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LOWER LIASSIC LAMELLIBRANCH FAUNA OF THE HIGASHINAGANO FORMATION IN WEST JAPAN

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LOWER LIASSIC LAMELLIBRANCH FAUNA OF THE HIGASHINAGANO FORMATION IN WEST JAPAN*

By

Itaru HAYAMI

With Plates V—VIII.

Abstract

The lower Liassic Higashinagano formation in Yamaguchi Prefecture of West Japan can be stratigraphically divided into five members, namely, basal conglomerate, *Cardinia toriyamai*-, *Prosogyrotrigonia inouyei*-, *Oxytoma*-sandstones and *Coroniceras* (?)-bearing sandy shale. In this paper are described the pelecypods in the sandstones which were only partly reported by YEHARA (1921), TORIYAMA (1938), KOBAYASHI and MORI (1954) and HAYAMI (1957). The predominant genera in this formation are *Parallelodon*, *Grammatodon*, *Oxytoma*, *Chlamys*, "*Aequipecten*," *Entolium*, *Plicatula*, *Plagiostoma*, *Ctenostreon*, *Liostrea*, *Prosogyrotrigonia*, *Cardinia*, *Praeconia*, *Sphaeriola*, *Lucina* (s. l.) and *Protocardia*. *Oxytoma inequivalve*, *O.* cf. *cygnipes*, *Chlamys textoria*, *Entolium* cf. *calvum*, *E.* cf. *lunare*, *Praeconia* cf. *tetragona* and some other forms are identical or comparable with foreign species from the Lias (mainly lower) of Western Europe and some other areas. No species of this fauna is common with the coeval pelecypods of the Niranohama formation in Northeast Japan and the lower Kuruma group in Central Japan. The faunal difference may be partly dependent upon the different sedimentary condition but can be properly attributed to the more or less isolated biogeography.

Contents

* Received May 25, 1959.

Introduction

In the western part of Yamaguchi Prefecture (Province of Nagato), West Japan, is seen a splendid sequence of Lower to Middle Jurassic marine sediments, which has been called Toyora group and regarded as one of the most complete Jurassic standards in this country. Since YOKOYAMA (1904 a) had described several ammonites from this district, KOBAYASHI (1926) divided it stratigraphically into four formations, namely Higashinagano, Nishinakayama, Utano and Nanami ones in ascending order. Subsequently the last was excluded from the Toyora group (s. s.) by TORIYAMA (1938). Still later MATSUMOTO and ONO (1947) accomplished the zoning of its main part by means of ammonites, whose generic identification was partly emended by ARKELL (1956). Guide fossils are, however, rather scarce in the Higashinagano formation mainly composed of neritic or littoral sandstones, although pelecypods and gastropods are fairly common at some horizons. The palaeontology of the Higashinagano fauna had been commenced by YEHARA (1921) with *Trigonia inouyei*, which was recently referred to *Prosogyrotrigonia* by KOBAYASHI and MORI (1954). TORIYAMA (1938) listed *Leda*, *Pecten* (*Syncyclonema*), *Lima*, *Myoconcha*, *Cardinia* and *Astarte* as the members of the fauna, but they remain undescribed except for a species of *Cardinia* which I (1958e) reported recently. Besides pelecypods, YABE and EGUCHI (1933) described *Anabacia cyclitoides* which was subsequently transferred to *Chomatoseris*. MATSUMOTO and ONO (1947) found *Juraphyllites** (*Harpophylloceras*?) sp. in the lower part and *Arietites* (*Coroniceras*?) sp. in the upper part, and suggested lower Lias for the formation. The opinion was later upheld by SATO (1956) when he found a *Vermiceras*-like ammonite in KOBAYASHI's collection.

Table 1. List of Fossils of the Higashinagano Formation

Locality / Species	Takayama		Higashinagano				Higashinakayama		
	1	2	3	4	5	6	7	8	9
Pelecypoda									
Nuculopsis (*Palaeonucula*) sp.					R				
Nuculana (*Dacryomya*) *toriyamae*, n. sp.					R			R	
Parallelodon infraliassicus, n. sp.					C				
Parallelodon cf. *infraliassicus*					R				
Parallelodon (?) *subnavicellus*, h. sp.					R				
Grammatodon toyorensis, n. sp.					C				
Modiolus magatama, n. sp.			R					R	
Meleagrinella japonica, n. sp.			R		?			R	R
Oxytoma cf. *cygnipes*					R				

* =*Rhacophyllites* auct., non ZITTEL, 1884.

	1	2	3	4	5	6	7	8	9
Oxytoma kobayashii, n. sp.									R
Oxytoma inequivalve				R					C
Chlamys textoria			R		C				
"*Aequipecten*" *toyorensis*, n. sp.					C	R			
"*Aequipecten*" sp.					R				
Entolium cf. *calvum*			C	?	C			C	
Entolium cf. *lunare*			R						
Entolium sp.									R
Entolium (?) sp.			R		R			C	
Plicatula subcirsularis, n. sp.					C				
Plicatula praenipponica, n. sp.					C				
"*Lima*" sp. indet.									R
Plagiostoma kobayashii, n. sp.					R				
Plagiostoma matsumotoi, n. sp.			R		C	R		R	?
Plagiostoma sp.									R
Antiquilima nagatoensis, n. sp.					R				
Ctenostreon japonicum, n. sp.					R				
Ctenostreon sp.					R				
Liostrea toyorensis, n. sp.	?				C				
Lopha sazanami, n. sp.					R				
Prosogyrotrigonia inouyei		R	C		R	C	R	C	
Cardinia orientalis, n. sp.			R			R			
Cardinia toriyamai					C			R	
Praeconia cf. *tetragona*					C				
Astarte a sp.					R				
Astarte b sp.					R				
Fimbria sp.					R				
Sphaeriola nipponica, n. sp.					C				
Lucina (s. l.) *hasei*, n. sp.					C				
Cardium (s. l.) *naganoense*, n. sp.	C				R				
Protocardia onoi, n. sp.					R				
Pleuromya sp.			R						
Gen. and sp. indet. a					R				
Gen. and sp. indet. b					R				
Gastropoda spp.	C				C	R		R	
Scaphopoda spp.					C				
Ammonite sp.					R				
Brachiopoda sp. (*Rimirhynchia*)					R				
Brachiopoda sp. (terebratuloid)			R						
Hexacorals									
Chomatoseris cyclitoides	C	C	R		C	C	R	C	
Isastraeid gen. and sp. indet.					C				
Crinoid sp. (isocrinid)					R				

Frequency:—C: common, R: rare.

Horizons:—Basal conglomerate (Loc. 1), *Cardinia toriyamai* bed (Loc.5), *Prosogyrotrigonia* bed (Locs. 2, 3, 6, 7, 8), *Oxytoma* bed (Locs. 4, 9).

Lately I collected many pelecypods and gastropods from the Higashinagano formation at many localities, and the collection in this institute was greatly amplified. In this paper are described 43 forms in 28 pelecypod genera including 22 new species as shown in Table 1, and briefly discussed the biostratigraphical, palaeoecological and palaeogeographical significances of this formation.

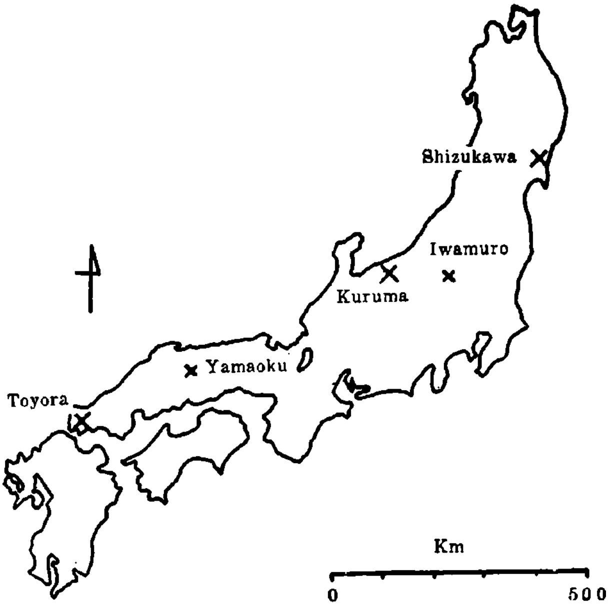


Fig. 1. Distribution of Lower Jurassic Rocks in Japan

Since most pelecypod specimens are represented by internal and external moulds, it is easy to examine their hinge, other internal characters and surface ornamentation. But simultaneously it is hard to obtain complete external moulds except for several species with comparatively flat valves. Therefore, their complete outlines are properly given by internal moulds. Merit to arenaceous matrix thematerials is almost free from secondary deformation, although their surface-marking are sometimes difficult to examine in detail.

Acknowledgements

The Toyora pelecypods were previously studied by Prof. Teiichi KOBAYASHI of the University of Tokyo, but they remain undersribed except for two inoceramids and a trigoniid. He transferred kindly his manuscript and place the collection of this institute to my disposal. Here I express my most sincere thanks to Prof. Teiichi KOBAYASHI for his kindness and constant encouragement throughout this study. I am also greatly indebted to Dr. Leslie R. Cox of the British Museum (Natural History) for his kind and instructive informations replying to my various questions, and to Prof. Tatsuro MATSUMOTO and Prof. Ryuzo TORIYAMA of the Kyushu University and Assist. Prof. Akira HASE of the Hiroshima University for the permission of examining their collections. Assist. Prof. Koichiro ICHIKAWA of the Osaka City University gave me many instructive informations. Thanks are also due to Dr. Katsura OYAMA of the Geological Survey of Japan for his various advices about malacology and zoological nomenclature.

Biostratigraphy

The Higashinagano formation is mainly composed of sandstones of variable grain-size. Generally speaking, the basal part consists of conglomerates or coarse sandstones, and the grain-size becomes gradually finer upwards. Sandstones are sometimes fairly coaly, but usually quartzose, well sorted, massive, light-coloured and non-bituminous. Their matrix is occasionally fairly calcareous. The distribution of this formation is limited to a narrow zone from the west of Takayama to Yuhara, and it may merge horizontally with bituminous rocks in the southern area of Tabe. (See Fig. 1)

At Takayama the formation begins with a thin basal conglomerate containing *Ostrea* (?) sp., *Modiolus* (?) sp., *Lucina* (s. l.) *hasei* and some gastropods though most of them are too badly preserved to describe palaeontologically (Loc. 1). *Prosogyrotrigonia inouyei* and *Chomatoseris cyclitoides* occur in middle part (Loc. 2).

There are two valleys at Higashinagano where most part of this formation is exposed. At the northern valley the base of unknown, but fine sandstones of middle part yield *Modiolus magatama*, *Chlamys textoria*, *Entolium* cf. *calvum*, *E.* cf. *lunare*, *Plagiostoma matsumotoi*, *Prosogyrotrigonia inouyei*, *Cardinia orientalis*, *Pleuromya* sp. and *Chomatoseris cyclitoides* (Loc. 3). The superjacent hard fine sandstone yields *Oxytoma inequivalve* (Loc. 4). At the southern valley fossiliferous medium sandstones rest clino-unconformably upon the "Toyogatake phyllites" which belong to Sangun metamorphic rocks. There is no basal conglomerate at the valley, and along the basal plane *Plicatula subcircularis* and *Liostrea toyorensis* form a gregarious fossil bank. It is directly overlain by massive grey medium sandstones which bears a striking lenticular fossil bed containing *Chomatoseris cyclitoides*, an isastraeid, columnar stellates of an isocrinid, scaphopods, gastropods, an ammonite and the greater part of pelecypods which are described in this paper (Loc. 5). *Prosogyrotrigonia inouyei* is comparatively rare at this locality. The medium sandstones merge upwards with fine, light grey sandstones which bears occasionally *Cardinia orientalis*, *Chlamys textoria*, "*Aequipecten*" *toyorensis*, *Entolium* cf. *calvum*, *Plagiostoma matsumotoi*, *Prosogyrotrigonia inouyei* and *Chomatoseris cyclitoides* (Loc. 6).

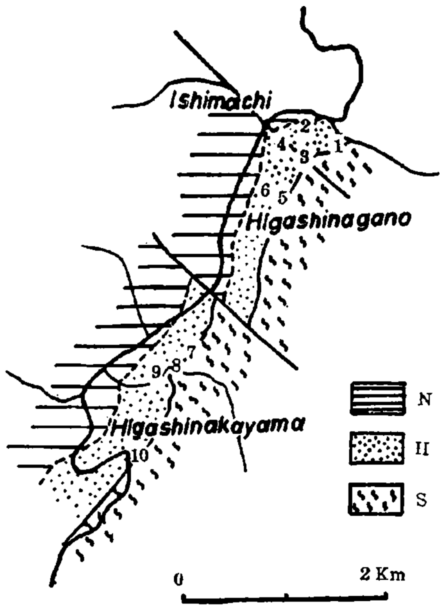


Fig. 2. Index map of Fossil Locality of the Higashinagano Formation in Toyora Asea.
S: Sangun metamorphic rocks;
H: Higashinagano Formation;
N: Nishinakayama Formation.

The Toyogatake phyllites are overlain by a thick basal conglomerate containing numerous colossal boulders of the metamorphic rocks at a valley of Higashinakayama about 2 kilometers southwest of Higashinakano. From an overlying somewhat coaly sandstone several specimens of *Nuculana* (*Dacryomya*) *toriyamae*, *Modiolus magatama*, *Meleagrinella japonica*, *Entolium* cf. *calvum*, *Prosogyrotrigonia inouyei* and *Cardinia toriyamai* were found by TORIYAMA and myself (Locs. 7 and 8). It is uncertain which fossil bed at Higashinagano this corresponds to, but all species are common with the fauna at Loc. 3, 5 or 6. The overlying hard fine sandstone yields sporadically *Oxytoma inequivalve*, *O. kobayashii*, *Plagiostoma* sp. and "*Lima*" sp. (Loc. 9). Besides, some ill-preserved pelecypods were found at the north of Yuhara, but their specific identification is very difficult. (Loc. 10).

The stratigraphy and division of the Higashinagano formation at these three sections can be summerized as Table 2.

Table 2.

	Takayama	Higashinagano	Higashinakayama
Higashinagano Fm.	Fine sandy shale	Fine sandy shale	Fine sandy shale. *Coroniceras?*
	Not represented	Fine hard sandstone. *Oxytoma inequivalve*	Fine hard sandstone. *Oxytoma inequivalve*, *Oxytoma kobayashii*
	Fine sandstone. *Prosogyrotrigonia inouyei*, etc.	Fine sandstone. *Pr. inouyei*, *Cardinia orientalis*, etc.	Medium sandstone. *Pr. inouyei*, *Cardinia toriyamai*, etc.
	Basal conglomerate. *Lucina hasei*, etc.	Medium sandstone. *Cardinia toriyamai*	Basal conglomerate

Since fossils are restricted to some narrow parts, it is difficult to carry out a biostratigraphical analysis by making a range chart of pelecypod species. The upper part is composed of fine sandy shale, which does not yield pelecypods. But in view of the lithology and predominant pelecypod species, this formation can be divided as follows.

5. *Coroniceras?*-bearing sandy shale .... 50 m+
4. *Oxytoma*-bearing fine hard sandstone .... 40–90 m
3. *Prosogyrotrigonia*-bearing fine sandstone........ 30–40 m
2. *Cardinia toriyamai*-bearing medium sandstone........ 20 m
1. Basal conglomerate (sometimes absent) .... 0–40 m

These five members correspond roughly to Nbc, Nbs, Ncs, Nss and Nsh by MATSUMOTO and ONO (1947) in ascending order. *Chomatoseris cyclitoides* is very common in *Cardinia toriyamai* and *Prosogyrotrigonia inouyei* beds, but unknown in upper horizon. MATSUMOTO and ONO reported *Juraphyllites* (*Harpophylloceras*)? from Nbs (almost equal to *Cardinia toriyamai* bed in my division). The total thickness of this formation measures about 200 meters. If considered that it corresponds lower Lias, the deposition seems fairly rapid, but the value is moderate and not especially large for other Mesozoic basin deposits in Japan.

Palaeoecology

All the pelecypods in this formation are marine. Neither brackish nor fresh water element was found. Two species of the Ostreidae and one of the Mytilidae contained are certainly also marine inhabitants. The mode of fossil occurrence is somewhat different among the fossil beds. In *Cardinia toriyamai* and *Prosogyrotrigonia* beds fossils are crowded and restricted to comparatively small lenses. Valves of pelecypods are never intact and often fragmental with water-worn surface. Apertures of gastropods are often broken. *Chomatoseris cyclitoides* is abundant in the fossil beds, and their reverse situation seen as often as normal one. Therefore it is reasonable to consider that the sedimentation occurred under a certain littoral or neritic condition where sea water was more or less agitated by waves or beach currents.

As supposed from colossal boulders of phyllitic rocks in the basal conglomerate, the Sangun metamorphic complex formed a somewhat steep shore line at that time, and the Liassic transgression occurred grandually from the northwestern direction. In *Oxytoma* and *Coroniceras?* beds fossils occur rather sporadically. They are also allochthonous, but the sedimentation may have been carried out under more off-shore and calm condition in view of the fossil-occurrence and lithology. The arenaceous Higashinagano formation passes upwards into argillaceous Nishinakayama formation which yields middle-upper Liassic ammonites, aptychi, belemnites, inoceramids, posidoniids and some pectinids. Because of the absence of upper Sinemurian and lower Pliensbachian ammonite zones, SATO (1957) suggested a certain hiatus between the two formations, but there is no evidence of regression in this period. Anyhow, the Nishinakayama formation shows more offshore and calm deposition than Higashinagano. As noted by MATSUMOTO and ONO (1947), the Nishinakayama ammonite fauna comprises many genera characteristic of the Tethys region. The presence of a colonial hermatypic hexacoral and predominance of tropical pelecypod genera (in Recent seas) such as *Plicatula* and *Fimbria* indicate that the temperature of sea water was fairly warm.

Significance of the Fauna

1. General Remarks

The Higashinagano fauna under consideration comprises more than 40 pelecypod species. Besides, several gastropods, scaphopods, ammonites, brachiopods (including *Rimirhynchia**), a crinoid (columnar stellates of an isocrinid) and hexacorals are found in association. Since no strict time-indicator is found in my collection, I do not intend to say the age of the fauna. But it is noticable that several pelecypods are identical with or closely related to some Liassic (properly lower Liassic) species hitherto known in Europe, northern Africa or Canada. No Triassic (inclusive of Rhaetic) element is found in the fauna. The generic assemblage is quite different from those of the Upper Triassic in Japan and its surroundings. On the contrary, the presence of *Grammatodon*, *Meleagrinella*, *Plagiostoma*, *Antiquilima*, *Ctenostreon*, *Praeconia* etc. suggests that this fauna is not older than Rhaetic. These facts coincide well with the chronology suggested by MATSUMOTO and ONO based on the occurrence of *Juraphyllites* (*Harpophylloceras?*) and *Arietites* (*Coroniceras?*) in this formation.

