present region.

***Bursa (Ranella) yabei* NOMURA and HATAI**

Pl. I (I), Fig. 18

Bursa yabei NOMURA and HATAI, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 141, pl. 17, figs. 14a-15b, 1936.
NOMURA and ZINBÔ, *ibid.*, no. 10, p. 342, 1936.

Bursa yabei was described from the Miocene Tanagura beds of Hukusima prefecture. It also occurs at Yanagawa in the Hukusima basin where the Miocene Yanagawa beds is developed. The specimen here under consideration measures about 18 mm in diameter and is much smaller than the type, but is identical in the form and sculpture.

This species is not the typical *Bursa*, it appears to belong the group of *Ranella* by having a shorter canal and prominent nodes on the surface.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2591.

Range:—Known only from the Miocene.

Family Muricidae

Genus *Murex* LINNÉ, 1758

Genotype:—*Murex pecten* MONTFORT = *Murex tribulus* LINNÉ; Recent, Indo-Pacific, and ranging to southern Japan.

Most of the living species of *Murex* s.s. are tropic and subtropic in distribution, ranging from shallow to deep water. The littoral forms are found among rocks and coral reefs.

The Moniwa specimen under examination seem to be not a typical *Murex*.

***Murex* species indet.**

A single mould, whose spire and the canal are embedded in the matrix.

The shell is small, its diameter about 20 mm in the last whorl which is nodose or somewhat spiny at shoulder. The revolving cords and axial plicae are nearly equal in strength.

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19894 (a).

Genus *Tritonalia* FLEMING, 1828

Genotype:—*Murex erinaceus* LINNÉ; Recent, European seas.

The genus has nearly the same habitat as *Murex*, but extends into colder water.

Ill-preserved specimens were collected from the Moniwa shell bed.

***Tritonalia* species indet.**

A few moulds with broad varices resembling *T. burnetti* (ADAMS and REEVE), a living species which ranges from Hokkaidô to Kyûsyû, Japan.

Occurrence:—Kita-Akai, G. I. S. Coll., Reg. No. 19941.

Family **Buccinidae**Genus **Siphonalia** A. ADAMS, 1863

Genotype:—*Buccinum cassidariaeformis* REEVE; Recent, Japan.

The present distribution of *Siphonalia* is in warm water, being found in Japan, California, Australia and New Zealand. *Siphonalia* s.s. is almost restricted to the warmer part of Japan, and inhabits in shallow to considerable depths.

The extinct forms are represented in the Moniwa fauna.

Siphonalia prespadicea NOMURA and ZINBÔ

Pl. II (II), Figs. 10-12b

Siphonalia prespadicea NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 343, pl. 20, figs. 6a, 6b. 1936.

Among the several specimens of this species from the Moniwa shell beds, some are much larger than the type described from the Yanagawa shell bed, Hukusima basin.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 2605; G. I. S. Coll., Reg. No. 16202. Goisi, S. H. M. Coll., Reg. No. 19916. Minami-Akai, S. H. M. Coll., Reg. No. 19882.

Range:—Known only from the Miocene.

Siphonalia* cf. *gravitesta NOMURA and ZINBÔ

Pl. III (III), Fig. 11

Compare with:

Siphonalia gravitesta NOMURA and ZINBÔ, Saito Ho-on Kai Mus., Res. Bull., no. 10, p. 340, pl. 20, figs. 4a, 4b, 1936.

Three imperfectly preserved specimens. The size, outline and certain sculptures of the specimens are almost identical with the named species, which was first described from the Yanagawa shell beds.

Occurrence:—Kita-Akai, S. H. M. Coll., Reg. No. 19940.

Genus **Babylonia** F. SCHLÜTER, 1838

Genotype:—*Babylonia spirata* (LAMARCK); Recent, Indo-Pacific.

Babylonia is also known as *Eburna*, or *Latrunculus*. Its present distribution is largely in the Indo-Pacific, ranging to Japan on the north and Australia on the south. They inhabit in shallow water along beaches.

The collection contains only an indeterminable specimen.

***Babylonia* species indet.**

An ill-preserved specimen, exposing part of the body-whorl. It resembles somewhat *B. japonica* (REEVE).

Occurrence:—Minami-Akai, S. H. M. Coll., Reg. No. 19895.

Genus *Neptunea* (BOLTEN) RÖDING, 1798

Genotype:—*Murex antiquus* LINNÉ; Recent, northern Europe.

Living species of *Neptunea*, also known as *Chrysodomus* are most abundant in cold waters, but are found also in temperate waters; they live mostly among rocks, ranging from shallow water to considerable depths.

Two species of the genus are distinguished in the Moniwa fauna.

Neptunea koromogawana NOMURA

Neptunea koromogawana NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 13, p. 170, pl. 23, figs. 5-7, 1937.

The less inflated last whorl, small aperture and wide fasciole serve to distinguish this species from the typical *Neptunea*.

Occurrence:—Moniwa, S. H. M. Coll., Rg. No. 2572.

Range:—Known only from the Miocene.

Neptunea (s.s.) species indet.

Imperfect specimens, resembling somewhat *N. intersculpta* SOWERBY in sculpture.

Occurrence:—Kita-Akaisi, G. I. S. Coll., Reg. No. 50134; S. H. M. Coll., Reg. No. 19942.

Family Nassariidae

Genus *Nassarius* DUMERIL, 1806

Genotype:—*Buccium mutabile* LINNÉ; Recent, Mediterranean Sea.

The distribution of the present species of *Nassarius*, also known as *Nassa* is nearly universal; abundant on shallow beach.

The Moniwa specimen is too poor for specific determination.

Nassarius (Hinia) species indet.

A small specimen; it somewhat resembles *N. (Hinia) dominulus* (TAPPARONE-CANIFERI) of our seas.

Occurrence:—Kita-Akaisi, S. H. M. Coll., Reg. No. 2592.

Family Turridae

Genus *Surculites* CONRAD, 1865

Genotype:—*Surcula (Surculites) annosa* CONRAD; Eocene, New Jersey.

Surculites s.s. is an extinct genus ranging from the Eocene to Miocene, but the subgenus *Megasurcula* in which the Moniwa specimen belongs is now living in Californian waters.

A single specimen of the genus is represented in the present collection; it may be, perhaps, a good horizon indicator of the Japanese older Neogene.

Surculites (Megasurcula) siogamaensis NOMURA

Pl. III (III), Figs. a, 9b

Surculites (Megasurcula) siogamensis NOMURA, Saito Ho-on Kai Mus., Res. Bull., no. 6, p. 223, pl. 17, figs. 3, 4, 1935.

A comparatively well preserved specimen having 14 nodes on the shoulder. The number of nodes is somewhat fewer than the type described from the Miocene of Siogama. The type locality is thought to be in a higher horizon than the type Moniwa.

The present species resembles *S. (Megasurcula) remondii* (GABB),¹⁾ a Californian species ranging from the Miocene to the Recent.

Occurrence:—Kita-Akasi, S. H. M. Coll., Reg. No. 19926.

Range:—Known only from the Miocene.

Family ConidaeGenus **Conus** LINNÉ, 1758

Genotype:—*Conus marmoreus* LINNÉ; Recent, Indo-Pacific.

The living species of the genus are abundantly represented in the tropic faunas, but some extend into the temperate waters. They mostly live in rock crevices in shallow water.

The Moniwa specimen is not a perfect one, but its occurrence is of special interest due to that it is found to extend far north of the area of its present distribution.

Conus moniwaensis n. sp.

Pl. II (II), Fig. 16

Shell medium in size, stoutly turbate, of about 6 ? whorls (apical whorls lost). Spire apparently very low, somewhat concave in general outline. Shoulder of last whorl rounded, bulging. Area between sutures on spire marked by a few, well defined grooves. Aperture narrow, linear, obliquely parallel-sided with a marked concavity of inner lip near base. Height ca. 40; diameter 27 mm.

A single specimen of the interior cast lacking its apex was examined. The detail sculpture of the outer surface is not known at present, but the shape is perhaps characteristic to distinguish it from any described species from Japan. The nearest ally with the present species is perhaps *C. eburneus* HWASS, a Recent species ranging from the Indo-Pacific to Japan, but differs from that species chiefly in having a broader last whorl with rounder shoulder.

Occurrence:—Moniwa; G. I. S. Coll., Reg. No. 23750.

Range:—Known only from the type locality.

VIII. SUMMARY

(1) Moniwa is a small village situated on the bank of the river Natori, southwest of the city Sendai.

(2) Moniwa is the type locality of the Moniwa beds, and also the Moniwa shell beds.

1) GABB, Geol. Surv. Calif. Paleont., vol. 2, p. 3, pl. 1, fig. 5, 1866; GRANT and GALE, Mem. San Diego Nat. Hist., vol. 1, p. 495, pl. 25, figs. 5, 6, 7, 8a, 8b, 1931.

(3) The Moniwa beds is the lowest member of the Sawoyama series, and its lower half is particularly rich in a fossil marine fauna; this faunal assemblage is named as the Moniwa shell bed.

(4) The Moniwa shell bed rests unconformably on the Natorigawa andesite and agglomerate group, and is composed of huge blocks of volcanic origin at the lower, and either medium sized conglomerate, or coarse grained sandstone at the upper.

(5) Fossils are found in great profusion at places, but their preservation is not perfect.

(6) Most abundant fossils are the shells of mollusks, but the remains of brachiopods, corals and other marine organisms are by no means rare.

(7) The present paper deals exclusively with the molluscan fauna; those of the other animal remains will be treated in the future opportunity.