It is certain that the Higashinagano formation is almost coeval with the lower parts of the Shizukawa and Kuruma groups respectively in northeastern and central Japan. The upper part (*Trigonia*-sandstone) of the Niranohama formation in Shizukawa and Hashiura areas has been considered Hettangian on the basis of *Yebisites* belonging to the Alsatitinae (MATSUMOTO, 1956) and an *Alsatites*-like ammonite (SATO, 1956). The overlying arenaceous shales of the Hosoura formation yield *Arnioceras* and later ammonites (SATO, 1957). As to the Kuruma group, the lowermost dated horizon is upper Pliensbachian indicated by *Amaltheus* and *Canavaria* (SATO, 1955), and there are more than 4,000 meters' thick strata below the horizon (KOBAYASHI et al., 1957). Generally speaking, Liassic pelecypod-bearing rocks in Japan can be classified roughly into three facies, namely bituminous (bakevelliid-eomiodontid) facies, sandstone (trigoniid) facies and sandy shale (ammonite-inoceramid) facies. The Higashinagano

* I thank Mr. A. TOKUYAMA of the University of Tokyo for his identifying of this brachiopod. *Rimirhynchia* has been known chiefly from the Lias of Europe.

formation is not very rich in trigoniids, but the mode of fossil-occurrence, assemblage and lithology bear many alliances to the "*Trigonia*-sandstones" which are commonly seen at several horizons of the Jurassic in Northeast Japan. Bituminous facies is not represented in Toyora area.

The predominant pelecypod genera in this formation are *Parallelodon*, *Grammatodon*, *Oxytoma*, *Chlamys*, "*Aequipecten*," *Entolium*, *Plicatula*, *Plagiostoma*, *Prosogyrotrigonia*, *Cardinia*, *astartids*, *Lucina* (s. l.) and *Sphaeriola*. Characteristic genera of Japan are commonly found in the bituminous facies of the Shizukawa and Kuruma groups, but scarcely in the present fauna. In this respect, the faunas of sandstone facies, in general, bears more cosmopolitan charater than other facies. The tendency agrees well with the fact on the Middle Jurassic Aratozaki fauna (HAYAMI, 1959b) and the Upper Jurassic Soma fauna (TAMURA, 1959, MS).

2. Comparison with the Pelecypods of the Shizukawa Faunal Province.

No common pelecypod species is found between the Higashinagano and Niranohama formations. This fact is probably in part due to different zoogeography between the two areas, if considered that they were distant from each other for more than 1,000 kilometers, as they are. The lower part of the Niranohama formation is composed of bituminous black shales and sandstones. The pelecypod fauna there is composed of *Modiolus*, *Bakevellia*, *Isognomon*, *Geratrigonia*, *Eomiodon*, *Yokoyamaina*, *Thracia* and *Cuspidaria* (YOKOYAMA, 1904b; KOBAYASHI and MORI, 1954; HAYAMI, 1957 a, b, 1958 a, b, c, d; 1959 a). It is readily recognized that the sedimentary environment is different from this formation. But the upper Niranohama formation is a striking "*Trigonia*-sandstone" whose sedimentary condition was seemingly not very apart from this in view of the litho- and fossil-facies. This formation yield no trigoniid but for *Prosogyrotrigonia inouyei*. It is noteworthy that there are no vaugoniids which in turn show acmaeic development coevally in the Niranohama formation.* Its comparable strata at Aikawazawa of Hashiura area bear an undescribed pelecypod fauna whose ecology is very similar to this fauna. In MORI's collection I distinguished *Meleagrinella*, *Chlamys* and *Plagiostoma*, though none is conspecific with those of this formation. It is interesting that the change of bio- and litho-facies from the lower part of this formation to the upper is comparable with that from the upper Niranohama to the lower Hosoura formation. These two sequences in western and northeastern Japan must be almost coeval and show as a whole a transgressive period after the Rhaetic emergence called "Toyogatake phase" by KOBAYASHI (1941). In the mode of fossil-occurrence and assemblage in categories higher than generic, the Higashinagano is especially similar to the Aratozaki formation in Shizukawa area, although the age of the latter is interpreted as Bajocian. The formation yields in some similarly lenticular fossil beds *Oxytoma*, *Entolium*, *Ctenostreon* and some other common genera with the Higashinagano besides some ammonites, brachiopods and colonial hexacorals (HAYAMI, 1959b). The resemblance may be due to the similar sedimentary condition.

3. Comparison with the Pelecypods of the Kuruma Faunal Province**

Between the Higashinagano and Kuruma pelecypod faunas there is only one

* The acme of *Vaugonia* is found in the Dogger and later in Europe, but it appears much earlier (Lias) in Japan (KOBAYASHI and MORI, 1955).

** Inclusive of the Iwamuro and Yamaoku formations whose pelecypod faunas are closely related to that of the Kuruma group.

comparable form, *Entolium* cf. *calvum*. Generally speaking, the Higashinagano formation is quite different from the bituminous rocks of the Kuruma group in lithology and hence they probably differ also in sedimentary condition. As suggested by KOBAYASHI et al. (1957), the Kuruma group was accumulated in an intermontane basin which formed a profound embayment. The presence of *Amaltheus* (SATO, 1955) shows that the Kuruma sea, at least temporarily, connected with the boreal ocean. The Kuruma pelecypod fauna comprising more than 45 species, which I described in papers of another series (1957 a-e, 1958 a, b, d) is composed of very different genera from the present one. The main constituent genera are *Mytilus*, *Bakevellia*, *Isognomon*, *Radulonectites*, *Cardinioides*, *Eomidon*, *Crenotrapezium*, *Thracia* and *Cuspidaria* (?) which are unknown in this formation. No trigoniid sandstone is represented in the Kuruma faunal province, but the lower part of the Domerio-Toarcian Shinatani formation (Ks^1 in KOBAYASHI et al., 1957) and a sandstone at Kamikawara are exceptionally non-bituminous and lithologically comparable with this. Such sandstones yield some pectinids and oxytomids which are never seen in other horizons of the Kuruma group. It may be an evidence that the assemblage of the Liassic pelecypods in Japan are generally much dependent on the sedimentary environment. But considering that the ammonite faunas of the two districts are also composed of different elements from each other, the Toyora area probably belonged to the third faunal province different from the Shizukawa and Kuruma ones.

Unfortunately no Liassic pelecypod fauna is known in the Outer Zone of Southwest Japan. But I expect that such a fauna, if discovered therefrom in future, is of similar generic assemblage to the present one of sandstone facies, since the Upper Jurassic Torinosu and Soma faunas bear many common genera with the Higashinagano and also cosmopolitan characters.

4. Comparison with Contemporaneous Foreign Pelecypods

Most of the Higashinagano pelecypods are new or indeterminable species, but several are identical or comparable with certain foreign Liassic species as listed below.

1) *Nuculana* (*Dacryomya*) *toriyamae* is fairly similar to *Leda texturata* from the lower Lias of France and *Nuculana* (*Dacryomya*) *graphica* from the middle Lias of Crimea.

2) *Parallelodon infraliassicus* is very similar to *Parallelodon buckmani* from the lower Lias of England. *Parallelodon* (?) *subnavicellus* resembles *Cucullaea navicella* from the lower Lias of France.

3) *Oxytoma* cf. *cygnipes* is almost indistinguishable from *O. cygnipes* from the lower to middle Lias of Europe and Canada. *Oxytoma inequivalve* is said to be a cosmopolitan species, though its distinction from certain Dogger and later species must be further studied on circum-Pacific specimens.

4) *Chlamys textoria* is also regarded as a cosmopolitan Liassic species. Its occurrence was hitherto reported from Morocco, Indonesia, Eastern Siberia, Mexico, Chile and Argentina besides Europe.

5) "*Aequipecten*" *toyorensis* is related to *Pecten priscus* from the lower Lias of Europe. "*Aequipecten*" sp. resembles *Pecten* (*Aequipecten*) cf. *semiarticulatus* from the middle Lias of Morocco.

6) *Entolium* cf. *calvum* and *E.* cf. *lunare* are certainly close allies to *E. calvum* and *E. lunare* from the lower Lias of Europe respectively.

7) *Plicatula praenipponica* is fairly similar to *P. daharensis* from the middle Lias of Morocco, though specifically distinguishable.

8) *Plagiostoma kobayashii* may be a close ally to *Lima garlandica* from the lower Lias of Alps, although some other similar forms are known in later horizons.

9) *Antiquilima* is known from the Lias and Aalenian of Europe, though no intimate species to *A. nagatoensis* is found.

10) *Prosogyrotrigonia inouyei* is related to *P. timorensis* from the Rhaetic of Timor, as noted by KOBAYASHI and MORI (1954).

11) *Cardinia* is common in the Upper Triassic in Japan, but in Europe and other region its greater development is seen in the lower Lias. *Cardinia toriyamai* is somewhat similar to several species from the lower Lias of Europe and Siberia, as noted before. *Cardinia orientalis* resembles *C. philea* from the Lias of Europe and its comparable form from Crimea and (?) Indochina.

12) There is a comparable form with *Praeconia tetragona* from the lower to upper (?) Lias of Europe.

Because of the different state of preservation and slight morphological or dimensional differences, it is impossible to answer with certain confidence whether these Toyora forms described under the same specific names are actually identical with foreign species. But they belong evidently to the same species groups. Since the distribution of these European species has not yet been clarified sufficiently in the eastern Tethys and Southeast Asia, it is difficult to determine whether such morphological differences are attributed to "Formenkreis" within one species, geographical subspecies or distinct species. In the circum-Pacific region many Liassic pelecypod faunas were announced from Indochina, Borneo, Timor, Molucca, New Guinea, New Caledonia, New Zealand, Lower Amur, North Alaska, Yukon, British Columbia, Alberta, Nevada, Mexico, Peru, Chile, Neuquen, Mendoza and Patagonia. The records of lower Liassic pelecypods are, however, still limited only to a few areas of them. Since the Upper Jurassic faunas bear many similarities to those of India, Somaliland, East Africa and Syria, the faunas of the Tethys region seem especially important for a study of this kind.

Systematic Descriptions

Family **Nuculidae** GRAY

Genus *Nuculopsis* GIRTY, 1911

Type-species:—*Nuucula girtyi* SCHENCK, 1934, Carboniferous, U. S. A. (=*Nucula ventricosa* HALL, 1858, non HINDS, 1843).

Subgenus *Palaeonucula* QUENSTEDT, 1930

Type-species;—*Nucula hammeri* DEFRANCE, 1825, upper Lias to lower Dogger, Europe (original designation).

Nuculopsis (*Palaeonucula*) sp. indet.

Plate V, Figure 1

Six minute specimens are at hand. Shell small, trigonal, nuculiform, inequilateral with a fairly posteriorly located umbo, much longer than high, strongly inflated (MM 3350, right internal mould, 5.0 mm. long; 4.0 mm. high; 1.5 mm. thick); antero-dorsal margin about 1.5 times as long as postero-dorsal, nearly straight; both margins meeting each other at beak with an obtuse angle of about 105 degrees; hinge composed of an anterior and a posterior series of taxodont denticles which are interrupted below beak; anterior denticles fairly stout, more than 9 in number; posterior ones much weaker and smaller in number; chondrophore unknown; adductors not strongly impressed; inner ventral margin smooth; surface smooth but for growth-lines.

Although QUENSTEDT's original diagnosis of *Palaeonucula* (as a section) is inapplicable for typical Jurassic species (SCHENCK, 1934; COX, 1940), the subgenus may include most Jurassic nuculids*. Judging from the developed anterior denticles, smooth inner ventral margin and geological occurrence, this can be referred to the subgenus. Because of the coarse-grained matrix, the detail of hinge characters and surface markings are not preserved. *Nucula navis* PIETTE in TERQUEM and PIETTE (1868) from the lower Lias of Paris basin has similar outline and dentition, but the dimensions of these specimens may be much smaller than that species.

Occurrence :— Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Nuculanidae**

Genus *Nuculana* LINK, 1807

(=*Leda* SCHUMACHER, 1817)

Type-species.—*Arca rostrata* GMELIN, Recent (monotypy).

Subgenus *Dacryomya* AGASSIZ, 1840

Type-species.—*Nucula lacryma* SOWERBY, 1824, Dogger, Europe (by HERRMANNSEN, 1846)

Nuculana (*Dacryomya*) *toriyamae* HAYAMI, new species

Plate V, Figures 2, 3

1938, *Leda* sp. listed by TORIYAMA, *Jour. Geol. Soc. Japan*, *Vol. 45*, *No. 533*, p. 251.

Description :— Shell medium for genus, very inequilateral, equivalve, elongated and rostrated posteriorly, not strongly inflated, about twice or more as long as high, becoming gradually narrower toward posterior and sharply pointed at the extremity; anterior margin short, rounded, postero-dorsal long, broadly concave; ventral broadly arcuate; umbo not very prominent, not strongly recurved, obviously opisthogyrous, lying at about a third or a little more of shell-length from front; numerous taxodont denticles arranged along pre- and post-umbonal margins; surface smooth except for faint concentric lines of growth; anterior adductor scar orbicular, clearly marked; pallial sinus unknown; escutcheon not impressed.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3352) left in. mould	14.0	7.0	2.0+
Paratype (MM 3353) left ex. mould	16.0	7.0	2.0+

* COX (1940) and many authors regarded *Palaeonucula* as a subgenus of *Nucula* LAMARCK, 1799, and FRENEIX (1958) as a subgenus of *Nuculoma* COSSMANN, 1907.

Observation and comparison:— Represented by six specimens showing internal and external characters. According to Cox (1940, p. 29), *Ryderia*, a group of Liassic nuculanids, is separable from *Dacryomya* by the more elongated rostrum, less prominent and scarcely incurved umbo and not impressed escutcheon. In the rostrate outline and other external features this species resembles *Ryderia* better than *Dacryomya*. But the name of *Ryderia* is said to have been proposed by WILTON (1830) for a figured but specifically unnamed shell. As the validity of the name as a subgenus cannot be warranted here, I refer it to *Dacryomya* provisionally.

Nuculana (*Dacryomya*) *doris* (d'ORBIGNY, 1850) (COX, 1936) (=*Nucula complanata* GOLDFUSS, 1836) from the Lias of Europe is specifically different from this in the more pointed and probably more flattened posterior rostrum. This is probably a close ally to *Nuculana* (*Dacryomya*) *graphica* (TATE, 1870) from the Lias of England and the Pliensbachian of Crimea (PČELINCEV, 1937), but the posterior rostrum may be more elongated in this species. This is also similar to *Leda tenuistriata* PIETTE and *Leda texturata* TERQUEM and PIETTE, 1868, from the lower Lias of Paris basin. The surface ornaments of this species are indiscernible probably because of the coarse matrix, but the concentric lamellae, even if present, are not so prominent as the French species. Moreover, the posterior rostrum seems more strongly curved upwards in this species. Besides, "*Nucula*" figured by QUENSTEDT (1858, p. 55, pl. 5, fig. 14-1) from the Lias α may be related, but the posterior rostrum is neither so curved nor so pointed at the extremity as the present species. *Nuculana* (*Dacryomya*) *stendolichos* KIMURA, 1956, from the Upper Jurassic Torinosu group shows an outline of typical *Dacryomya*, and easily distinguishable from this in the more inflated and more elliptical shell-body and more strongly recurved umbo.

Occurrence:— Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5). The holotype procured by TORIYAMA at Higashinakayama (Loc. 8).

Family **Parallelodontidae** DALL

Genus *Parallelodon* MEEK and WORTHEN, 1866

(=*Macrodon* BUCKMAN, 1844 non MÜLLER, 1842; *Beushausenia* COSSMANN, 1897)

Type-species:—*Macrodon rugosus* BUCKMAN, 1844, Dogger, England (original designation).

Parallelodon infraliassicus HAYAMI, new species

Plate V, Figures 4-6

Description:— Shell medium to small, quadrate, inequilateral with a slightly expanded posterior part than anterior, about twice as long as high, strongly inflated; anterior margin gently arcuate, forming about 100 degrees with hinge-line; posterior one sometimes fairly sinuated, meeting hinge-line with an obtuse angle; ventral margin subparallel to hinge or slightly prosocline, provided with a sinuation of variable depth in middle part which corresponds with median sulcus on surface; hinge-line long, linear, occupying nearly shell-length; umbo slightly rising above hinge-line, not recurved, lying at about two-fifths of hinge-line from front; dentition *Grammatodon*-like, asymmetrical, composed of two or three elongated subhorizontal posterior teeth, about six prosocline anterior ones and several small opisthocline median ones; anterior and median ones subsymmetrically divergent from a point at base of hinge-plate just below beak; cardinal (ligament) area very narrow; adductors weakly impressed, pallial line distinct, slightly sinuated near ventral sinus; surface marked with several irregularly spaced concentric growth-lamellae and numerous fine radial threads.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3355) left in. mould	18.5	9.0	4.0
Paratype (MM 3356) left in. mould	22.5	11.5	5.5
Paratype (MM 3357) left ex. mould	12.0	6.0	3.0

Observation and comparison:— Represented by seven specimens which reveal clearly the surface-markings and dentition. In the non-alate outline this is somewhat different from typical *Parallelodon* composed of *P. rugosus* and *P. hirsonensis*, and can be included in *Beushausenia* of ARKELL's sense. The hinge of this species seems also more or less deviated from that of *rugosus* (ARKELL, 1930, p. 299, fig. 1; pl. 14, figs. 1, 2), for the anterior teeth are opisthocline and denticles not divergent from a point below the umbo in ARKELL's. Such a dentition as this species is commonly seen in *P. buckmani* RICHARDSON, *P. keyserlingii* (D'ORBIGNY) and many other Jurassic parallelodontids which were grouped by ARKELL (1930) as subgenus *Beushausenia* COSSMANN,, 1897. ARKELL regarded the absence of posterior wing as a subgeneric criterion to distinguish it from *Parallelodon* (s. s.). Subsequettly BRANSON (1942) pointed out that the type of *Beushausenia*, *Macrodon hirsonensis* D'ARCHIAC, 1842, is assignable to *Parallelodon* (s. s.), and proposed *Cosmetodon* for *Arca keyserlingii* D'ORBIGNY by ARKELL (1930, pl. 14, fig. 9, 9a) as the substitute of *Beushausenia* in ARKELL's sense. *Cosmetodon*, however, cannot be anyhow accepted as a substitute of *Beushausenia* COSSMANN, because of the different type species. Prior to BRANSON, COX (1940) stated that the development of wing is fairly variable within one species of the living Arcidae. As to hingement, COX* is of opinion that no generic distinction between *P. rugosus* and *P. keyserlingii* cannot be based on the hinge-teeth and other characters which are very similar in both species. In fact, the inclination of anterior and median denticles is somewhat variable within one species as I (1959 a) noted about *P. niranohamensis* HAYAMI, 1958c.