(8) Of the molluscan fauna, 37 families, 51 genera and 70 species including specifically indeterminable forms are distinguished.

(9) The characteristic features of the fauna are: (a) the assemblage of rocky shore inhabitants intermingled with a few exotic sandy or muddy shore forms, (b) decidedly warm aspect represented by *Cypraea*, *Conus* and others, (c) the large number of extinct forms, and (d) a few number of new species.

(10) Common species between the Moniwa fauna and that of the Pliocene Tatumokuti shell bed are very few, this is due to the difference in age on one hand, and to the changes of certain physical conditions during past ages on the other.

(11) The evidence afforded by the fauna as well as the stratigraphic position of the said bed indicate that the age of the Moniwa shell bed can be roughly stated to be the lower Miocene in a two fold classification.

IX. INDEX

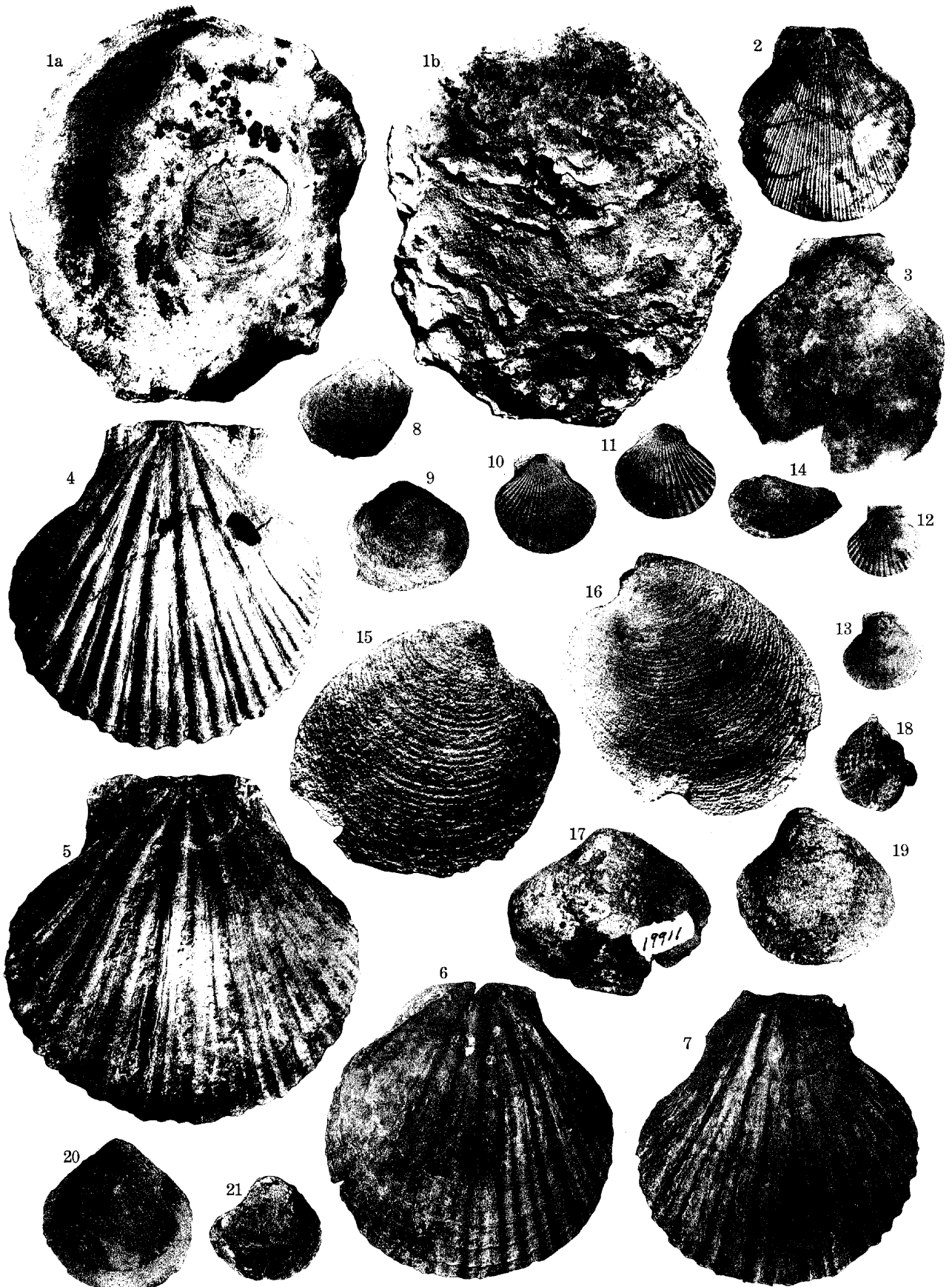
	PAGE		PAGE
<i>Acesta</i>	21	Cardiidae	24
<i>Acmaea</i>	32	<i>Cardium</i>	24
<i>Acmaea</i> species indet.	32	<i>Cardium</i> (<i>Cerastoderma</i> ?) <i>goisiense</i> n. sp.	25
Acmaeidae	32	<i>Cardium</i> (<i>Trachycardium</i> ?) <i>shioharensis</i> YOKOYAMA .	25
<i>Aequipecten</i>	19	Cassiidae	39
<i>Anomia</i>	21	<i>Cerastoderma</i>	25
<i>Anomia cytaeum</i> GRAY	21	<i>Chama</i> species indet.	24
Anomiidae	21	Chamidae	24
<i>Arca</i>	14	<i>Cheilea</i>	36
<i>Arca</i> cf. <i>ocellata</i> REEVE	15	<i>Cheilea yanagawaensis</i> NOMURA and ZINBÔ	36
Arcidae	14	<i>Chione</i>	26
<i>Argobuccinum</i>	40	<i>Chlamys</i>	17
<i>Argobuccinum</i> (<i>Fusitriton</i>) <i>nipponense natorianum</i> n. subsp.	40	<i>Chlorostoma</i>	32
<i>Babylonia</i>	42	Codakiidae	24
<i>Babylonia</i> species indet.	42	Conidae	44
Buccinidae	42	<i>Conus</i>	44
Bursidae	40	<i>Conus moniwanus</i> n. sp.	44
<i>Bursa</i>	40	<i>Crassatellites</i>	22
<i>Bursa</i> (<i>Ranella</i>) <i>yabei</i> NOMURA and ZINBÔ	41	<i>Crassatellites paucillus</i> (YOKOYAMA)	23
Calyptraeidae	37	Crassatellitidae	22
Capulidae	36	<i>Crepidula</i>	37
<i>Capulus</i>	36	<i>Crepidula</i> cf. <i>aculeata</i> (GMELIN)	37
<i>Capulus natorianus</i> n. sp.	36	Cymatiidae	40
		<i>Cypraea</i>	38
		<i>Cypraea</i> species indet.	38

	PAGE		PAGE
Cypraeidae	38	<i>Pecten (Chlamys) kaneharai</i> YOKOYAMA	18
Dentaliidae	31	<i>Pecten (Chlamys) nisataiensis</i> OTUKA	18
<i>Dentalium</i>	31	<i>Pecten (Chlamys) notoensis</i> YOKOYAMA	18
<i>Dentalium cf. weinkauffi</i> DUNKER	31	<i>Pecten (Chlamys) protomollitus</i> NOMURA	17
<i>Doliocassis</i>	39	<i>Pecten (Aequipecten) yanagawaensis</i> NOMURA and ZINBÔ	19
<i>Dosinia</i>	26	Pectinidae	16
<i>Dosinia kaneharai</i> YOKOYAMA	26	Phalium	39
<i>Dosinia nomurai</i> OTUKA	26	<i>Phalium (Semicassis) cf. japonicum</i> (REEVE)	39
<i>Fusitriton</i>	40	<i>Phalium (Doliocassis) yabei</i> NOMURA and HATAI	39
<i>Glycymeris</i>	15	<i>Pitar</i>	27
<i>Glycymeris</i> species indet.	15	<i>Pitar itoi</i> (MAKIYAMA)	27
Haliotidae	31	<i>Polinices</i>	38
<i>Haliotis japonica</i> REEVE	32	<i>Polinices</i> (s.s.) cf. <i>melanostoma</i> (GMELIN)	38
Hiatellidae	30	<i>Pseudamusium</i>	20
<i>Hinia</i>	43	<i>Pseudogrammatodon</i>	15
Hipponycidae	36	<i>Pseudogrammatodon dalli</i> (SMITH)	15
<i>Kaneharaia</i>	26	<i>Ranella</i>	41
<i>Lima</i>	21	<i>Saxidomus</i>	27
<i>Lima (Acesta) cf. goliath</i> SOWERBY	21	<i>Saxidomus cf. nuttallii</i> (CONRAD)	27
<i>Lima (Limatula) subauriculata</i> (MONTAGU)	21	<i>Schizothaerus</i>	29
<i>Limatula</i>	21	<i>Semicassis</i>	39
Limidae	21	<i>Sinum</i>	38
<i>Lucina</i>	24	<i>Sinum</i> (s.s.) <i>yabei</i> OTUKA	38
<i>Lucina</i> species indet.	24	<i>Siphonalia</i>	42
<i>Macoma</i>	29	<i>Siphonalia</i> (s.s.) cf. <i>gravitesta</i> NOMURA and ZINBÔ ..	42
<i>Macoma</i> (s.s.) <i>tokyoensis</i> MAKIYAMA	30	<i>Siphonalia</i> (s.s.) <i>prespadicea</i> NOMURA and ZINBÔ ..	42
<i>Mactra</i>	28	<i>Solen</i>	30
<i>Mactra</i> (?) <i>charischema</i> MATSUMOTO	28	<i>Solen</i> species indet.	30
<i>Mactra (Spisula) polynyma voyi</i> (GABB)	29	Solenidae	30
Mactridae	28	<i>Spisula</i>	29
<i>Megasurcula</i>	44	<i>Spondylus</i>	20
<i>Morum</i>	39	<i>Spondylus</i> species indet.	20
<i>Morum macandrewi</i> (SOWERBY)	39	<i>Surculites</i>	43
<i>Murex</i>	41	<i>Surculites (Megasurcula) siogamensis</i> NOMURA	44
<i>Murex</i> species indet.	41	<i>Taras</i>	23
Muricidae	41	<i>Taras cumingi</i> (HANLEY)	23
<i>Mya</i>	31	<i>Taras ustus</i> (GOULD)	23
<i>Mya cf. arenaria</i> LINNÉ	31	<i>Tegula</i>	32
Myiidae	31	<i>Tegula (Chlorostoma) protonigerrima</i> n. sp.	32
Nassaridae	43	Tellinidae	29
<i>Nassarius</i>	43	<i>Trachycardium</i>	25
<i>Nassarius (Hinia) species indet.</i>	43	<i>Tritonalia</i>	41
Naticidae	37	<i>Tritonalia</i> species indet.	41
<i>Neptunea</i>	43	Trochidae	32
<i>Neptunea</i> species indet.	43	<i>Trochus</i>	33
<i>Neptunea koromogawana</i> NOMURA	43	<i>Trochus</i> (s.s.) <i>goisiiensis</i> n. sp.	33
<i>Nuculana</i>	14	<i>Trochus</i> (s.s.) <i>oidensis</i> n. sp.	33
<i>Nuculana moniwaensis</i> n. sp.	14	<i>Trochus</i> species indet.	34
Nuculanidae	14	Turbinidae	35
<i>Ostrea</i>	22	<i>Turbo</i>	35
<i>Ostrea sinensis</i> GMELIN	22	<i>Turbo parvuloides</i> n. sp.	35
<i>Ostrea</i> species indet.	22	<i>Turbo</i> species indet.	35
Ostreidae	22	<i>Turcica</i>	34
<i>Panope</i>	30	<i>Turcica pretimperialis</i> n. sp.	34
<i>Panope</i> (s.s.) <i>japonica</i> (A. ADAMS)	30	Turridae	43
<i>Paphia</i>	27	Ungulinidae	23
<i>Paphia</i> ? <i>takadatensis</i> (MATSUMOTO)	28	Veneridae	25
<i>Pecten</i>	16	<i>Venus</i>	25
<i>Pecten (Pseudamusium) akihoensis</i> MATSUMOTO	20	<i>Venus yokoyamai</i> MAKIYAMA	26
<i>Pecten (Chlamys) arakawai</i> NOMURA	17	<i>Xenophora</i>	37
<i>Pecten</i> (s.s.) <i>kagamianus</i> YOKOYAMA	16	<i>Xenophora cf. eruta</i> (REEVE)	37
		Xenophoridae	37