In the dentition, narrow cardinal area and quadrate outline this is very close to *Parallelodon buckmani* (RICHARDSON) in ARKELL (1930, pl. 14, fig. 8) from the lower Lias of England. But the shell is smaller and slightly more elongated, the umbo being more posteriorly located and the posterior teeth much shorter. The ventral sinuation in *buckmani* is probably not so distinct as this species. *Parallelodon niranohamensis* HAYAMI, 1958c, from the Hettangian of North Japan is an almost coeval species and similar in the surface-markings. That species has, however, a much broader hinge-plate, more terminal umbo and more clearly impressed anterior adductor scar. This is somewhat similar to *Beushausenia (Areocucullaea) daharensis* DUBAR, 1948, from the Domerian of Morocco, but the cardinal area is much narrower than DUBAR's In one left external mould the median sulcus is considerably deep as if it belong to *Torinosucatella* TAMURA,

* According to his personal communication.

** *Catella* was originally established as a subgenus of *Grammatodon*, but NICOL (1954) said "It is probably a parallelodontid."

1959b. *Torinosucatella* was proposed as a subgenus of *Catella* HEALEY, 1908,** but seems more related to *Parallelodon* than *Catella* or *Grammatodon*, judging from the presence of fine radial threads on the surface, elongated outline and the absence of posterior carination.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Parallelodon cf. *infraliassicus* HAYAMI

Plate V, Figures 7a, b

Represented by a well preserved right specimen composed of external and internal moulds. Shell medium, about 2.5 times as long as high (MM 3359, 24.5 mm. long; 10.0 mm. high; 4.0 mm. thick), well inflated, a little alate posteriorly; posterior margin slightly sinuated below posterior wing; ventral sinuation broad but indistinct; umbo located at about a third from front; hinge same as typical *infraliassicus*.

This is different from the typical form from the same fossil bed in the more elongated outline, posteriorly expanded shell and more anteriorly located umbo. The posterior wing is absent in the typical form but distinct in this. But if consider that the variability of outline is often great in one parallelodontid species, it is probable that this is merely a varietal form of the preceding species.

Occurrence:—Rare in *Cardinia toriyamai* bed and Higashinagano (Loc. 3)

Parallelodon (?) *subnavicellus* HAYAMI, new species

Plate V, Figures 18, ~~[illegible] Plate III, Figure [illegible]~~

Description:—Shell medium, inequilateral, elongated-ovate, modarately inflatted, about 2.5 times as long as high (holotype, MM 3360, right internal mould, 41.0 mm. long; 17.0 mm high; 6.5 mm thick); anterior margin broadly arcuate, rounded at the dorsal extremity; ventral one nearly straight, subparallel to hinge without ventral sinuation; posterior margin very oblique, not sinuated, passing gradually into dorsal margin without any angulation; umbo recurved, but not highly rising above hinge, lying at about a third of shell-length from front; surface marked with fine concentric lamellae and numerous faint growth-lines; radial marking absent at all; hinge consisting of two rather weak sub-horizontal posterior and number of granular anterior and median teeth on a narrow hinge plate; no plate for adherence of posterior adductor; musculature and ligament structure unknown.

Observation and comparison:—Represented by a specimen which is composed of right internal and external moulds. The outline and the absense of ventral sinus and radial ornamentation are very strange for *Parallelodon*. The hinge structure is, however, related to the genus. In fact, the obtuse postero-dorsal truncation reminds one of a cucullaeid, but the outline is too elongated and the hinge too asymmetrical to refer it to that genus. This is somewhat similar to *Cucullaea wellmanni* MARWICK, 1953, from the Oretian-Otamitan (mainly Carnic) of New Zealand, judging from the outline, dentition and absence of ventral sinus and posterior wing. But this is distinguishable from that species by the rounded antero-dorsal extremity and subparallel ventral margin to hinge-line. *Macrodon* cf. *curionii* Bittner in TRECHMANN (1918), which is identical with *C. wellmani* according to MARWICK, has more *Parallelodon*-like outline and faint radial ornamentation. *Cucullaea navicella* TERQUEM and PIETTE, 1868, from the lower Lias of eastern Paris basin is very similar to this in the non-alate outline and the absence of radial ornamentation, and evidently congeneric with this. But the outline of the French species is not so elongated as this. Besides, *Parallelodon banburyensis* (SEELEY, MS) from the lower Lias of England may be related to this, judging from the description of external and internal characters by ARKELL (1930, p. 340). But it is said that faint radials are descernible near the ventral margin in that form. This seems to belong to an unnamed genus of the Parallelodontidae.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5)

Family **Cucullaeidae** FINLAY and MARWICK, em. NICOL

Genus *Grammatodon* MEEK, 1860

Type-species:—*Cucullaea inornata* MEEK and HAYDEN, 1858, Lias, U. S. A. (monotypy).

Grammatodon toyorensis HAYAMI, new species

Plate V, Figures 9-12

Description:—Shell small, equivalve, inequilateral, roundly trapezoidal, strongly inflated, sharply carinated postero-ventrally, much longer than high; anterior margin broadly arcuate, subrectangular to hinge-line, passing gradually into venter; ventral margin not sinuated; posterior margin slightly concave, forming a small postero-dorsal wing, fairly abruptly turned into venter at a sharp carination which is gradually weakened towards ventral periphery; hinge-line straight, occupying almost whole shell-length; umbo rising highly above hinge, recurved, lying at about two-fifths of length from front; cardinal area moderate in breadth, provided with several chevron-like ligament grooves; dentition of typical *Grammatodon*, composed of a posterior series of three elongated subparallel teeth and anterior and median series of divergent granular teeth from a point below beak; the anteriormost tooth subhorizontal; no plate for adherence of posterior adductor; surface marked with several radial riblets and fine concentric lines of growth; radials very weak and densely spaced except for about five prominent ones distributed on each lateral area; surface somewhat lanceolate in postero-ventral area but concentric element much weaker in remaining part.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3361) left in. mould	14.0	9.0	4.5
Paratype (MM 3362) left in. mould	12.0	8.5	4.0
Paratype (MM 3363) left ex. mould	15.0+	8.0+	5.0

Observation and comparison:—Represented by 11 specimens. Although the postero-dorsal part is somewhat unusually auriculated, the small dimensions, dentition, sharp posterior carination, limited distribution of prominent radials in each lateral area and other characters coincide well with those of *Grammatodon* (s. s.) defined by Cox (1940). The ornamentation of right valve is unknown in detail, but this is not a member of subgenus *Indogrammatodon* Cox, 1937, which is characterized by the different mode of ornamentation on two valves and relatively large dimensions.

In the ornamentation this is fairly similar to *Grammatodon concinnus* (PHILLIPS) and *G. alsaticus* (ROEDER) in ARKELL from the Oxfordian of England and also to *G. andohouensis* COX, 1940, from the Bathonian of Cutch. But the posterior margin is more sinuated to form a more distinct postero-dorsal wing in these specimens, and the dimensions are much smaller. *Grammatodon takiensis* KIMURA, 1956 (TAMURA, 1959 b) from the Upper Jurassic Torinosu group in Southwest Japan is also similar in the surface-markings, but differs from this in the less inflated shell and more trapezoidal outline. *Grammatodon (Indogrammatodon ?) nakanoi* HAYAMI, 1958 c, from the Hettangian of Northeast Japan is readily distinguishable from this by the presence of widely spaced and stout radials on the whole surface of left valve, less prominent postero-ventral carination, non-alate outline and larger dimensions. *Grammatodon* (?) sp. in HAYAMI (1958 d) from the Domerio-Toarcian of Central Japan differs in having lattice ornaments on the whole shell-surface and more elongated outline, although they are similar in dentition.

In the Triassic there are several species hitherto referred to *Grammatodon*, but I think that they are not typical except for *Macrodon otagoensis* WILCKENS, 1927. This species is probably one of the oldest representative of *Grammatodon* (s. s.). *Grammatodon inaequivalvis* (GOLDFUSS, 1836) (ARKELL, 1930) is almost coeval with this, but it may be a primitive form of *Indogrammatodon*.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Mytilidae** FLEMING

Genus *Modiolus* LAMARCK, 1799

(=*Volsella* SCOPOLI, 1777; *Modiola* LAMARCK, 1801)

Type-species:—*Mytilus modiolus* LINNÉ, 1758, Recent.

Modiolus magatama HAYAMI, new species

Plate V, Figure 13

Description:—Shell small, modioliform, expanded postero-ventrally, well inflated; shell-obliquity approximately 40 degrees; hinge-line comparatively short, passing gradually into posterior margin with a rounded obtuse angle of about 135 degrees; umbo not terminal; anterior margin rounded, projected to some extent beyond umbo; antero-ventral margin slightly sinuated near junction of anterior wing and main body; anterior wing roundly subtrigonal, occupying about a fifth of whole surface, defined from main body by an inconsipicuous sulcus; greatest convexity lying near center of valve; surface marked with fine concentric lines which are more or less regular in interval; hinge and dysodont teeth not observed, probably undeveloped; ligament structure unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3366) left in. mould	17.5	13.5	4.0
Paratype (MM 3367) left ex. mould	11.5	7.5+	2.5

Observation and comparison:—Three specimens are at hand. The holotype is the largest and reveals the complete outline. The paratype, though more or less broken, shows fine concentric surface-makings. This species is thus characterized by the small size, short hinge-line, and regular concentric markings. It is somewhat similar to *Modiolus minimus* (SOWERBY, 1821) (DUMORTIER, 1867; PFLÜCKER, 1868; ARKELL, 1933) from the Rhaetic of England. Compared with ARKELL's from the pre-*planorbis* bed of Dorset, it it different in having less trigonal, more curved and elongated outline and less terminal umbo. PFLÜCKER's specimen has probably more irregularly spaced concentric lamellae. The shell convexity seems slightly stronger than the Rhaetic species. In the surface-markings it is allied to *Mytilus tenuissimus* TERQUEM and PIETTE, 1868, from the Lower Lias Paris basin, but the outline is more slender and the anterior wing better defined than that species.

Occurence:—Rare in *Prosogyrotrigonia inouyei* bed at Higashinagono (Loc. 3) and Higashinakayama (Loc. 8).

Family **Aviculopectinidae** ETHERIDGE

Genus *Meleagrinella* WHITFIELD, 1885

(=*Echinotis* MARWICK, 1935)

Type-species:—*Avicula curta* HALL, Jurassic, U. S. A. (by COX, 1941).

Meleagrinella japonica HAYAMI, new species

Plate V, Figurs 20–22

Description:—Shell small, inequivalve, inequilateral, slightly prosocline, slightly longer than high; left valve strongly inflated, main body suborbicular; anterior wing very small, scarcely defined from antero-dorsal part of main body; posterior wing narrow but distinctly separated, protruded backwards, pointed at extremity; hinge-line short, straight; umbo small, suborthogyrous, situated near mid-length, rising slightly above hinge-line; surface ornamented with more than 45 fine radial riblets, which increase their number by irregular insertion; concentric growth-lamellae fairly prominent; hinge-plate narrow; ligament structure unknown; right valve weakly convex, probably smaller than left, orbicular, provided with a narrow anterior wing and profound byssal notch below it; umbo scarcely rising above hinge; surface apparently smooth.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3368) left in. mould	15.0	13.5	4.5
Paratype (MM 3369) left in. mould	10.0	9.5	3.0
Paratype (MM 3370) right in. mould	7.5	8.0	1.5

Observation and comparison:—Represented by internal and external moulds of three left valves and a right internal mould. Though the ligament structure is unknown, this is referable to *Meleagrinella* by the orbicular main body, undeveloped anterior wing and surface ornamentation. ICHIKAWA (1958) studied the shell-structure and ligament of *Meleagrinella* and included the genus in his new subfamily Oxytominae. Although no attempt has been made to reexamine the taxonomic position of many Jurassic species hitherto referred to *Pseudomonotis*, most of them are considered to belong to *Meleagrinella*. In the outline and development of the posterior wing resembles *Meleagrinella echinata* (SMITH) (SOWERBY, 1819; MORRIS and LYCETT, 1853; POMPECKJ, 1901; ROLLIER, 1914; DOUGLAS and ARKELL, 1932; MARWICK, 1935; COX, 1940, etc.), a famous, world-widely distributed Middle Jurassic species. According to COX (1940) the radial ribbing of *echinata* is fairly variable among Cutch specimens, but the present specimens have more delicate and densely speed radials than any of that species. This differs from *Pseudomonotis ovalis* (PHILLIPS) in ARKELL (1933) and *P.maltonensis* ARKELL, 1933, from the Corallian in the less oblique and more developed and and pointed posterior wing. *Avicula substriatus* ZIETEN (GOLDFUSS, 1836; CHAPUIS and DEWALQUE, 1853) from the Lias of Europe has also an obtuse posterior wing and more prosocline main body. *Monotis olifex* and *M. papyria* QUENSTEDT, 1856, from the lower Lias have more expanded areas and obtuse postero-dorsal extremities, though the mode of radials seems fairly similar.

Occurrence:—Rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3) and Higashinakayama (Loc. 8). A similar form occurs in Y_2 beds of the Yamaoku formation at Osakabe, northern Okayama Pref. (listed as *Pseudomonotis* n. sp. by KONISHI, 1954).

Genus *Oxytoma* MEEK, 1864

Type-species:—Avicula münsteri (BRONN nom. nud.) GOLDFUSS, 1836, Middle and Upper Jurassic, cosmopolitan (original designation)

Oxytoma cf. *cygnipes* (YOUNG and BIRD)

Plate V, Figure 14

cf. 1822, *Pecten cygnipes* YOUNG and BIRD, Yorkshire, pl. 9, fig. 3.
cf. 1839, *Avicula cygnipes* PHILLIPS, Illust. Geol. Yorkshire, I, pl. 14, fig. 3.
cf. 1839, *Avicula longicostata* STUTCHBURY, *Ann. Mag. Nat. Hist., N. S., Vol 2*, p. 163 (non Strickland).
cf. 1857, *Avicula cycnipes* DUMORTIER, Note sur quelques Fossiles, p. 7, pl. 4, figs. 1–4.
cf. 1869, *Avicula cycnipes* DUMORTIER, Études pal. Dépots jura. Bassin du Rhône III, p. 294, pl. 35, figs. 6–9.
cf. 1957, *Oxytoma cygnipes* FREBOLD, *Geol. Surv. Canada, Mem. 287*, p. 67, pl. 16, figs. 1–5.

Description of Toyora specimen (left valve):—Shell medium for genus, inequilateral, not strongly inflated, thin, probably more or less longer than high (MM 3371, left in. mould, 30.0+mm. long; 26.0+mm. high; 5.5 mm. thick); hinge-line long, straight; anterior wing comparatively small, obtusely truncated; posterior one wide, trigonal, protruded backwards, pointed at extremity; posterior margin broadly sinuated below posterior wing; umbo slightly rising above hinge, lying at about a forth of hinge-length from front; surface ornamented with seven narrow but highly raised primary radial ribs which insert some 30 faint tertiary riblets; secondary ribs distinguishable from tertiaries in posterior half but much weaker than primaries; radials curved forwards in anterior area but almost straight in median and posterior areas; posterior wing smooth except for numerous tertiaries; primaries weakly plicated and impressed on internal surface; growth-lamellae comparatively weak; hinge structure and right valve unknown.

Observation and comparison:—Represented only by a specimen composed of left external and internal moulds. Its ventral peripheral part is broken off. This form obviously belongs to a certain infra-generic group altogether with some Rhaetic and Liassic species such as *Oxytoma cygnipes* (YOUNG and BIRD), *O. scanicum* (LUNDGREN), *O.* sp. in TRECHMANN (1923) and *O. longicostatum* (STRICKLAND). This group is characterized by the comparatively large size, small number of primary ribs which are clearly defined from secondaries and tertiaries in prominence and often give rise to digitations of the ventral margin. Compared with *O. scanicum* (LUNDGREN) (TROEDSSON, 1951) from the Lias of Scania, the shell-convexity seems smaller and the interval of primary ribs not so sulcated. TROEDSSON (1951) noted that the growth-lines between the ribs are concave in *scanicum* but nearly straight in *cygnipes* and *longicostatum*. DUMORTIER's figure (1869) bears more alliances to *scanicum* than *cygnipes* in this respect. *O. longicostatum* (STRICKLAND) (ARKELL, 1933) from the Rhaetic of England resembles this, but the tertiary ribs are probably weaker ahd sometimes small spines appear on the primaries in that species. This is most closely allied to *O. cygnipes* in FREBOLD (1957) from the Sinemurian of the Fernie group in Western Canada. The number of primaries is 5 or 6 in the Fernie form and 7 in the present specimen. The difference, however, cannot serve a specific distinction, since the number of costae is generally variable to some extent within one species of *Oxytoma*.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5). *O. cygnipes* was hitherto reported from the Pliensbachian of Europe and the Sinemurian of Western Canada. The present specimen occurs from the basal part of the Higashinagano formation ane its age is assigned to be Hettangian.