Explanation to Plate I

All figures are nearly in natural size.

- Figs. 1a, 1b. *Ostrea sinensis* GMELIN. Interior (a) and outer (1b) surface of right valve from Moniwa; G. I. S. Coll., Reg. No. 23717.
- Figs. 2, 3. *Pecten (Pseudamusium) akihoënsis* MATSUMOTO. Outer surface of left (2) and right (3) valves from Kita-Akai; G. I. S. Coll., Reg. No. 16077.
- Figs. 4, 5, 6, 7. *Pecten (Chlamys) notoensis* YOKOYAMA. Outer surface of right (4) and left (5) valves or different individuals from Moniwa; G. I. S. Coll., Reg. No. 2992. Outer surface of right (7) and left (6) valves of different individuals from Kumano-dô; S. H. M. Coll., Reg. No. 2624.
- Figs. 8, 9. *Crassatellites pauvillus* (YOKOYAMA). Mould specimens from Kumano-dô; S. H. M. Coll., Reg. No. 2616.
- Figs. 10, 11, 12, 13. *Pecten (Aequipecten) yanagawaensis* NOMURA and ZINBÔ. Outer surface of left (10, 11) and right (12) valves from Moniwa; S. H. M. Coll., Reg. No. 2577. Interior of left (13) valve from the same locality shown in the preceding; ditto.
- Fig. 14. *Nuculana moniwaensis* n. sp. Holotype (mould) from Moniwa; S. H. M. Coll., Reg. No. 2569.
- Figs. 15, 16. *Dosinia kaneharai* YOKOYAMA. Mould specimens of right (15) and left (16) valves of the same individual from Goisi; G. I. S. Coll., Reg. No. 50144.
- Fig. 17. *Mactra (Spisula) polynyma voyi* (GABB). A mould of a left valve from Goisi; S. H. M. Coll., Reg. No. 19911.
- Fig. 18. *Bursa (Ranella) yabei* NOMURA and HATAI. An imperfect specimen from Kita-Akai; S. H. M. Coll., Reg. No. 2591.