Oxytoma kobayashii HAYAMI, new species

Plate V, Figures 15–17

Description:—Shell small, very inequiualve, inequilateral, prosocline, much longer than high; left valve pteriform, strongly inflated; anterior wing well-defined, very small, trigonal, subvertically truncated; anterior margin in its front probably gaped, passing gradually into venter; posterior wing developed, well-defined, flattened, projected backwards beyond posterior extremity of main body, acutely pointed at end; posterior margin deeply sinuated below it; hinge-line straight, unusually long, extending over almost whole shell-length; umbo located at about a sixth of hinge-length from front, recurved, prosogyrous, rising slightly above hinge-line; apical angle exclusive of wings about 80 degrees; surface ornamented with about 11 straight radial costae which are more densely spaced on both lateral areas than on middle part; posterior wing smooth; radials weakly impressed on internal surface; secondary ribs not observed; right valve weakly inflated, having a small, well-defined anterior wing of *Oxytoma*-type and pointed posterior one; byssal notch narrow but deep; surface smooth for numerous fine radial riblets; hinge and ligament structure unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3372) left in. mould	16.5	12.0	4.5+
Paratype (MM 3373) left valve	9.5	8.0	2.5
Paratype (MM 3374) right ex. mould	12.5	8.5	2.0

Observation and comparison:—Four specimens are at hand. The subterminal umbo, small apical angle and elongated posterior wing are somewhat unusual for *Oxytoma*, and the outline and simple costation of left valve remind one of *Pteroperna* MORRIS and LYCETT, 1853. In the strong inequivalveness and the byssal structure, however, this is referable to *Oxytoma*. The radials of *Oxytoma* are usually composed of more one two orders of promominence in left valve, but secondaries are indiscernible on the surface of the paratype (pl. I, fig. 16). This is distinguishable from hitherto described species of *Oxytoma* by the small anterior wing, elongated and pointed posterior wing, subterminal umbo, long hinge-line and small apical angle.

Occurrence:—The holotype belongs to an old collection of the Geological Institute, University of Tokyo, and other specimens were collected by KOBAYASHI and myself from *Oxytoma* bed at Higashinakayama (Loc. 9).

Oxytoma inequivalve (SOWERBY)

Plate V, Figures 18, 19: Plate VII, Figure 1

1819, *Avicula inequivalvis* SOWERBY, Min. Conch., Vol. 3, p. 78, pl. 244, fig. 2 (non fig. 3).
1958, *Oxytoma inaequivalvis* ICHIKAWA, *Palaeontogr.*, *Bd. 111*, p. 159, 161*.
non 1959, *Oxytoma* cf. *inequivalve* HAYAMI, *Japan*, *Jour. Geol. Geogr.*, *Vol. 30*, p. 57, pl. 5, figs. 6–11 (non *inequivalve* SOWERBY)**.

Description of Toyora specimens:—Shell small for genus, pteriform, plano-convex, highly inequivalve, longer than high; left valve moderately inflated with a slightly salient umbonal region above hinge; anterior wing moderate in width, subtrigonal, subvertically truncated; posterior one projected backwards, pointed at extremity, but not protruded beyond posterior extremity of main body; hinge-line moderate in length; umbo located at about a fourth of hinge-length from front; apical angle exclusive of wingth about 90 degrees; surface ornamented with 14 or 15 straight radial primary ribs; secondary median ribs improminent or absent; tertiaries very weak; right valve having numerous faint radial threads and short radial furrows near ventral margin which may interlock with ribs on counter valve; hinge and ligament structures uuknown.

Measurement in mm.	Length	Height	Thickness
(MM 3375) left valve	11.5	8.5	2.0
(MM 3376) left valve	12.0	9.5	3.0
(MM 3377) right in. mould	8.0	5.5	0.5

Observation and comparison:—Three left and four right valves are at hand. The left valves are somewhat variable in shell-obliquity and shell-convexity. But it may be due to an individuality within one species, since those characters generally vary among ontogenetical stages as I noted elsewhere (1959 b). This form is clearly distinguishable from *O. kobayashii* from the same horizon in the weaker inflation of both valves, shorter posterior wing and larger apical angle. It belongs undoubtedly to "Formenkreis der *Oxytoma inaequivalvis*" by WAAGEN (1901) which appears to have lived from the Rhaetic to the Lower Cretaceous. The "Formenkreis" is one of the groups which have given rise to most differences of opinion as to taxonomy and nomenclature among Jurassic pelecypods. WAAGEN (1901), ROLLIER (1914), GILLET (1924), ARKELL (1933), COX (1935, 1940), DECHASEAUX (1938), TROEDSSON (1951) and some others discussed this problem. *Oxytoma münsteri* (GOLDFUSS, 1836), the type-species of the genus, has been regarded by the greater part of these authors as a synonym or merely a varietal

* The synonymy, variability and distinction among *inequivalve*, *münsteri* and their related forms were discussed.

** The form should be renamed *Oxytoma* cf. *münsteri* (GOLDFUSS) as noted in the post-script of that paper.

from of *O.inequivalve*, until ICHIKAWA (1958) clarified the specific distinction between about European material. ARKELL (1933) disignated the lectotype of *inequivalve* to the specimen (SOWERBY, 1819, pl. 244, fig. 2, left) from the middle Lias of England. "The true *Oxytoma inaequivalvis* from the middle Lias of England has only 14 or 15 primary ribs (counting two minute ones at the anterior end), and there are no median ribs of a secondary order of magnitude in the interspaces, which are covered with very numerous and extremely fine radial threads or riblets (tertiaries)" (ARKELL, 1933, p. 195). ICHIKAWA (1958) examined the "cotypes" of *O. münsteri* and clarified the radial ribbing of three orders of prominence. He said further about *O. inequivalve* (s. s.) preserved in British Museum, "In Bezug auf die radial Skulpture der rechten Klappe ist zu bemerken, dass auch das Original-Handstück des Lectotypus eine rechte Klappe mit ausgesprochen weitständig angeordneten Radialfurchen enthält." The resemblance and differences among *inequivalve*, *münsteri* and two Japanese forms in my mind are shown in table 3.

Table 3. Main characters of typical and Japanese forms of *Oxytoma inequivalve* and *Oxytoma münsteri*.

	characters	*O. inequivalve* typical form (ARKELL, 1933)	*O. inequivalve* present form	*O.* cf. *münsteri* Aratozaki form (HAYAMI, 1959 b)	*O. münsteri* typical form (ICHIKAWA, 1958)
left valve	outline	prosocline	prosocline	variable	very prosocline
	convexity	moderate	moderate	moderate (mature) strong (immature)	strong
	posterior wing	ill-defined pointed	ill-defined pointed	well-defined pointed	well-defined pointed
	umbo	slightly salient	slightly salient	moderately (mature) highly (immature)	highly salient
	primary ribs	14–15	14–15	14–17	12–18
	secondary ribs	absent	improminent	present	present
	dimensions	moderate	small	small	small
right valve	convexity	weak	weak	weak	weak
	ornamentation	faint radial threads	faint radial threads	fine radial striae	radial ribs
	radial furrows	present	present	absent	absent
	age	middle Lias	lower Lias	lower Dogger	middle Dogger

In these respects the Toyora specimens are identical with *O. inequivalve* SOWERBY (inclusive of *O. sinemuriense* D'ORBIGNY, 1850 and *O. intermedium* EMMRICH, 1853, as subspecies), although the dimensions may be somewhat smaller than typical European forms.

This form is different from *O.* cf. *münsteri* in HAYAMI (1959 b) from the Bajocian Aratozaki formation of Northeast Japan in the much weaker shell-convexity, weaker secondaries in left valve and presence of radial furrows near ventral periphery of right valve. As I showed in the synonymic list related to the Aratozaki form, many forms from various Jurassic stages in other areas than Europe have been referred to *inequivalve* or *münsteri*. Which species-group they belong to is difficult to say, unless their right valves occur in association. The peripheral region of right valve seems to tend to be damaged because of the ill-development of nacreous layer and fragile marginal zone of reverse convexity. As to Japanese Jurassic specimens, however, it is now ascertained that the lower Liassic ones are similar to *inequivalve* and the Bajocian ones to *münsteri*. The tendency seems to coincide with the fact about European material.

Occurrence:—Common in *Oxytoma* bed at Higashinagano (Loc. 4) and Higashinakayama (Loc. 9).

Family **Pectinidae** LAMARCK

Genus *Chlamys* RÖDING, 1798

Type-species:—*Chlamys cinnabarina* RÖDING, 1798, Recent (by HERRMANNSEN, 1846).

Chlamys textoria (SCHLOTHEIM)

Plate V, Figures 23–27

1820, *Pecten textorius* SCHLOTHEIM, Petrefactenkunde, p. 229.
1836, *Pecten textorius* GOLDFUSS, Petref. Germ., Bd. 2, p. 45, pl. 89, figs. 9 a–d.
1836, *Pecten texturatus* GOLDFUSS, *Ibid.*, p. 45, pl. 90, fiig. 1.
1850, *Pecten phillis* D'ORBIGNY, Prodrome, I, p. 257.
1850, *Pecten textorius* D'ORBIGNY, *Ibid.*, I, p. 219.
1853, *Pecten textorius* CHAPUIS and DEWALQUE, *Mém. cour. Séance, Tom. 25*, p. 209, pl 32, fig. 2.
1855, *Pecten texturatus* TERQUEM, *Mém. Soc. géol. France, Sér. 2, Tom. 5*, p. 104.
1856, *Pecten textorius* QUENSTEDT, Der Jura, p. 78, pl. 9, fig. 12; p. 147, pl. 18, fig. 17; non p. 500, pl. 67, fig. 5.
1856, *Pecten textorius-torulosi* QUENSTEDT, *Ibid.*, p. 311, pl. 42, fig. 10.
1856, *Pecten textorius* OPPEL, Die Juraformation, p. 223.
1863, *Pecten textorius* SCHLOENBACH, *Zeit. deut. geol, Gesell., Bd. 15*, p. 543.
1865, *Pecten textorius* BRAUNS, *Palaeontogr., Bd. 13*, p. 121.
1867, *Pecten textorius* DUMORTIER, Études pal. Dép. jura. Bassin de Rhône, II, p. 71, pl. 13, fig. 1.
1868, *Pecten textorius* TERQUEM and PIETTE, *Mém. Soc. géol. France, Sér. 2, Tom. 8*, p. 103.
1868, *Pecten texturatus* TERQUEM and PIETTE, *Ibid., Sér. 2, Tom. 8*. p. 104.
1869, *Pecten textorius* DUMORTIER, Études pal. Dép. jura. Bassin de Rhône, III, p. 139, pl. 22, fig. 2; p. 303, pl. 39, figs. 1, 2.
1871, *Pecten textorius* BRAUNS, Der untere Jura, p. 387.
1872, *Pecten textorius (olifex)* FRITZGARTNER, Die Pentacriniten, p. 33.
1874, *Pecten textorius* DUMORTIER, Études pal. Dép. jura. Bassin de Rhône, IV, p. 199, pl. 44, fig. 12.
1890, *Pecten (Chlamys) textorius* PARONA, *Atti. Soc. Ital. Sci. Nat., Vol. 33*, p. 83, pl. 1, figs. 11, 12.
1891, *Pecten textorius* BEHRENDSEN, *Zeit. deut. geol. Gesell., Bd. 43, Pt. 1*, p. 389.

1894, *Pecten textorius* MÖRICKE, *N. Jahrb. f. Min. usw.*, *BB. 9*, p. 37.
1900, *Pecten textorius* PHILIPPI, *Zeit. deut. geol. Gesell.*, *Bd. 52*, p. 86.
1902, *Pecten textorius* JENENSCH, *Abh. geol. Spezialk. Elsass-Lotha.*, *N. F.*, *Bd. 5*, p. 17.
1903, *Pecten textorius* BURCKHARDT, *Palaeontogr.*, *Bd. 50*, p. 7.
? 1905, *Pecten textorius* BENECKE, *Abh. geol. Spezialk. Elsass-Lothr.*, *N. F.*, *Bd. 6*, p. 111, pl. 5, figs. 1, 2.
1904, *Pecten textorius* WUNSTORF, *Jahrb. preuss. geol. Landes.*, *1904*, p. 516.
1908, *Pecten (Chlamys) textorius* TRAUTH, *Mitt. geol. Gesell. Wien*, *Bd. 1*, p. 451
1912, *Pecten textorius* POELMANN, Jura von Hellern, p. 37.
1914, *Pecten textorius* JAWORSKI, *N. Jahrb. f. Min. usw.*, *BB. 37*, p. 285.
1915, *Pecten textorius* JAWORSKI, *Ibid.*, *BB. 40*, p. 437.
1915, *Pecten textorius* var. *torulosa* JAWORSKI, *Ibid.*, *BB. 40*, p. 437.
1920, *Pecten (Chlamys)* cf. *textorius* JAWORSKI, *Jaarb. Mijnb. Ned. Oost-Indie*, *49e jaarg. Verhand. 2*, p. 194, pl. 1, fig. 1.
1923, *Pecten textorius* HUMMEL, *Palaeontogr.*, *Supple.*, *Bd. 4*, *Lief. 3*, *Abt. 4*, p. 162, pl. 11, fig. 10.
1923, *Pecten torulosus* ERNST, *Palaeontogr.*, *Bd. 65*, p. 52, pl. 1, fig. 8.
1926, *Pecten (Chlamys) textorius* JAWORSKI, *Actas Acad. Nac. Cienc.*, *Vol. 9. Nos. 3–4*, p. 167.
1926, *Chlamys textoria* STAESCHE, *Geol. Pal. Abh.*, *N. F.*, *Bd. 15*, p. 30.
1926, *Chlamys* aff. *textoriae* STAESCHE, *Ibid.*, *N. F.*, *Bd. 15*, p. 32, pl. 1, figs. 8, 9.
1926, *Chlamys torulosi* STAESCHE, *Ibid.*, *N. F.*, *Bd. 15*, p. 33, pl. 1, fig. 1.
1926, *Chlamys* cf. *phillis* STAESCHE, *Ibid.*, *N. F.*, *Bd. 15*, p. 34, pl. 1, fig. 12.
1931, *Pecten textorius* var. *torulosa* WEAVER, *Mem. Univ. Washington*, *Vol. 1*, p. 271, pl. 28, figs. 165, 166.
1934, *Chlamys textorius* DACQUÉ, Wirbelose der Jura, p. 208.
1936, *Chlamys textorius* DECHASEAUX, *Ann. Paléont. Tom. 25*, p. 13, pl. 1, figs. 1–4.
1936, *Chlamys textorius* JOLY, *Mém. Mus. roy. d'Hist. nat. Belg.*, *Mém. No. 79*, p. 109.
1939, *Chlamys* aff. *textorius* MULLER and FERGUSON, *Bull. Geol. Soc. America*, *Vol. 50*, p. 1611.
1942, *Pecten (Chlamys) textorius* LEANZA, *Rev. Museo La Plata*, *N. S.*, *Vol. 2*, *No. 10*, p. 172, pl. 7, fig. 2.
1942, *Pecten (Chlamys) textorius* var. *torulosa* LEANZA, *Ibid.*, *N. S.*, *Vol. 2*, p. 173, pl. 7, fig. 4.
? 1946, *Chlamys textorius* GARDET and GÉRARD, *Prot. Rép. Franç. Maroc*, *Notes et Mém.*, *No. 64*, p. 15, 21.
? 1951, *Chlamys textoria* TROEDSSON, *Kungl. Fysio. Säll. Handl.*, *N. F.*, *Bd. 62*, *Nr. 1*, p. 213, pl. 20, figs. 14–16.
1952, *Pecten (Chlamys) textorius* KIPARISOVA, *Trans. All Soviet Union*, *Ceol. Inst.*, *1952*, p. 17, pl. 4, figs. 1–5.
? 1957, *Chlamys textoria* BERINI, *Ist. Geol. Pal. Geogr. Univ. Milano*, *Ser. P. Publ.*, *No. 92*, p. 42, pl. 3, fig. 2.

Description of Toyora specimens:—Shell medium for genus, acline, inequivalve, subequilateral exclusive of auricles, higher than long; left valve moderately inflated, while inflation of right valve is much weaker; antero-dorsal margin slightly sinuated; postero-dorsal one nearly straight; ventral margin broadly arcuate; hinge-line fairly long, occupying about three-fourths of shell-length, straight; dorsal margin often rising slightly above hinge-line in anterior part of right valve; umbo lying near mid-point of length, pointed with an acute apical angle of about 80 degrees or slightly more; byssal auricle fairly large, protruded, depressed, linguiform, supported by a developed auricular sulcus, forming a profound byssal notch below; left anterior auricle large, about twice as wide as posterior, triangular, provided with a slightly sinuated anterior margin which corresponds with byssal notch on counter valve; posterior auricle subequal between two valve, comparatively small, obtuse-trigonal, well-defined; surface marked with 65 or more (in adult stage) delicate radial costae and numerous fine concentric fila crossing costae and their interspaces; radials somewhat irregular in strength and breadth, more or less flat-topped in right valve but more angular in left; number of radials increased by irregular bifurcation in right valve and by insertion in left valve; concentric scales undeveloped; auricles including byssal one marked also with several radials and numerous concentric lamellae, though radials become weaker in their upper parts; ctenolium present; resilifer triangular, internal.

Measurement in mm.	Length	Height	Thickness
(MM 3379) right ex. mould	27.0+	34.5	3.0
(MM 3380) right ex. mould	14.0	16.5	1.5
(MM 3381) right ex. mould	12.5	15.5	1.5
(MM 3382) left ex. mould	28.0	27.0+	4.5+

Observation and comparison:—Nine specimens, of which six are right external moulds, are at hand. The left valve is represented by two imperfect specimens. A left external mould is considerably large and have about 70 radials, while they are about 40–55 in most specimens. The external and intereal characters are almost equal to those of *Chlamys* (s. s.), if one ignores the considerable inequivalveness (properly the different convexity between two valves) which is commonly seen in Liassic species.

In the general outline, large anterior auricle, mode of radial ribbing, prominent concentrics and inequivalveness, these specimens are referable to *Chlamys textoria* (SCHLOTHEIM), a famous Liassic cosmopolitan species. In comparison with GOLDFUSS' figures of similar size the radials are evidently larger in number and the posterior auricle is slightly smaller, though these characters are seemingly fairly variable among the figures. In these respects this may be closer to *Pecten texturatus* GOLDFUSS, 1836, but I consider *texturata* to be conspecific with *textoria* in agreement with many authors. GOLDFUSS' (1836, pl. 89, fig. 9a), BENECKE'S (1905), LEANZA'S (1942), TROEDSSON'S (1951) and BERINI'S (1957) specimens of moderate size have only 20–30 radials, and it is doubtful if they are actually conspecific with such a multicostate form as these specimens. I think that the ornamentation of *C. textoria* is fairly variable, as pointed out by DECHASEAUX about European specimens. The variability of the number of radials is principally due to the slight differences in the stage of bifurcation or insertion. The apical angle of this form, though it increases slightly through growth, is fairly constant and almost equal to those of European specimens. According to DECHASEAUX (1936) *Chlamys textoria* is somewhat long ranged from Hettangian to Toarcian in Paris basin. QUENSTEDT (1856) and some others assigned some Dogger and Malm specimens to *textoria* or its varieties, but I refer them to *C. dewalquei* or other more advanced species in agreement with STAESCH (1926) and DECHASEAUX (1936). Those Oolite species have more stout radials and probably less inequivalve shell than *textoria*. Such a tendency is ascertained also between the present form and *Chlamys kobayashii* HAYAMI, 1959c, from the Bajocian Tsukinoura and Kosaba formations in Northeast Japan. It can be generally said that

Liassic species of *Chlamys* in Japan have more inequivalve shells (more flattened right valves) than Middle Jurassic and later ones. The tendency well agrees with COX's statement (1952, p. 4). In the circum-Pacific region *Chlamys textorius* and its comparable forms were recorded from Mexico, Neuquén, Peru, Amur and Taliabu. Although the specific identity cannot always be warranted, *textorius* or its close allies certainly flourished world-widely in Liassic times. Amur specimens illustrated by KIPARISOVA (1952) show special resemblance to this form, but South American ones seem mainly paucicostate forms.

This resembles *Chlamys kotakiensis* TAKAI and HAYAMI, in HAYAMI (1957 e) from the lower (?) Lias of Central Japan in the radial ribbing and inequivalveness. The material of *kotakiensis* is more or less deformed, and its precise comparison with this is difficult. Though I noted before that *kotakiensis* differs from *textoria* by finer radials, the Kuruma and present forms are almost equal in their number. But the apical angle appears slightly larger, radials and concentrics less prominent, byssal auricle smaller, and auricles of left valve worse-defined than the present form. *Chlamys kurumensis* KOBAYASHI and HAYAMI and its comparable form in HAYAMI (1957 e) resemble this in the flat right valve but differ in the larger apical angle, more-flat-topped radials and narrower intervals. At a glance *Chlamys similis* KIPARISOVA, 1954, is similar to this in the outline, but that species is, I presume, a close ally to *Chlamys mojsisovicsi* KOBAYASHI and ICHIKAWA, 1949, from the Carnic of Japan which differs from this in the more equivalve shell, smaller byssal auricle and less prominent radials on it. The apical angle is almost equal to that of the type of *mojsisovicsi* from Sakawa basin but slightly smaller than those of Nabae (NAKAZAWA, 1952), Sakuradani (ICHIKAWA, 1954 a) and Mine specimens.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) and rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3).

Genus *Aequipecten* FISCHER, 1887

Type-species:—Pecten opercularis LINNÉ, 1758, Recent (monotypy).,

"*Aequipecten*" *toyorensis* HAYAMI, new species

Plate VI, Figures 1–5

Description:—Shell small, subequivalve, equilateral exclusive of auricles, *Chlamys*-like in outline, a little higher than long; both valves strongly inflated, but left valve slightly more convex than right; antero- and postero-dorsal margins of shell-body nearly straight, forming an apical angle of approximately 90 degrees; ventral one subcircular; anterior auricle of right valve comporatively large, protruded, supported by a narrow auricular sulcus; posterior one of each valve subequal, comparatively small, well defined, triangular, subvertically truncated; byssal notch moderate in depth, angular; ornamentation of each valve composed of about 15 stout, highly elevated and non-bifurcated radial costae; radials simple in left valve but in right valve faint grooves and secondary riblets inserted respectively on costae and grooves; byssal auricle marked with three or more weak radials; concentric growth-lines weak and almost indiscernible; internally, radial plications strongly impressed on inner surface near ventral periphery, but umbonal region almost smooth; ctenolium and cardinal crura not observed, probably absent.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3384) right ex. mould	13.0	14.0	3.0
Paratype (MM 3385) left ex. mould	12.0	13.0	3.5
Paratype (MM 3386) right in. mould	11.0	11.5+	2.0+
Paratype (MM 3387) right in. mould	5.0	5.5	1.0+

Observation and comparison: —Represented by a dozen of specimens. Auricles are mostly broken, but a protruded byssal auricle and byssal notch are clearly observed in the holotype. Judging from the small number of ribs and strong shell-convexity this belongs to "*Aequipecten*" which has been used also for Mesozoic species by many authors. *Radulopecten* ROLLIER, 1911, was deemed by COX (1952) to include some Mesozoic species hitherto referred to *Aequipecten*. *Radulopecten* is defined by about 12 or fewer radial costae whose aspect is quite different between two valves. In this species the shell-convexity is slightly different, but broadly undulated ribs and imbricated concentric scales as seen in that genus are absent. This is morphologically more similar to *Cryptopecten* DALL, BARTSCH and REHDER, 1938 (type: *Cr. alli* DALL, BARTSCH and REHDER, original designation). Such weak secondaries and faint grooves on primaries are sometimes observed also in some living species of *Cryptopecten*. But in *Cryptopecten* the right valve is slightly more inflated than left (HABE, 1951–1953), while it is just the reverse in this species. STAESCHE (1926) and ARKELL (1931) are probably right in insisting that Cenozoic *Aequipecten* is not direct descendants from Mesozoic "*Aequipecten*". COX is also of opinion that true *Aequipecten* appeared at first in the Oligocene. *Pecten priscus* SCHLOTHEIM, 1820 (GOLDFUSS, 1836; TERQUEM and PIETTE, 1868; DUMORTIER, 1867, 1869; STAESCHE, 1926, etc.) from the lower Lias of Europe may be the closest ally to this species. The number of radials and of byssal auricle are quite similar, but the radials of each valve are evidently more flattened at tops and bottoms in this species. *Pecten aequilis* QUENSTEDT, 1858, is conspecific with *priscus* according to DECHASEAUX (1936). *Pecten interstriatus* MÜNSTER in BITTNER (1901) differs from this in the more simple ribs in the right valve. *Pecten lykosensis* KRUMBECK, 1905, from the Upper Jurassic is similar to this in the ornamentation of right valve but different in the smaller number of radials and presence of prominent scales on the radials of left valve. *Chlamys* (*Aequipecten*) *macfadyeni* COX, 1935a, from the Upper Jurassic of British Somaliland has about 19 ribs and they are seemingly more rounded at tops than in this species. *Aequipecten vulgaris* KIMURA, 1951 (TAMURA, 1959b) from the Upper Jurassic Torinosu group in Sakawa, Sakuradani and Sakamoto areas is very similar in many respects, but this is distinguishable from the Torinosu species by the more flat-topped and broader primaries in right valve and the less flabellate outline with a slightly smaller apical angle. The above mentioned species (inclusive of this) are probably congeneric and form a distinct group from *Aequipecten*, *Chlamys* and *Radulopecten*. PHILIPPI (1900a) and STAESCHE (1926) combined such species in the *priscus*-group. DECHASEAUX (1936, p. 86) discussed the relationship between *priscus*-group and *Pseudopecten* BAYLE, 1897 (type: *P. equivalvis* SOWERBY, 1818) and suggested that *Pseudopecten* is a small branch of the *priscus*-group in Sinemurian. The type-species does not agree with this species in the *Patinopecten*-like outline, large apical angle, simple radials and by far larger dimensions. In view of the differences, it is concluded that most species belonging to the *priscus*-group belong to a certain unnamed genus of the

Pectinidae. The generic name of this species is, therefore, provisional.

Occurrence :—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5). A specimen in pl. II, fig. 4 from *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 4) is unusuary of large size but probably conspecific.

"*Aequipecten*" sp. indet.

Plate V, Figure 2

cf. 1948, *Pecten* (*Aequipecten*) *semiarticulatus* ? MENEGHINI in DUBAR, *Notes et Mém. Serv. géol. Maroc, No. 68*, p. 216, pl. 28, Figs. 22–25.

Represented by an imperfect external mould of right (?) valve. Shell medium, slightly inequilateral, moderately inflated (MM 3390, 19.0+mm. long; 18.5+mm. high; 3.0+mm. thick); apical angle about 90 degrees; surface marked with more than 13 stout radial costae, which are faintly curved outwards in anterior (?) part; ribs flattened at tops, but intervals marked with numerous oblique scales; auricles and internal structure unknown.

The differs obviously from the preceding species in the larger dimensions and the presence of many prominent scales between radials. The scales remind one of *Radulopecten*, but the radials are too many. This is probably intimate to *Pecten* (*Aequipecten*) *semiarticulatus*? in DUBAR (1948) from the Domerian of of Morocco with regard to the ornamentation with similar number of radials and fine oblique scales. But further comparison is impossible, since the internal structure, auricles and counter valve are unknown.

Occurrence :—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Amusiidae** RIDEWOOD

Genus *Entolium* MEEK, 1865

(=*Syncyclonema* MEEK, 1864; *Protamussium* VERRILL, 1899)

Type-species :—*Pecten demissus* PHILLIPS, 1829, Dogger to lower Malm, Europe (original designation).

Entolium cf. *calvum* (GOLDFUSS)

Plate VI, Figures 6–9

cf. 1836, *Pecten calvus* GOLDFUSS, Petref. Germ., Bd. 2, p. 74, pl. 99, fig. 1.
cf. 1858, *Pecten calvus* QUENSTEDT, Der Jura, p. 184, pl. 23, fig. 1.
? 1908, *Entolium calvum* THEVENIN, *Ann. de Pal., Tom. 3*, p. 23, pl. 23, fig. 11.
cf. 1926, *Chlamys calva* STAESCHE, *Geol. u. Pal. Abhandl., N. F., Bd. 15, Ht. 1*, p. 58, pl, 2, figs. 11, 12.
cf. 1936, *Entolium calvus* DECHASEAUX, *Ann. de Pal., Tom. 25*, p. 60.
cf. 1936, *Entolium calvus* JOLY, *Mém. Mus. roy. d'Hist. nat. Belg., Mém., No. 79*, p. 108.
1938, *Pecten* (*Syncyclonema*) sp. listed by TORIYAMA, *Jour. Geol. Soc. Japan, Vol. 45, No. 533*, p. 251.
cf. 1951, *Entolium calvum* TROEDSSON, *Kungl. Fysiogr. Sällsk. Handl., N. F., Bd. 62, Nr. 1*, p. 216, pl. 20, figs. 9–13.
cf. 1957, *Entolium* sp. in HAYAMI, *Trans. Proc. Pal. Soc. Japan, N. S. No. 28*, p. 125, pl. 20, fig. 17.

Description of Toyora specimens :—Shell small to medium, inequivalve, inequilateral, trigonally obricular exclusive of auricles, weakly inflated, higher than long; test thin; antero-dorsal margin and postero-dorsal nearly straight, passing gradually into venter; apical angle between them about 90 degrees or a little less; hinge-line short and straight, although dorsal margins of auricles fairly rise above it in right valve, forming about 220 degrees or more at beak in adult specimens; auricles well defined, depressed, more or less obtusely truncated at corners in each valve; anterior auricle about twice as wide as posterior, slightly projected forwards, forming a shallow byssal notch in right valve, but its anterior margin subvertical in left valve; ctenolium absent; cardinal crura comparatively weak; a pair of straight blunt internal ridges running from umbo to antero- and postero-ventral peripheral regions, forming an angle of about 70 degrees at beak, somewhat weakened near periphery; resilifer subtriangular, internal, bordered by a strong ridge on each side; surface smooth without any strong concentric lamellae; anterior auricle having distinct growth-lamellae.

Measurement in mm.	Length	Height	Thickness
(MM 3391) right in. mould	22.0	25.0	2.5
(MM 3392) left ex. mould	13.5	15.0	2.0
(MM 3393) left in. mould	16.0	17.5	2.0

Observation and comparison:—Many specimens are at hand. The unequal auricles are observed in all specimens. In right valve the dorsal margins of auricles rises above the hinge-line to variable extent, forming internally a ribbon-like structure of *Entolium*-type. The byssal notch is usually present but very variable in depth.

Such a shallow byssal notch and unequal auricles are often seen in Liassic *Entolium* which is distinguished as "*hehlii*-groupe" by DECHASEAUX (1936). STAESCH (1926) considered that *Entolium* is characterized by the absent byssal notch and the subequal auricles, and regard such species as transitional between *Chlamys* and *Entolium*. But many other authors including DECHASEAUX (1936) and TROEDSSON (1951) are of opinion that they are not related to *Chlamys*. The Toyora specimens have a pair of weak internal ridges along the boundaries along antero- and postero-dorsal margins of main body and weak cardinal crura which are commonly seen in *Entolium* and other amusiids but never in the Pectinidae. *Entolium* appeared already in the Triassic, and its ancestral forms are found in *Pernopecten* in the Upper Palaeozoic (NEWELL, 1938). The unequal auricles (often with a slight byssal notch at certain ontogenetical stage) and a pair of internal ridges seem fairly conservative characters from the Carboniferous to Mesozoic entoliids. *Entolium inequivalve* HAYAMI, 1959, from the Upper Jurassic and *E. orbiculare* (SOWERBY) from the Cenomanian have also slight byssal notches especially in their early ontogenetical stages. Therefore, the phylogeny *Chlamys* to *Entolium* in the Lias epoch suggested by STAESCHE (1926) cannot be accepted.

This form is closely related to, if not identical with, *Entolium calvum* (GOLDFUSS) from the lower Lias of Swabia, Paris basin and Scania. Judging from GOLDFUSS' original figure the typical form may have a slightly more elongated outline but this is quite similar to the Swabia and Scania specimens illustrated by STAESCHE (1926) and TROEDSSON (1951) in the general outline of two valves, apical angle, mode of byssal sinuation and unequality of auricles, although no mention was given as to their internal characters. The dimensions may be a little larger than European forms. The auricles are seemingly slightly more protruded upwards than in Scania specimens. But their development is probably more or less related to the ontogeny of individuals in the present form. The age of *calvum* is Hettangian in Paris basin (DACQUÉ, 1934; DECHASEAUX, 1936: JOLY, 1936) and early Sinemurian in Scania (TROEDSSON, 1951), and the present form must be nearly coeval with the European ones. This is also similar to *Entolium lundgreni* MOBERG in TROEDSSON (1951) from Scania. TROEDSSON regarded that it is not far apart from *calvum* but different in the shell-sculpture and curvature of umbo. In the weakness of concentric lamellae this is closer to *calvum* than *lundgreni*. *Entolium cingulatum* (GOLDFUSS, 1836) (STAESCHE, 1926; TROEDSSON, 1951) differs from this in the absence of distinct byssal notch and less unequal auricles.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) and rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3) and Higashinakayama (Loc. 8). A left (?) valve collected by KOBAYASHI from the Kuruma group at Kamikawara (HAYAMI, 1957 e) is comparable with this form.

Entolium cf. *lunare* (ROEMER)

Plate VI, Figure 11

cf. 1839, *Pecten lunaris* ROEMER, Verst. nord. Oolithengebirges, p. 26.
cf. 1871, *Pecten lunaris* BRAUNS, Untere Jura, p. 398.
cf. 1915, *Pecten (Entolium) lunaris* ROLLIER, *Mém. Soc. pal. Suisse*, p. 469.
cf. 1926, *Entolium lunare* STAESCHE, *Geol. u. Pal. Abh., N. F., Bd. 13, Ht. 1.* p. 96, pl. 4, figs. 1, 2.

Description of Toyora specimens:—Shell medium, equilateral, trigonal-orbicular exclusive of auricles, nearly as high as long; right valve not strongly inflated; antero- and postero-dorsal margins long, slightly sinuated, forming an apical angle of about 115 degrees at beak; auricles small, subequal, obtusely truncated; their dorsal margins fairly rising above hinge-line; byssal notch absent; surface smooth but for faint growth-lamellae; cardinal crura narrow but stout, ridge-like; a pair of strong internal ridges running from beak to antero- and postero-ventral peripheral regions. Left valve unknown.

Measurement in mm.	Length	Height	Thickness
(MM 3396) right ex. mould	22.5	22.0	2.0
(MM 3397) right in. mould	21.0	22.5	2.0

Observation and comparison:—Two specimens are at hand. This form is different from the preceding in the subequal auricles, absence of byssal notch, larger apical angle, sinuated antero- and postero-dorsal margins of main body and presence of strong cardinal crura. Although the dimensions are somewhat small, it is probably a close ally to *Entolium lunare* (ROEMER) from the lower Lias of Europe, in view of the resemblance of outline to STAESCHE's figures. *Pecten demissus* in BENECKE (1905) from the Aalenian show a similar outline to this, but typical *E. demissum* (PHILLIPS) from Middle to Upper Jurassic has probably larger auricles according to STAESCHE (1926) and DECHASEAUX (1936). Besides, *Entolium fossatum* MARWICK, 1953, from the Aratauran (lower Lias) of New Zealand has a similar outline and inner structure, but the auricles of *fossatum* are said to be fairly unequal in size.

Occurrence: —Rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3).

Entolium sp. indet.

Plate VI, Figure 10

A right internal mould differs from above mentioned two forms in the larger dimensions and vertically elongated outline. (MM 3398, 16.0 mm. long; 20.0mm. high; 3.0+mm thick). Anterior auricle is slightly larger than posterior, but byssal notch absent. The produced dorsal margin above hinge and distinct internal ridges from umbo to antero- and postero-ventral perepheries show that this belongs to *Entolium*, but specifically it is indeterminable, since its exterior is unknown.

Occurrence:—Rare in *Oxytoma* bed at Higashinakayama (Loc. 9). KOBAYASHI coll.

Entolium (?) sp. indet.

Plate VI, Figures 11, 12, 13.

Represented by an imperfect external and an internal mould of different left valves. Shell small to medium, flabelliform, weakly inflated (MM 3399, left in. mould, 14.0 mm. long; 13.0 mm. high); antero- and postero-dorsal margins slightly sinuated, forming an apical angle of about 120 degrees; auricles unequal; anterior one large, subrectangularly truncated, marked with numerous fine growth-lamellae; posterior one comparatively small, obtusely truncated at corner; surface smooth without any prominent growth-lines.

Since the right valve and detail of internal structure are unknown, it is difficult to say that it belongs actually to *Entolium*. Such a flabelliform outline is somewhat similar to "*Camptonectes*" *subflabelliformis* HAYAMI, 1957e, and its allies from the Lias of Central Japan. But the shell is much less inflated than the Kuruma forms, though it is probable that this is congeneric with them.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Plicatulidae** IREDALE

Genus *Plicatula* LAMARCK, 1801

Type-species.—*Plicatula gibbosa* LAMARCK, 1801, Recent (=*Spondylus plicatus* LINNÉ, 1758) (monotypy).