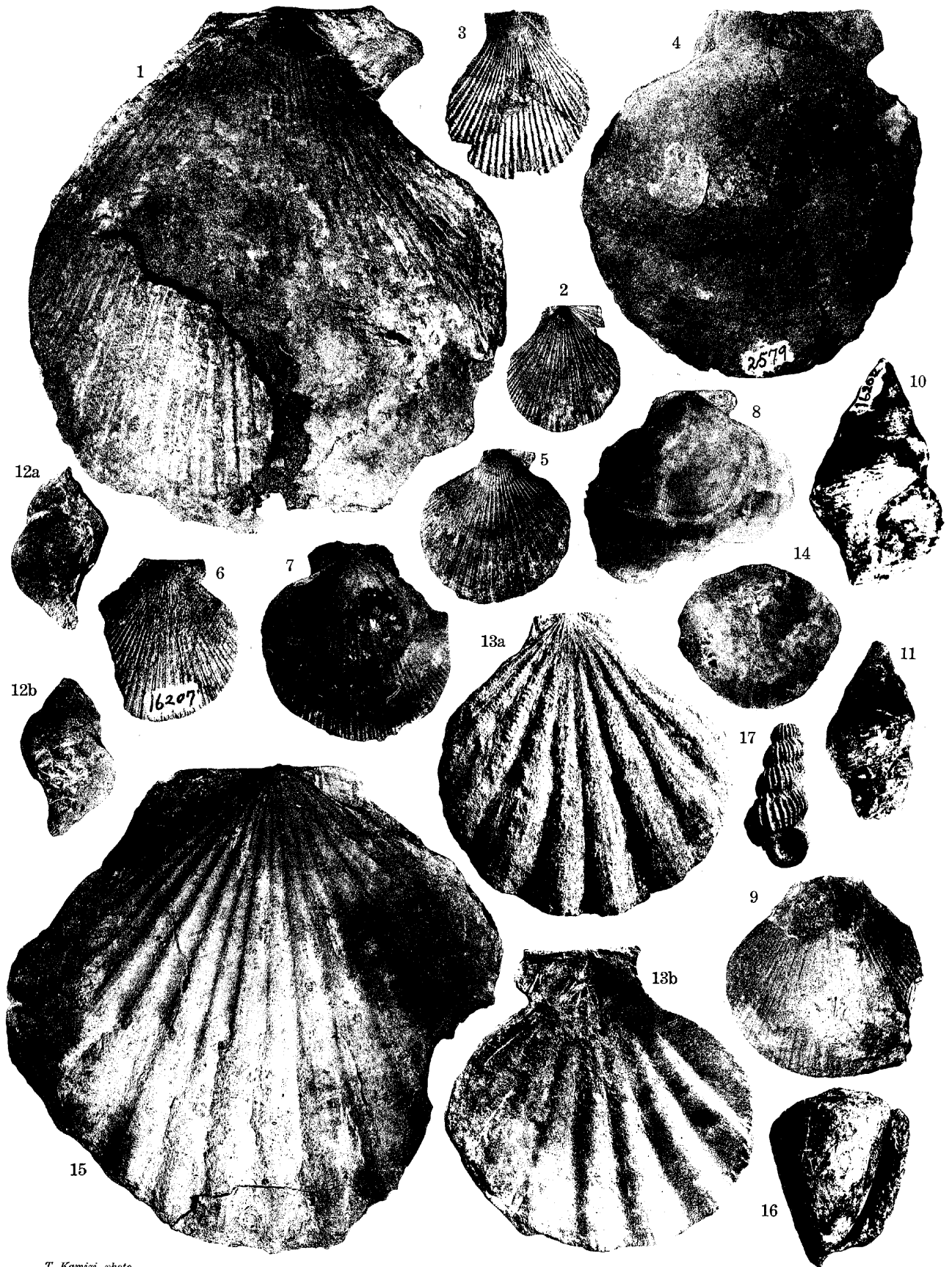


T. Kamizi, photo.

Explanation to Plate II

All figures are nearly in natural size

- Figs. 1, 2, 3. *Pecten (Chlamys) arakawai* NOMURA. A full grown specimen of a right valve (1) from Kita-Akai; S. H. M. Coll., Reg. No. 2004. A young individual of right (2) and left (3) valves from the same locality as above; G. I. S. Coll., Reg. No. 16079.
- Fig. 4. *Pecten (Pseudamusium) akihoënsis* MATSUMOTO. A right valve from Moniwa; S. H. M. Coll., Reg. No. 2579.
- Figs. 5, 6. *Pecten (Chlamys) nisataiensis* OTUKA. A right valve from Goisi; S. H. M. Coll., Reg. No. 19925. A right valve (6) from Kita-Akai (6); G. I. S. Coll. Reg. No. 16207.
- Figs. 7, 8, 9. *Pecten (Chlamys) protomollitus* NOMURA. A left valve (7) from Moniwa; G. I. S. Coll., Reg. No. 23716. Right (8) and left (9) valves from the same locality as above; S. H. M. Coll., Reg. No. 2580.
- Figs. 10, 11, 12a, 12b. *Siphonalia* (s.s.) *praespadicea* NOMURA and ZINBÔ. Apertural views (10, 11) of the specimens from Kita-Akai; G. I. S. Coll., Reg. No. 16202. Side views (12a, 12b) of the same specimen from Kita-Akai; S. H. M. Coll., Reg. No. 19875.
- Figs. 13a, 13b. *Pecten (Chlamys) crassivenius* YOKOYAMA. Outer (13a) and inner (13b) surfaces of right valve of the same specimen from Tunaki; G. I. S. Coll., Reg. No. 16165.
- Fig. 14. *Anomia cytaeum* GRAY. Upper valve from Goisi; G. I. S. Coll., Reg. No. 19909.
- Fig. 15. *Pecten* (s.s.) *kagamianus* YOKOYAMA. Outer surface of left valve from Kumanodô; S. H. M. Coll., Reg. No. 5589.
- Fig. 16. *Conus moniwanus* n. sp. Holotype (mould) from Moniwa; G. I. S. Coll., Reg. No. 23750.
- Fig. 17. *Epitonium* sp. A specimen from Tunaki; G. I. S. Coll., Reg. No. 16031.
- Fig. 19. *Cardium (Trachycardium ?) shiobarensis* YOKOYAMA. A mould of left valve from Moniwa; S. H. M. Coll., Reg. No. 2573.
- Fig. 20. *Glycymeris* species indet. A mould specimen from Moniwa; S. H. M. Coll., Reg. No. 2574.
- Fig. 21. *Maetra (?) charischema* MATSUMOTO. A mould of left valve from Kumanodô; S. H. M. Coll., Reg. No. 19936.

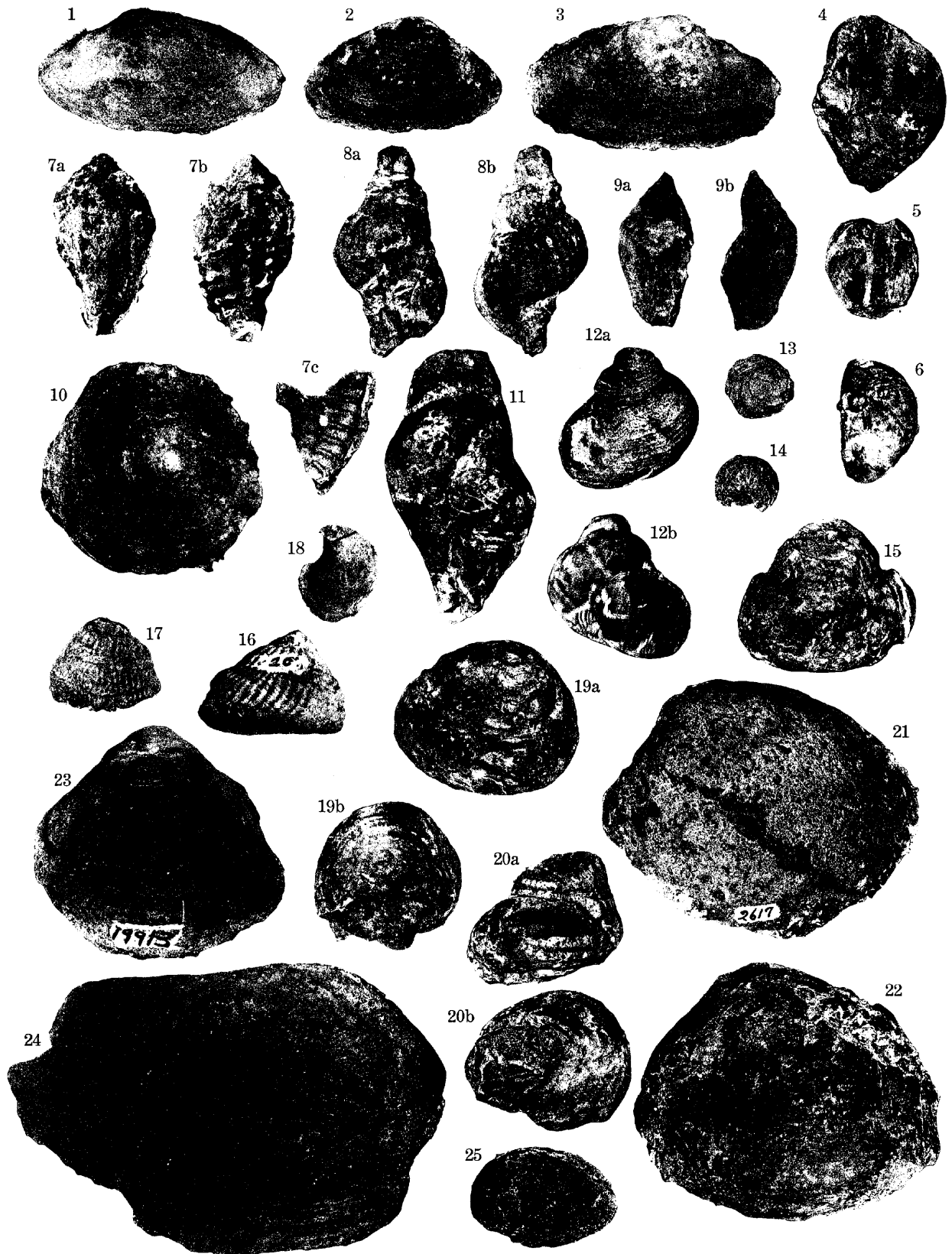


T. Kamizi, photo.

Explanation to Plate III

All figures are nearly in natural size.

- Figs. 1, 2, 3. *Paphia* (s.s.) ? *takadatensis* (MATSUMOTO). Moulds of left (1) and right (2) valves from Moniwa; S. H. M. Coll., Reg. No. 2578. Mould of a right valve (3) from Kumanodô; S. H. M. Coll., Reg. No. 2612.
- Figs. 4, 5, 6. *Cypraea* species indet. Lateral view (4, 6) of a mould from Minami-Akai; S. H. M. Coll., Reg. No. 19892. Apertural view, of an imperfect specimen from the same locality as the preceding; ditto.
- Figs. 7a, 7b, 7c. *Morum macandrewi* (SOWERBY). A mould specimen from Minami-Akai; S. H. M. Coll., Reg. No. 19891.
- Figs. 8a, 8b. *Argobuccinum* (*Fusitriton*) *nipponense natorianum* n. subsp. Holotype from Kita-Akai; S. H. M. Coll., Reg. No. 19928.
- Figs. 9a, 9b. *Surculites* (*Megasurcula*) *siogamensis* NOMURA. Specimen from Kita-Akai; S. H. M. Coll., Reg. No. 19926.
- Fig. 10. *Xenophora* cf. *exuta* (REEVE). Apical view of mould specimen from Kita-Akai; S. H. M. Coll., Reg. No. 2590.
- Fig. 11. *Siphonalia* (s.s.) cf. *gravitesta* NOMURA and ZINBÔ. An imperfect specimen from Kita-Akai; S. H. M. Coll., Reg. No. 19940.
- Figs. 12a, 12ab. *Turbo parvuloides* n. s. Holotype from Minami-Akai S. H. M. Coll., Reg. No. 19877.
- Figs. 13, 14. *Turbo* species indet. Specimens from Goisi; S. H. M. Coll., Reg. No. 19915.