Plicatula subcircularis HAYAMI, new species

Plate VI, Figures 14-16

Description:—Shell medium for genus, inequivalve, subequilateral, irregular in outline but usually subcircular, weakly inflated, nearly as high as long; not alate, adhering to an object with umbonal area of right valve; ornamentation different between two valves; in right valve surface irregularly undulated, smooth in umbonal area but having quite irregularly disposed small low tubercles on remaining part; in left valve shell-surface not so irregularly undulated, provided with numerous spiny tubercles which are radially arranged and subequal at interval; rows of tubercles never bifurcated but occasionally increasing their number by insertion; hinge moderate in width; right valve having a pair of subparallel strong crural teeth which are bordered by a pair of deep crural sockets and interrupted by a deeply submerged central pit; left valve having a pair of finely crenulated and elongated crural teeth which form an obtuse chevron of about 120 degrees at beak; resilifer located at upper part of central pit, strongly impressed on right valve but weakly on left; adductor monomyarian, large, orbicular, subcentral; pallial line indistinct.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3401) left in. mould	19.0	16.5	2.0
Paratype (MM 3402) left ex. mould	14.5+	18.0	2.5
Paratype (MM 3403) right in. mould	25.0	20.5	3.0
Paratype (MM 3404) right ex. mould	13.5	13.0	2.5

Observation and comparison: —Two right specimens and many left ones were obtained. In view of the hinge-structure this is certainly referable to *Plicatula*, but the suborbicular outline is very unique. The large angle between the two crural teeth in left valve reminds one of *Dimya* ROUAULT (type: *D. deshayesiana* ROUAULT, monotypy), but the crural teeth are stout and adductor monomyarian in this species. I could find no comparable species with this in foreign literatures.

Occurrence: —Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5)

Plicatula praenipponica HAYAMI, new species

Plate VI, Figures 17–19

Description: —Shell large for genus, inequilateral, elongated subvertically, fairly irregular in outline, not alate, often more or less contorted, much higher than long; test fairly thick; hinge-line short, rounded; left valve having numerous irregular, often bifurcated radial riblets on whole surface and a few irregularly disposed spines near ventral margin; mode of ornamentation changed fairly abruptly in middle stage; hinge of right valve symmetrical; resilifer deep, elongated, variable in inclination but usually subvertical, defined from crural sockets on both sides by a pair of subparallel ridges; crural teeth usually stout, elongated, strongly crenulated laterally as if trigoniid's cardinals, apart from beak with narrow flattened areas; adductor monomyarian, suborbicular, strongly impressed, subcentral or slightly posterior; pallial line distinct, entire. Nothing known of right valve.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3406) left in. mould	27.5	32.0	4.0
Paratype (MM 3407) left in. mould	29.0	36.5	4.5
Paratype (MM 3408) left in. mould	20.0+	38.0	3.5+

Observation and comparison: —Represented by six specimens. The holotype specimen composed of left external and internal moulds shows clearly the surface ornamentation and characteristic dentition. The outline and shell-convexity are quite variable among individuals. A specimens (fig. 17) has a somewhat contorted outline and slightly concave internal surface of ventral area. Another specimen has an opisthocline resilifer and bordered teeth whose inclination is more asymmetrical than other specimens. But these must be conspecific with one, another, since the hinge-structure and other essential characters are identical.

The hinge of this species appears to be fairly deviated from Recent and most Mesozoic species of *Plicatula*. More precisely, the two crenulated crural teeth are unusually strong, situated apart from the resilifer in left valve and fairly curved along the rounded pre- and post-umbonal margins. Such a peculiar feature of hinge and large dimensions suggest that this belongs to another subgenus than *Plicatula* (s. s.). DESLONGCHAMPS (1859) noted that *Harpax* PARKINSON, 1811, should be retained for certain Mesozoic species. But many other authors considered that they are synonymous. According to STOLICZKA (1871), *Harpax* has generally stronger and more parallel hinge-teeth, often larger size and thick test than *Plicatula*, but that it would not be justifiable to recognize *Harpax* as a distinct genus, since the two are essentially the same in the general characters. On the other hand it is certain that undoubted species of *Plicatula* appeared already in the Lias, for instance, *P. spinosa* SOWERBY in GOLDFUSS (1836). They are so similar to Recent typical *Plicatula* in hinge and external characters that no subgeneric distinction is required. I refer this species tentatively to *Plicatula*, since it is unknown to me whether the type-species of *Harpax* is actually separable from *Plicatula* in a higher category than species or they are synonymous.

Plicatula daharensis DUBAR, 1948, including some varietal forms from the Domerian of Morocco is probably intimate to this in view of similar size, ostreid-like irregular outline, disposition of strong crural teeth and abrupt change of ornamentation in middle stage. But the umbo is not so pointed and the ventral area not so roughly plicated as in the African species. This resembles *Plicatula hekiensis* NAKAZAWA, 1955, from the Carnic Nabae group in the general outline and musculature, but differs in the much larger dimensions and presence of radial ribs and spines on the surface. This is readily distinguishable from the preceding species from the same fossil bed in the larger dimensions, elongated outline, different ornamentation, stronger crural teeth and sockets in left valve.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) The scarceness of right valves of this and the preceding species in comparison with left valves may imply that the shells adhered to objects by means of right valves and then only left valves were derived and brought into this shell-bank.

Family **Limidae** D'ORBIGNY

Genus *Lima* BRUGUIÈRE, 1797

(=*Radula* KLEIN, 1753, pre-LINNÉ)

Type-species:—*Ostrea lima* LINNÉ, 1758, Recent (tautonymy).

"*Lima*" sp. indet.

Plate VI, Figure 20

Represented by a small left valve. Shell inequilateral, moderately inflated, higher than long (MM 3410. 9.5mm. long; 11.0mm. high; 2.5mm. thick); surface marked with 16 or slightly more radial costae; secondary costae apparently.

This is referable to *Lima* of wide sense and probably a member of *Pseudolimea* ARKELL, 1926, but its exact generic position is indeterminable, because of ignorance of the internal structure. This is similar to *Lima columbiae* Warren, 1931, from the Lias of British Columbia. *Lima densicosta* QUENSTEDT in TONI, 1912 from the Lias is also similar in the outline but different from this in having more numerous radials.

Occurrence: —Rare in *Oxytoma* bed at Higashinakayama (Loc. 9). Collected by KOBAYASHI.

Genus *Plagiostoma* SOWERBY, 1814

Type-species:—*Plagiostoma gigantea* SOWERBY, 1814, Lias, Europe (by STOLICZKA, 1871).

Plagiostoma kobayashii HAYAMI, new species

Plate VI, Figures 21–23

Description: —Shell medium for genus, equivalve, inequilateral, gibbose and somewhat *Acesta*-like in outline, with length almost equal to height, not strongly inflated; anterior margin nearly straight or slightly sinuated; posterior one gently arcuate but slightly concave near junction with posterior auricle; dorsal margin forming an obtuse chevron of about 150 degrees at beak; hinge-line straight, moderate in length; umbo lying more or less anteriorly from mid-point of hinge-length, slightly rising above it; apical angle between anterior and posterior margins exclusive of auricles measuring about 90 degrees; anterior umbonal ridge sharp, long, forming an angle of about 50 degrees with hinge; auricles very unequal; anterior one narrow, concave, obtusely truncated, scarcely visible from normal direction to valve-margin; posterior auricle large, obtuse-triangular, flattened, not clearly defined from postero-dorsal surface; surface of main body and posterior auricle ornamented with about 65 radial costae; radials more or less flat-topped, nearly straight, regular in prominence, disposed nearly equidistantly but slightly curved outwards and somewhat roughly spaced in posterior part and auricle; their interspaces almost as broad as costae, weekly striated transversely; growth-lines very weak; lunule* well defined, marked with several weak radials, slightly concave, nearly perpendicular to valve-margin; cardinal area very obtusely triangular, slightly asymmetrical with an anteriorly located summit, provided with a ligament pit which is comparatively large, fairly deep, slightly prosocline and rounded at base; inner surface weakly plicated by impression of radials; musculature unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3411) right ex. mould	31.5+	29.5+	3.5
Paratype (MM 3412) right in. mould	48.5	50.0+	6.0

Observation and comparison: —Four specimens are at hand, though all are more or less broken. The holotype (fig. 21) is an external mould of left valve, showing regular radial ornaments and posterior auricle. The general outline of this species is presumable from growth-lines on the mould and the paratype. The large ill-defined posterior auricle and general outline reminds one of *Acesta* H. and A. ADAMS, 1858, which survives now in deep seas. Many living and Tertiary species of that genus in Eastern Asia are monographed by OYAMA (1943). The umbo is located very anteriorly and the ligament pit very prosocline in all species of *Acesta,* though the exterior of *Acesta* is almost indistinguishable from *Plagiostoma.* In this point *Acesta* is similar to *Mysidioptera* SALOMON, 1895, and

* COX (1943) introduced the term for the anterior slope (more or less excavated area in front of anterior umbonal ridge), though it is unkown if it is actually homologous to the true lunule in dimyarian pelecypods.

Plagiostoma with an acline or slightly prosocline pit to *Lima* (s. s.). There are several Jurassic species hitherto assigned to *Acesta* (ARKELL, 1932; DECHASEAUX, 1936b), but COX (1952) stated that they seemed to be more related to *Plagiostoma*. Many palaeontologists including COX (1943, 1952) assigned *Plagiostoma* as a subgenus of *Lima*, but I treat here the former as a distinct genus. *Acesta* was probably derived from *Plagiostoma* in Cretaceous and is regarded as its subgenus.

This species is very similar to *Lima* (*Plagiostoma*) *pontonis* LYCETT in MORRIS (1853) (COX, 1943) from the Bajocian of England in the ornamentation and outline, but the umbonal area is less inflated and the intervals of costae slightly broader than that species. This is distinguishable from *L.* (*Pl.*) *semicircularis* GOLDFUSS, 1836 (CHAPUIS and DEWALQUE, 1853; GREPPIN, 1900; COX, 1943) from the Aalenian in the broader interval of radials, narrower main body and larger obliquity between hinge and anterior umbonal ridge (it is about 30 degrees in *semicircularis*). *L.* (*Pl.*) *cardiiformis** in BENECKE (1905) and *L.* (*Pl.*) *ferruginea* BENECKE, 1905, from the Aalenian of eastern Paris basin, which the two are synonymous with each other according to DECHASEAUX (1936b), have more prominent umbo and more widely spaced radial costae. *Lima compressa* TERQUEM, 1855, from the lower Lias, regarded as a *Plagiostoma* by DECHASEAUX, differs from this in the comparatively small posterior auricle and more delicate radials. This may be a close ally to *Lima garlandica* WINKLER, 1886, from the lower Lias of Alps, but the posterior auricle is probably more obtusely truncated and worse defined than this species. *Lima* (*Pl.*) *enormicosta* TAMURA (MS), the main constituent species of "the *Lima*-sandstone fauna" in the Upper Jurassic of Soma area differs from this in the irregular and rough costation and more profoundly excavated lunule.

Occurrence: —Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Plagiostoma matsumotoi HAYAMI, new species

Plate VI, Figures 24, 25; plate VII, Figures 1-3

Description: —Shell medium to small for genus, gibbose, inequilateral, equivalve, not strongly inflated, almost as long as high; test comparatively thin; anterior margin nearly straight or slightly concave at junction with posterior auricle, broadly arcuate, passing gradually into venter; umbo lying very slightly anteriorly from midpoint of hinge-length, not rising above dorsal margin; apical angle exclusive of auricles about 95 degrees; hinge relatively short; anterior umbonal ridge fairly sharp, long, defining an elongated lunule in its front, forming an angle of about 35 degrees with hinge; anterior gaping, if present, very slight; surface marked with faint concentric growth-lamellae and 65 or a little more weak narrow radial striae which are more or less sinuous, almost effaced in central area and often punctate at bottoms in posterior area; intervals becoming broader towards anterior periphery; posterior auricle ill-defined, obtuse-triangular, comparatively small, marked also with fine radial grooves; lunule excavated, smooth except for coarse growth-lamellae; internally, cardinal area obtuse-triangular, moderate in breadth, provided with a slightly prosocline triangular ligament pit which is situated slightly anteriorly from mid-point; a pair of short crura-like teeth present near both peripheries of hinge area; inner surface and

* COX (1943, p. 183) stated that *P. cardiiformis* SOWERBY is a Great Oolite species misinterpreted by MORRIS and LYCETT.

ventral margin quite smooth; musculature unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3414) left in. mould	27.5	26.5	3.5
Paratype (MM 3415) left ex. mould	37.5	37.0	5.0
Paratype (MM 3416) right in. mould	34.0	34.0	4.5+

Observation and comparison:—Many specimens show external and internal characters. The holotype (fig. 25) is relatively small, but well preserved, showing complete outline. The faint, sinuous, sometimes effaced radial striae are commonly seen in *Acesta*, but known also in many species of *Plagiostoma*. The presence of crura-like teeth on both lateral sides of hinge area is probably unknown in *Plagiostoma*, but it can be expected that similar teeth will be found in most species of the genus, if the internal structure is carefully examined. Cox (1943) announced the presence of a well developed tooth on the anterior auricle of *Lima* (*Plagiostoma*) *hersilia* D'ORBIGNY. It may correpond with the anterior tooth in this species. Recent species of *Lima* (s. str.) have also teeth-like projections, though they are generally much weaker.

This resembles the preceding species from the same fossil-bed in the ill-defined posterior auricle, gibbose outline and number of radials. But in *kobayashii* radials are never effaced in the central surface, stronger and clearly impressed on the internal surface, and the posterior auricle larger. The anterior umbonal ridge is more opisthocline in this species. Cox (1943, p. 156) noted that its inclination with regard to the hinge-axis is fairly constant in specimens of the same species, and I take it a diagostic character between the two species. *Lima compressa* TEROUEM, 1855, from the lower Lias resembles this in the weak radials, but they are more effaced in the central part of this species and the obliquity is smaller than that species. *Lima* (*Plagiostoma*) *aciculata* (MÜNSTER) (ARKELL, 1932) from the Corallian is similar to this, but the radials seem more densely spaced in the anterior area. This resembles also *L.* (*Pl.*) *amnifera* WILDBORNE, 1883 (Cox, 1943) from the upper Toarcian, but is distinguishale by the absence of a linear groove in front of anterior umbonal ridge and more effaced radials on the middle surface. *L.* (*Pl.*) *savrassovi* KIPARISOVA, 1952, from the Lias of Amur may have stouter radial striae.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) and rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Locs. 3 and 6) and Higashinakayama (Loc. 8). KOBAYASHI collected a similar specimen from *Oxytoma* bed at Higashinakayama (Loc. 9).

Plagiostoma sp. indet.

Plate VI, Figure 26

A small right valve (MM 3420, 18.0mm. 16.0mm. high; 2.5mm. thick) does not agree with either of *Plagiostoma kobayashii* and *P. matsumotoi* in the broader main body and nearly smooth surface. This is anyhow a member *Plagiostoma* but specifically indeterminable.

Occurrence:—Rare in *Oxytoma* bed at Higashinagano (Loc. 9). Collected by KOBAYASHI.

Genus *Antiquilima* Cox, 1943

Type-species:—*Lima antiquata* SOWERBY, 1821, upper Lias, England and Germany (original designation)

Antiquilima nagatoensis HAYAMI, new species

Plate VII, Figures 4 a–c

Description:—Shell medium in size, inequilateral, linguiform but somewhat opithocline, not strongly inflated, much higher than long; anterior margin sinuated near junction with anterior auricle; posterior margin gently arcuate, passing gradually into venter; dorsal margin forming an subsymmetrical obtuse chevron of about 140 degrees at beak; antero- and postero-dorsal corners angular and obtusely truncated; hinge-line short, defining a broad triangular cardinal area provided with a large subcentral trigonal ligamant pit; anterior umbomal ridge absent at all; lunule not impressed; byssal gaping wide, elongated, occupying greater part of anterior margin; anterior auricle very large, flattenend but its anterior marginal zone fairly thickened; posterior auricle comparatively small, ill-defined from main body, obtusely truncated; surface ornamented with 40 or a little more fine radial costae of primary strength and somewhat irregular growth-lamellae; radials distributed irregularly, sometimes interrupted by growth-lamellae, increasing their number through growth by irregular insertion, much narrower than interspace; secondaries much weaker than primaries even at ventral periphery; anterior auricle marked with strong growth-lamellae, and posterior auricle with several weak radials; hinge edentulous; pallial line simple; radials not impressed on internal surface; inner ventral margin smooth.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3421) right ex. mould	24.5	33.5	6.5
Paratype (MM 3422) right in. mould	14.0+	21.0+	?

Observation and comparison:—Represented by six specimens. The exterior and interior are well revealed in the holotype composed of external and internal moulds. In the holotype the radials are interrupted by some strong growth-lamellae and their directions are abruptly turned outwards. It is one of original characters instead of an accidental damage, for such a tendency is also found in some related species to this.

The elongated outline, large anterior auricle, wide byssal gape, characteristic radial and concentric markings and other features coincide well with the diagnosis of *Antiquilima* Cox, 1943. *Antiquilima*, based on *Lima antiquata* SOWERBY from the Lias of England, was originally proposed as a subgenus of *Lima*, but I regard here it as a distinct genus. The mode of ornamentation and byssal structure of *Antiquilima* seem very different from *Lima* and *Plagiostoma*. On the other hand, the morphological resemblance between *Antiquilima* and *Ctenoides* MÖRCH, 1853 (type: *Lima scabra* BORN, by STOLICZKA, 1871) is noteworthy. Compared with the Recent species of *Ctenoides*, it is found that the two genera differ clearly in the shell-inclination, development of anterior auricle and ornamentation. Cox (1943) said "*Antiquilima* is abundant in the Lias and persists into the lower Inferior Oolite, then becoming extinct—a fact which also justifies its separation from Recent *Ctenoides* and suggests that the similarity between the two groups constitutes a case of parallel evolution." In fact, many Lower Cretaceous species of *Ctenoides* (WOODS, 1904, etc.) and a Upper Jurassic one (KIMURA, 1951) show clear difference from the Liassic group and many allied characters to Recent species.

This is similar to *Lima* (*Antiquilima*) *antiquata* SOWERBY, 1821 (GOLDFUSS, 1836) and *L.* (*A.*) *cubiferens* WHIDBORNE, 1883 (COX, 1943), but specifically distinguishable from them by the more densely spaced radial costae and more rounded corner of anterior auricle. *Lima nodulosa* TERQUEM, 1855, from the lower Lias of Paris basin and Mexico (JAWORSKI, 1929) shows a similar outline and a wide byssal gape in front of anterior auricle, and probably can be included in *Antiquilima*. But the concentric lamellae are more regular and weaker, and the radials are broader with numerous small tubercles in that species. *Lima praelonga* MARTIN, 1863, from the lower Lias differs from this in the presence of stout primary radials of smaller number and less oblique main body.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Genus *Ctenostreon* D'EICHWALD, 1862

Type-species:—*Ostrea pectiniformis* ZIETEN, 1832, Dogger, Europe (monotypy)*.

Ctenostreon japonicum HAYAMI, new species

Plate VII., Figures 5, 6

Description: —Shell small for genus, inequilateral, not strongly inflated, nearly acline but somewhat irregular in outline, more or less higher than long; antero-dorsal margin slightly concave, while postero-dorsal one broadly convex, auricles very unequal; anterior one trigonal with a sigmoidal anterior margin, acutely protruded forwards as *Chlamys'* byssal auricle, strongly marked with erect growth-lamellae; posterior one trigonal, flattened, obtusely truncated; hinge-line rather short; surface of main body ornamented with about 13 roof-like radial plications; growth-lines very weak on main body; internal structure as in normal *Lima;* a large, somewhat elongated, trigonal central pit present; hinge edentulous; byssal gape fairly wide, occupying anterior margin of anterior auricle. Left valve unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3424) right ex. mould	22.5	24.5+	5.0
Paratype (MM 3425) right ex. mould	26.5	23.0+	5.0

Observation and comparison: —Represented by four right specimens. The holotype (Fig. 5) and paratype (Fig. 6) are fairly different from each other in the development of anterior auricle, but the difference is certainly due to the variability within a species. The *Chlamys*-like protruded anterior auricle is somewhat unfamiliar for limids, but the auricular sulcus is absent and the cardinal area external and triangular with a trigonal pit of limid-type. Judging from the presence of byssal gape and the mode of radial ribbing,** this is an early member of *Ctenostreon*, an aberrant but characteristic limid genus ranging from the Lias to Lower Cretaceous, though the dimensions are considarably smaller than normal species.

* See COX (1952, p. 63, footnote).

** The radial plications of *Ctenostreon* are about 12 in number according to ARKELL's diagnosis of the genus (1932).

Lima tuberculata TERQUEM, 1855, non BROCCHI, 1814,* from the lower Lias of eastern Paris basin and *Ctenostreon terquemi* TATE (ARKELL, 1933)* from the pre-*planorbis* bed of England are nearly coeval with this and similar in the surface ornamentation. However, this is different from the two in the more developed anterior auricle and coarse concentrics on it. This may be more closely allied to *Ctenostreon chlamidiforme* ROLLIER, 1911 (=*Ct. pectiniforme* BENECKE, 1905, non SCHLOTHEIM, 1820) from the Aalenian. The species has also a *Chlamys*-like protruded anterior auricle which is strongly marked with erect growth-lamellae as this species. But the auricle is more triangular with a more pointed antero-dorsal extremity than BENECKE's.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Ctenostreon sp. indet.

Plate VI, Figure 27

There is another smaller left specimen composed of external and internal moulds, which is similar to the preceding species in the radial ornamentation. Its dimensions are much smaller (MM 3427, 16.5mm. long; 19.5mm. high; 1.5mm. thick), and may be its juvenile specimen. But it differs from the material of *japonicum* in the opisthocline shell, weaker shell-convexity and smaller anterior auricle without strong growth-lamellae. Since no left valve of *japonicum* is represented, it is now impossible to determine whether this is conspecific with *japonicum* or belongs to another species.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Ostreidae** LAMARCK

Genus *Liostrea* DOUVILLÉ, 1904

Type-species: —*Ostrea sublamellosa* DUNKER, 1851, lower Lias, Europe (by DOUVILLÉ, 1904).

Liostrea toyorensis HAYAMI, new species

Plate VII, Figures 7, 8

Description: —Shell medium to large, inequivalve, subequilateral, variable in outline but usually subovate, more or less expanded towards venter, fairly higher than long; left valve strongly inflated; convexity strong especially near ventral periphery; umbonal area not coiled; right valve comparatively flat or weakly inflated; umbo opisthogyrous, lying nearly at mid-length; surface of right valve marked with irregular concentric growth-lamellae; no radial ornaments; ligament area of left valve very wide, laminated; provided with a large trigonal opisthocline pit; in right valve ligament area much narrower and pit smaller; adductor scar strongly impressed in each valve, orbicular, lying slightly posteriorly to center.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3428) left in. mould	59.0	68.0	14.5+
Paratype (MM 3429) left in. mould	59.0	69.5	13.5+
Paratype (MM 3430) right in. mould	39.0	39.0+	6.0+

* JOLY (1936) pointed out the homonym and renamed the species *Ctenostreon terquemi* JOLY, but the specific name is also preoccupied by *Lima terquemi* TATE from the pre-*planorbis* bed of Somerset which is certainly referable to *Ctenostreon* and may be specifically different from JOLY's.

Observation and comparison:—Represented by three left internal, a right external and two right internal moulds. The outline of this species is probably not so variable as usual in normal ostreids. Judging from the absence of radial plication, general outline and geological occurrence, this is referable to *Liostrea* which has been said to comprise most Jurassic species of non-coiled and non-plicated ostreids. DOUVILLÉ noted that *Liostrea* has less inequivalve shells than Recent *Ostrea* (s. s.), but the difference seems to me somewhat obscure, as pointed by ARKELL (1932) and others. In this species the inflation of left valve is unusually strong for normal species of the genus. The strong convexity near ventral periphery is commonly seen in the three internal moulds, and may be a striking character of this species. In this respect this may be more related to subgenus *Catinula* than *Liostrea* (s. s.). But the umbonal area of left valve is considerably flattened, and *Gryphaea*-like appearance is not recognized.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) and rare in the basal conglomerate at Takayama (Loc. 1).

Genus *Lopha* RÖDING, 1798

(=*Alectryonia* FISCHER DE WALDHEIM, 1807; *Alectryonella* SACCO, 1897)

Type-species:—Mytilus crista-galli LINNÉ, 1758, Recent (by DALL, 1898).

Lopha sazanami HAYAMI, new species

Plate VII, Figures 9, 11

Description:—Right valve medium to large, subequilateral, variable in outline, but usually ovate, feebly convex, more or less higher than long; umbo lying submesially; surface marked with numerous lamellose concentric growth-lamellae and about 17 radial plications which become gradually prominent towards ventral periphery and sometimes are bifurcated; umbonal area fairly smooth, nearly flat; right valve having a small triangular ligament pit, narrow ligament area and rather weakly impressed, orbicular and subcentral adductor scar; no crenulation on lateral areas of hinge-plate; nothing known of left valve.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3432) right ex. mould	58.5	76.5	8.0
Paratype (MM 3433) right in. mould	38.0	45.5	6.0+

Observation and comparison:—Represented by two right external moulds and a right internal. There is another external mould (Pl. III, Fig. 10) which is apparently different from the holotype and other specimens in the weaker growth-lamellae and more angular radial plications. It is unknown whether it is a left valve of this species or belongs to another species. *Lopha* is typically characterized by the strongly angulated radial plicae, and Mesozoic species have, in general, rather narrow outlines and median partings whence plications are divergent on the anterior and posterior slops. The plicated surface of this species reminds one of *Lopha*, but the plications are weaker, more numerous and rounded in comparison with typical *Lopha*. Hence, its reference to *Lopha* is provisional. This is seemingly different from normal Mesozoic species in the broadly ovate outline and absence of median parting. *Ostrea* (s. s.) has also many radials on the surface, but they are much weaker and scarcely plicated except for ventral periphery.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Trigoniidae** LAMARCK

Genus *Prosogyrotrigonia* KRUMBECK, 1924

Type-species.—*Prosogyrotrigonia timorensis* KRUMBECK, 1924, Upper Triassic (Rhaetic ?), Timor (original designation).

Prosogyrotrigonia inouyei (YEHARA)

Plate VII, Figures 12–14

1921, *Trigonia inouyei* YEHARA, *Jour. Geol. Soc. Japan, Vol. 38,* p. 8, pl. 15, figs. 1–2.
1931, *Trigonia inouyei* YEHARA, *Trigoniae* in Japan, p. 22, text-fig.
1954, *Prosogyrotrigonia inouyei* KOBAYASHI, in KOBAYASHI and MORI, *Japan. Jour. Geol. Geogr., Vol. 25, Nos. 3–4,* p. 157, pl. 15, figs. 3–5.

Occurrence: —Common in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3, 6) and Higashinakayama (Loc. 8), and rare in *Cardinia toroyamai* bed at Higashinakayama (Loc. 5). The specimens from the last locality are much smaller than those from other localities. A specimens from a boulder near Loc. 6 is about 55 mm. in length and unusually large for this species.

Family **Cardiniidae** ZITTEL

Genus *Cardinia* AGASSIZ, 1841*

Type-species:—*Unio concinnus* SOWERBY, 1821, lower Lias and Rhaetic, Europe, Greenland and Siberia.

Remarks: —As discussed before (HAYAMI, 1958e), *Cardinia* can be classified into several groups on the basis of the outline, umbonal structure and surface-ornamentation. *Concinna*-group, i. e. *Cardinia* (s. s.) is characterized by the elongated outline, undeveloped lunule and weak surface ornaments, and it is not impossible that the group was derived from a different stock from that of *hybrida* and other groups.

Concinna-group

Cardinia orientalis HAYAMI, new species

Plate VII, Figure 1

Description: —Shell large for genus, equivalve, inequilateral, elongate-ovate, not strongly inflated, about 1.7 times as long as high; test thick; antero-dorsal margin slightly sinuated in front of umbo; postero-dorsal margin long, gently curved down to siphonal; apical angle about 120 degrees in external view but actually smaller owing to hidden lunule; ventral margin broadly arcuate without sinuation; curvature of margin strong near anterior and posterior extremities of shell; umbo fairly prosogyrous, but not much protruded above lunule, lying at about a sixth of length from front; lunule probably not deep but clearly defined; escutcheon present, nearly vertical; surface smooth but for several irregular concentric lamellae and numerous growth-lines; cardinal teeth apparently obso-

* The decision of the International Commission on Zoological Nomenclature, Opinion 292.

lete; laterals AI, AII, PI and PII remote, short, gradually strengthened towards lateral sides; adductor impression stout, of *Cardinia*-type, a small pedal scar present above anterior adductor scar; umbonal cavity shallow.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3439) right in. mould	81.0	47.0	10.0
Paratype (MM 3440) left in. mould	96.5+	96.5	12.5+

Observation and comparison: —Three specimens are at hand. The holotype specimen composed of internal and external moulds shows the hinge, musculature and non-imbricated surface ornaments. This can be included in *concinna*-group with regard to the large size, elongated-ovate outline, unexcavated lunule and weak ornamentation. In most species of *concinna*-group listed before (HAYAMI, 1958e), the shell is twice or more as long as high. In this respect this may be transitional between *concinna*- and *crassissima*-groups. *Cardinia concinna* SOWERBY, 1821, *C. copides* RYCKHOLT, 1850 and *C. hennoquii* TERQUEM, 1855 resemble this, but have more elongated outline. *Cardinia philea* D'ORBIGNY, 1850, from the lower to middle Lias of Europe may be also allied to this. Especially Caucasus specimen described by PČELINCEV (1937) as *C.* cf. *philea* shows similar ornaments and shell-elongation. But typical *philea*, as illustrated by BOULE (1906), has a slightly more elongated shell and less terminal umbo than these specimens.

Occurrence:—Rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Locs. 3,6)

Hybrida-group

Cardinia toriyamai HAYAMI

1938, *Cardinia* sp. listed by TORIYAMA, *Jour. Geol. Soc. Japan, Vol. 45, No. 533*, p. 251.

1958, *Cardinia toriyamai* HAYAMI, *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 11, Pt. 2*, p. 121, pl. 11, figs. 1-11.

Occurrence: —Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5) and rare in *Prosogyrotrigonia inouyei* bed at Higashinakayama (Loc. 8, TORIYAMA coll.). Several well preserved specimens were amplified from Loc. 5, after the original description of this species had been published. I note then that the ventral margin is slightly sinuated mesially in early stage but the sinuation gradually diminishes later. Such a tendency is, however, not always seen in the newly collected specimens.

Family **Astartidae** GRAY

Genus *Praeconia* STOLICZKA, 1871

(=*Theveninia* ROMAN, 1921)

Type-species.—*Astarte terminalis* ROEMER, 1842, Dogger, Europe (original designation).

Plate VII, Figures 15, 16; Plate VIII, Figures 2-4

Praeconia cf. *tetragona* (TERQUEM)

cf. 1855, *Cardita tetragona* TERQUEM, *Mém. Soc. géol. France, Sér. 2, Tom. 5*, p. 83, pl. 20, figs. 9, 9a.

non 1862, *Cardita tetragona* ETALLON, Lethea Bruntrutana, p. 201, pl. 24, fig. 16.*

non 1872, *Cardita tetragona* LORIOL, *Mém. Soc. Linn. Normandie, Vol. 16*, p. 284, pl. 16, fig. 18.*

* Synonyms of *Praeconia rhomboidalis* (PHILLIPS) according to ARKELL (1934).

cf. 1936, *Praeconia tetragona* JOLY, *Mém. Mus. roy. d'Hist. nat. Belg., No. 79*, p. 127, pl. 2, figs. 5 a–c.
cf. 1937, *Praeconia* sp. ex gr. *tetragona* in PČELINCEV, *Mon. Pal. USSR, Vol. 48*, p. 21, pl. 5, fig. 18.
cf. 1938, *Astarte* (*Thevenínia*) aff. *tetragona*? in DUBAR, *Notes et Mém. Serv. géol. Maroc, No. 68*, p. 177, pl. 16, figs. 9 a, b.

Description of Toyora specimens:—Shell small to large, subquardate, equivalve, inequilateral, moderately inflated, expanded postero-ventrally, much longer than high; antero-dorsal margin short, slightly sinuated in front of beak, provided with a small but deeply excavated lunule; postero-dorsal margin long, subhorizontal, turned somewhat abruptly into siphonal; ventral margin straight or slightly concave, oblique to hinge; umbo not prominent, very prosogyrous, subterminal; surface marked with six or more imbricated and widely spaced concentric lamellae and numerous faint growth-lines in adult stage; imbrications much weaker and smaller in number in immature stage; escutcheon elongated, nearly vertical, striated by oblique growth-lamellae; dentition of *Astarte*-type; left valve having to cardinal teeth 2 and 4 b; 2 tubercular, stout; 4b elongated, subhorizontal, gradually weakened posteriorly; right valve having a stout, trigonal cardinal 3b and a weak small 3a formed by thickening of pre-umbonal margin; laterals undeveloped; anterior adductor scar wedge-like, very strongly impressed, but *Myoconcha*-like buttress absent; posterior adductor scar large but comparatively weak; pallial line entire; inner ventral margin weakly toothed; umbonal cavity shallow.

Measurement in mm.	Length	Height	Thickness
(MM 3442) left ex. mould	47.0+	29.0+	8.5+
(MM 3443) left in. mould	41.0	26.0	9.0+
(MM 3444) left in. mould	18.0	12.5	3.5
(MM 3445) right in. mould	18.0	12.0	3.5

Observation and comparison:—Seven specimens are at hand. The first specimen (Pl. IV, fig. 4) is an incomplete external mould, exhibiting the splendidly imbricated surface. The second (fig. 3) is an internal mould of left valve showing the hinge, musculature and ventral dentation. Two other specimens (Pl. III, fig. 15, 16; Pl. IV, fig. 2) are probably young individuals. The ventral margin seems nearly straight in juveniles, while a distinct sinuation is found in adults. The ontogeny can be outlined also from the growth-lines of the first specimen.

Such an imbricated surface and ventral sinuation remined one of a cardiniid, but it is referable to *Praeconia* by the quadrate outline and dentition of *Astarte*-type. *Praeconia* is undoubtedly a distinct genus of the Astaridae, but bears some affinities to the Cardiniidae and Myoconchidae in dentition and musculature. I think that the genus is a Jurassic side branch of the trunk of the Astartidae. Both may have been derived almost simultaneously from preheterodont pelecypods. *Theveninia* was originally used as a subgenus of *Astarte* by ROMAN (1921) and later by DUBAR (1948). The type of *Theveninia* (*Hippodium gibbosum* D'ORBIGNY, upper Lias, original designation) has small size and strongly imbricated, widely spaced concentric lamellae on the surface, and may constitute a distinct group from *Astarte terminalis*. But I think that they are generically inseparable. *Cardita tetragona* TERQUEM, 1855, from the lower Lias of Paris basin, which was later correctly referred to *Praeconia* by JOLY (1936), is very similar to this in the above mentioned characters, although the dimensions of these specimens are often large for that species. The first specimen has much stronger concentric lamellae than TERQUEM's and JOLY's figures, while the surface-markings of smaller specimens are almost identical with them. As to the outline this has a slightly more strongly curved anterior margin, but it is doubtful that such a slight difference is worthy of a specific distinction. *Praeconia* sp. ex gr. *tetragona* in PČELINCEV (1937) and *Astarte* (*Theveninia*) aff. *tetragona*? in DUBAR (1948) are also comparable with this. *Astarte* (*Theveninia*) *gibbosa* (D'ORBIGNY) in ROMAN (1921) from the Bajocian of France differs in the more inflated and much smaller shell.

Occurrence :—Common in *Cardinia toriyamai* bee at Higashinagano (Loc. 5).

Genus *Astarte* SOWERBY, 1817

(=*Crassina* LAMARCK, 1819)

Type-species :—*Astarte lurida* SOWERBY, 1817, Upper Lias and Dogger, Europe (by STOLICZKA, 1871).

Astarte a sp. indet.

Plate VII, Figure 17

Represented by an internal mould of right valve. Shell very small, inequilateral, moderately inflated, longer than high (MM 3447, right internal mould, 6.5 mm. long; 6.0 mm. high; 1.5 +mm. thick), trigonally orbicular in outline; antero-dorsal margin fairly sinuated in front of umbo, rather short; postero-dorsal margin long, nearly straight; ventral one subsymmetrically arcuate; umbo very prosogyrous, acute, lying at about a third of length from front; right valve having a strong, triangular cardinal 3b and elongated weak 5b; cardinal sockets 2′ and 4b′ distinct; laterals obsolete; inner ventral margin marked with about 35 transverse crenules; exterior unknown.

This is safely referred to *Astarte* (s. l.) in view of the dentition, prosogyrous umbo and mode of marginal crenulation. In the absence of distinct 3a this is seemingly more related to subgenus *Nicaniella* CHAVAN, 1945, than *Astarte* (s. s.) This is probably a new form, but the specific identification is still deferred untill its exterior is known.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Astarte b sp. indet.