- Figs. 15, 16. *Tegula* (*Chlorostoma*) *protonigerrima* n. sp. Back view of paratype (15) from Minami-Akai; S. H. M. Coll., Reg. No. 19934. Back view of holotype (16) from Kita-Akai; G. I. S. Coll., Reg. No. 16201.
- Fig. 17. *Trochus* (s.s.) *goisiensis* n. sp. Back view of holotype from Goisi; S. H. M. Coll., Reg. No. 19907.
- Fig. 18. *Capulus natorianus* n. sp. Holotype from Kita-Akai; S. H. M. Coll., Reg. No. 19933.
- Figs. 19a, 19b. *Trochus* (s.s.) *oidensis* n. sp. Holotype showing back (19a) and basal (19b) views from Minami-Akai; S. H. M. Coll., Reg. No. 19875.
- Figs. 20a, 20b. *Turcica preimperialis* n. sp. Holotype showing back (20a) and basal (20b) views from Minami-Akai; S. H. M. Coll., Reg. No. 19881.
- Fig. 21. *Saxidomus* cf. *nuttallii* (CONRAD). A smallest specimen of moulds in the collection from Kumanodô; S. H. M. Coll., Reg. No. 2617.
- Fig. 22. *Pitar itoi* (MAKIYAMA). A specimen from Goisi; S. H. M. Coll., Reg. No. 19919.
- Fig. 23. *Cardium* (*Cerastoderma* ?) *goisiense* n. sp. Holotype from Goisi; S. H. M. Coll., Reg. No. 19913.
- Fig. 24. *Schizothaerus* cf. *nuttallii* (CONRAD). A mould specimen from Goisi; S. H. M. Coll., Reg. No. 19923.
- Fig. 25. *Haliotis japonica* REEVE. A mould specimen from Minami-Akai; S. H. M. Coll., Reg. No. 19893.



T. Kamizi, photo.