Plate VIII, Figures 5 a, b

A solitary specimen composed of left internal and external moulds is at hand. Shell small, inequilateral, weakly carinated posteriorly,well inflated, much longer then high (MM 3448, left internal mould, 7.5 mm. long; 6.0 mm high; 2.0 mm. thick); posterior margin fairly abruptly turned into venter at postero-dorsal and postero-ventral corners; surface marked with somewhat irregular and coarse concentric lines; inner ventral margin marked with some 30 transverse crenules which are more roughly spaced in posterior part than in anterior; hinge unknown; adductor impressions weak for astartid.

In the presence of ventral crenules this resembles the preceding form, but the outline is more quadrate and the crenules are more widely spaced in the posterior part than that form. The small size and outline are at a glance similar to *Prorokia* BOEHM, 1883 (type: *Cardita ovalis* QUENSTEDT, 1852, Malm, Europe, original designation), such as *Prorokia rustica* (LYCETT, 1863) (COX and ARKELL, 1948) from the British Great Oolite series. The mode of shell-convexity is, however, not typical of *Prorokia*. This is very similar to DUMORTIER's figure (1874) described as *Astarte lurida* in the outline and surface-markings, but typical *A. lurida* SOWERBY seems to me less quadrate in outline.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5.).

Family **Fimbriidae** NICOL

Genus *Fimbria* MEGERLE, 1811

(=*Corbis* CUVIER, 1817)

Type-species:—*Fimbria magna* MEGERLE, 1811, Recent (=*Venus fimbriata* LINNÉ, 1758) (monotypy).

Fimbria sp. indet.

3449-8-9 Plate VIII, Figure 9

Only a fragmental external mould is at hand (MM 3449). Whether it is right or left is unknown. Shell small for genus, ovate, longer than high; surface marked with more than 13, narrow, equidistant, raised, not sinous concentric ribs and numerous fine interstitial radial threads; radials somewhat weakened laterally. Judging from the characteristic ornamentation, it is referable to *Fimbria* which is considered as an element of warm sea. It may be the earliest representative of the genus.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5.).

Genus *Sphaeriola* STOLICZKA, 1871

Type-species:—*Cardium madridi* D'ARCHIAC, 1842, Bathonian, Europe (original designation).

51-8-10
52-8-11
50-8-12
53-8-13

Sphaeriola nipponica HAYAMI, new species

Plate VIII, Figures 10–13

Description:—Shell medium to fairly large for genus, equivalve, subequilateral, globose in outline with length more or less in excess of height, well inflated; the greatest convexity lying subcentrally or slightly posteriorly; test pronouncedly thick in full-grown stage; shell-margin gently arcuate without any striking angulation or sinuation, though antero-dorsal corner sometimes obtusely angulated; siphonal margin not clearly defined from postero-dorsal and ventral; postero-dorsal margin a little longer than antero-dorsal; umbo slightly prosogyrous, recurved, rising highly above hinge-margin, lying submesially; surface smooth except for numerous fine concentric growth-lines; hinge somewhat *Schafhäutlia*-like, consisting of two cardinals in each valve; right valve having strong cardinals 3a and 3b which are subsymmetrically disposed, imcompletely differentiated from each other and form an obtuse chevron of about 100 degrees at beak; left valve having a nearly acline tubercular cardinal 2 and narrow elongated 4a; the former interrupted from beak by a continuous and chevron-like cardinal socket 3a′–3b′; the latter formed by a thickening of pre-umbonal margin, ill-defined from it; lateral teeth undeveloped, although sometimes a small elevation is seen on posterior hinge area of right valve; lunule absent or, if present, very small; escutcheon very narrow but well marked; ligament opisthodetic, external; adductor impressions subequal, slightly elongated subvertically but very weakly impressed; pallial line obscure but certainly entire; inner ventral margin quite smooth.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3450) right in. mould	24.5	22.5	9.0
Paratype (MM 3451) right in. mould	44.0	44.0	12.5
Paratype (MM 3452) left in. mould	31.5	31.5	10.0
Paratype (MM 3453) left ex. mould	21.5	19.5	6.0

Observation and comparison:—Many specimens are available for study. The chevron-like hinge-structure is seen in the holotype and other internal moulds. Large specimens show stronger shell-convexity than small ones; and it is probably due to shell-thickening in gerontic stage. The hinge-structure and the presence of lateral-like projection at the posterior hinge area of right valve bear some affinities to *Fimbria* MEGERLE, 1811, but the shell-surface is almost smooth and lack any radial and concentrics ribs. The globular outline with strong convexity, smooth surface and hinge-teeth including the chevron-like 3a–3b and weak subhorizontal 4a are closer to those of *Sphaeriola* STOLICZKA. According to STOLICZKA (1871), *Sphaeriola* is readily distinguishable from *Fimbria* by the absence of lateral teeth and more globular outline. The lateral-like projection in this species is weak and even invisible, and it cannot be warranted that it is actually homologous with the posterior lateral of normal heterodont pelecypods. Such strongly inflated shells with chevron-like cardinals are known as *Schafhäutlia* COSSMANN, 1897 (=*Gonodon* SCHAFHÄUTL, 1863; *Gonodus* WÖHRMANN, 1893) in the Triassic. The type-species of *Schafhäutlia* (*Isocardia ovata* MÜNSTER in GOLDFUSS, 1836) is an Oolitic species, but the greater development of the genus is seen already in the Triassic. Unfortunately, I could not observe the hinge structure of either the type-species or Japanese Triassic species, but the dentition of several Triassic species was clearly illustrated by BITTNER (1895, 1901), FRECH (1907) and DIENER (1925). The cardinal teeth 3a and 3b in right valve are ill-differentiated and united beneath the umbo in Triassic *Schafhäutlia*, but in *Sphaeriola* and this species the chevron is not so obtuse as in that genus. The subhorizontally elongated cardinal 4a of this species is not so developed as typical *Sphaeriola* in D'ARCHIAC's figure. In this respect it may be transitional between Triassic *Sphafhäutlia* and Jurassic *Sphaeriola*.

It is very similar in the hinge, if the undeveloped cardinal 4a is ignored, to *Sphaeriola madridi* (D'ARCHIAC, 1842) (LAUBE, 1867; ROLLIER, 1913) from the Dogger of Western Europe, the type of the genus. But concentric lines are much weaker in the present species. In this point it may be more closely related to *Sphaera madridi* in MORRIS and LYCETT (1853) from the Great Oolite, which should be referred to *Sphaeriola oolithica* (ROLLIER, 1913) according to COX and ARKELL (1948, 1950). It is, however, characterized still more delicate concentrics, more rounded antero- and postero-dorsal margins and smaller apical angle. *Sphaeriola leedae* MARWICK, 1953, from the Aratauan (lower Lias) of New Zealand is nearly coeval but differs from it in the more inequilateral outline and more differentiated cardinal 3a and 3b. *Corbis* (*Sphaeriola*) *sibirica* KIPARISOVA, 1952, from the Lias of Amur is also similar to it, but the umbo is more salient in that species. Its further comparison with the Amur species is impossible, since the hinge is unknown.

Occurrence:—Common in *Cardinia toriyamai* bed at Higashinagano (Loc. 5.).

Family **Lucinidae** FLEMING

Genus *Lucina* LAMARCK, 1799 (sensu lato)

Lucina (s. l.) *hasei* HAYAMI, new species

Plate VIII, Figures 6–8

Description:—Shell small for lucinid, inequilateral, suborbicular, well inflated, nearly as long as high; post-umbonal margin nearly straight, forming an apical angle of about 100 degrees with slightly sinuated pre-umbonal margin, fairly abruptly turned into siphonal margin; ventral margin symmetrically arcuate; umbo prominent, prosogyrous, rising highly above dorsal margin; surface ornamented with strongly imbricated concentric lamellae whose intervals become gradually broader towards venter; hinge of lucinoid type, composed of two cardinals and a pair of isolated short laterals in each valve, though 3a is embryonal and often indiscernible; escutcheon clearly defined; lunule narrow but strongly impressed; anterior adductor scar strongly impressed and fairly elongated downwards; posterior one subovate; pallial line distinct, entire, close to ventral margin; inner ventral margin smooth without crenulations.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3455) left ex. mould	8.5	8.5	3.5
Paratype (MM 3456) right ex. mould	11.0	10.5	3.0+
Paratype (MM 3457) right ex. mould	9.0	8.5	3.0
Paratype (MM 3458) right in. mould	7.5	7.0	2.5

Observation and comparison:—Many specimens are at hand. The holotype (figs. 7a, b) composed of external and internal moulds reveals concentric ornamentation and muscle structure. The exterior with such a strong ornamentation reminds one of a certain astartid especially *Eriphylopsis* MEEK, 1876, but the concentrics are strongly imbricated and the musculature is clearly of *Lucina*-type. It cannot, however, be a typical *Lucina*, since *Lucina* (s. s.) is characterized by an almost edentulous hinge. A comprehensive study of fossil lucinids was undertaken by CHAVAN (1937–1938), but the dentition and musculature of Jurassic species are not as yet sufficiently clarified. CHAVAN is of opinion that subgenus *Callucina* DALL, 1901, of *Lucina* is present already in the Jurassic and several Oolite species belong to the subgenus. In the undeveloped cardinal 3a and presence of short laterals, this is fairly similar to the subgenus. But the cardinals are so stout and concentric lamellae so strongly imbricated that I hesitate to apply the subgeneric name to it. Externally it is somewhat similar to young specimens of *Prosogyrotrigonia inouyei* (YEHARA) from the same bed, but readily distinguished by the more prominent umbo, continuous and imbricated concentrics and presence of a distinct lunule. In the ornamentation this is at a glance akin to some specimens of *Eomiodon vulgaris* HAYAMI, 1958, from various horizons of Lias in

Northeast and Central Japan, but distinguishable from it by the less elongated shell, smaller lunule and different mode of occurrence, even if their hinges are not observable.

Occurrence:—Common in basal conglomerate at Takayama (Loc. 1) and in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Family **Cardiidae** LAMARCK

Genus *Cardium* LINNÉ, 1758 (sensu lato)

Cardium (s. l.) *naganoensis* HAYAMI, new species

Plate VIII, Figures 14, 15

Description:—Shell small to medium, equivalve, subequilateral, elliptical, moderately inflated, much longer than high; test moderate in thickness; antero-dorsal margin a little concave; postero-dorsal one nearly straight; ventral one broadly arcuate; the greatest convexity lying near center of valve; umbo slightly prosogyrous, submesial, rising slightly above hinge-margin; surface smooth except for faint concentric lines of growth; no trace of posterior radial ribbing present, but inner ventral margin marked with numerous fine transverse crenules; dentition of cyclodont-type; right valve having two conical cardinals 3a and 3b and a pair of isolated laterals which are symmetrically elongated along antero- and postero-dorsal margins; musculature unknown.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3461) right in. mould	21.5	17.5	5.0
Paratype (MM 3462) left in. mould	29.0	23.5	6.0

Observation and comparison:—Represented by three specimens. The holotype composed of right external and internal moulds exhibits the smooth surface and dentition of cardiid-type. The ventral crenules may imply the presence of radial ribbing, but they are, if present, much weaker than growth-lines. It is considered as a member of cyclodonts, but the generic position is uncertain. So far as I am aware, most Jurassic cardiids belong to *Protocardia* or *Pterocardia*, and no allied species is found in foreign literatures. Several Jurassic species hitherto referred to *Cardium* have distinct radial ornaments. This may belong to a certain unnamed genus of the Cardiidae, and its generic referrence to *Cardium* (s. l.) is provisional.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Genus *Protocardia* BEYRICH, 1845

Type-species:—*Cardium hillanum* SOWERBY, 1812, Cretaceous, England (by HERRMANNSEN, 1847).

Protocardia onoi HAYAMI, new species

Plate VIII, Figures 16–18

Description:—Shell small, fairly inequilateral, subtrigonal, well inflated, more or less longer than high; posterior carination fairly sharp but gradually weakened towards postero-ventral periphery; umbo submesial, orthogyrous, rising highly above hinge-margin; radial ribs about 23 in number, distributed not only in posterior area but 3 or 4 also in front of posterior carination, gradually weakened towards anterior; whole surface marked with numerous faint growth-lamellae, but concentric ribs absent; left valve provided with a pair of short lateral teeth subparallel to pre- and post-umbonal margins; cardinal teeth and musculature not observed.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3463) left ex. mould	14.0	13.0	4.5+
Paratype (MM 3464) left in. mould	15.0	12.5	?

Observation and comparison:—Four specimens are at hand. The holotype composed of left external and internal moulds shows radial ornaments of *Protocardia*-type. The most anterior radial rib does not coincide with the posterior carination in this species. It is somewhat similar to *Protocardia contusa* HEALEY, 1908, from the Napeng beds of Upper Burma and to *P. kurumensis* HAYAMI, 1958d, from the Domerio-Toarcian of Central Japan. But it is different from the former in the larger number of radials and the more obscure boundary of their distribution, and from the latter in the absence of prominent concentric ornamentation on the anterior and middle parts of shell-surface. *Protocardia rhaetica* (MERIAN) (MOORE, 1861; ARKELL, 1933; TROEDSSON, 1951) and *P. phillipiana* DUNKER, 1851 (QUENSTEDT, 1858) from the Rhaeto-Lias of Europe, which have been often treated as a single species, differ from this in the more wide-spaced radials and more postero-ventrally expanded outline.

Occurrence:—Rare in *Cardinia toriyamai* bed at Higashinagano

Family **Pleuromyacidae** ZITTEL

Genus *Pleuromya* AGASSIZ, 1843

Type-species:—*Mya gibbosa* SOWERBY, 1825, Upper Jurassic, Europe (by HERRMANNSEN, 1847)

Pleuromya sp. indet.

Plate VIII, Figure 19.

All ill-preserved internal mould of left valve (MM 3467, 13.0mm. long; 7.5 mm. high) is referable to *Pleuromya* from the outline, though specifically indeterminable.

Occurrence:—Rare in *Prosogyrotrigonia inouyei* bed at Higashinagano (Loc. 3).

Incertae sedis

Genus and species indet. a

Plate VIII, Figure 21

A right internal mould is at hand (MM 3468, 29.5mm. long; 23.5mm. high 7.0+mm. thick). Shell medium, trigonally ovate with straight pre- and post-umbonal margins, elongated posteriorly, moderately inflated; test probably thick; hinge composed of a slightly prosocline triangular cardinal tooth which is bordered on each side by a triangular socket; adductor scars very large and strongly impressed; pedal scar distinctly marked above anterior adductor; pallial line distinct, entire; test sharply truncated at ventral margin, which is marked with numerous transverse crenules. This bears some alliance to the Astartidae in the large adductor scars and other muscle features, but differs from them tolerably in the dentition and outline.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

Genus and species indet. b

Plate VIII, Figure 20

Represented by three specimens. Shell medium, equivalve, subequilateral, subrhomboidal to orbicular in outline, much longer than high (MM 3469, right in. mould, 42.0mm. long; 31.0mm. high; 6.5mm. thick); antero-dorsal margin broadly excavated, while postero-dorsal is nearly straight; lunule elongated but narrow; umbo slightly prosogyrous, submesial; hinge-composed of two small cardinal teeth in each valve having an isolated anterior lateral tooth; ventral margin smooth; surface smooth but for growth-lines. It seems to belong to the Superfamily Lucinaceae, but, so far as I am aware, there is no generic name suitable for this form.

Occurrence: —Rare in *Cardinia toriyamai* bed at Higashinagano (Loc. 5).

References

Many references cited in the preceding paper (HAYAMI, 1958e, pp. 127-130) and only in the synonymies are omitted here.

D'ARCHIAC, A. (1842), Description géologique de départment de l'Aisne. *Mém. Soc. géol. France, Sér. 1, Tom. 5.*

ARKELL, W. J. (1926), Studies in the Corallian Lamellibranch Fauna of Oxford, Berks, and Wilts. 1. Limidae. *Geol. Mag., Vol. 63, No. 5.*

——— (1929-1937), A Monograph of British Corallian Lamellibranchia. *Palaeontogr. Soc. London.*

——— (1930), The generic Position and Phylogeny of some Jurassic Arcidae. *Geol. Mag., Vol. 67, Nos. 7 and 8.*

——— (1933), The Jurassic System in Great Britain. *Oxford.*

——— (1956), Jurassic Geology of the World. *Edinburgh.*

BAYLE, M. M. and COQUAND, H. (1850), Mémoire sur les Fossiles secondaires recueillis dans le Chili. *Mém. Soc. géol. France, Sér. 2, Tom. 4.*

BENECKE, E. W. (1905), Die Versteinerungen der Eisenerzformation von Deutsch-Lothringen und Luxemburg. *Abhandl. geol. Spezialk. Elsass-Lothr., N. F., Heft 6.*

BERINI, L. (1957), Studi paleontologici sul Lias del Monte Albenza (Bergamo). Lamellibranchi e gastropoi del Lias inferiore. *Ist. Geol. Pal. Geogr. Univ. Milano, Ser. P, No. 92.*

BITTNER, A. (1895), Lamellibranchiaten der alpinen Trias. *Abhandl. geol. Reichsanst., Bd. 18, Heft 1.*

——— (1901), Lamellibranchiaten aus der Trias des Bakonyerwaldes. *Result. wissensch. Erforsch. Balatonsees, Bd. 1, Teil 1.*

BODEN, K. (1911), Die Fauna des Unteren Oxford von Popilany in Lithauen. *Geol. u. Pal. Abhandl. Jena, N. F., Bd. 10.*

BRANSON, C. (1942), *Paralleloden, Grammatodon,* and *Beushausenia* (=*Cosmetodon,* new name). *Jour. Pal., Vol. 16, No. 2.*

CHAVAN, A. (1937–1938), Essai critique de Classification dés Lucines. I–IV. *Jour. Conchyl., Vol. 81–82.*

——— (1945), Les Lamellibranches hétérodontes des sables Astartiens de Cordebugle (Calvados). *Ibid., Vol. 86.*

COSSMANN, M. (1897), Revue critique Paléozoologie, 1. *Paris.*

——— (1925), Sur quelques pélécypodes du Jurassique français. *Bull. Soc. géol. France, Sér. 4, Tom. 24.*

COX, L. R. (1930), On British Fossils named by William SMITH. *Ann. Mag. Nat. Hist., Ser. 10, Vol. 6.*

——— (1935), Jurassic Gastropoda and Lamellibranchia. *The Mesozoic Palaeontology of British Somaliland.*

——— (1936), The Gastropoda and Lamellibranchia of the Green Ammonite Beds of Dorset. *Quart. Geol. Soc. London, Vol. 92, Pt. 4.*

——— (1937), Notes on Jurassic Lamellibranchia. II. On *Indogrammatodon*, a new Subgenus from the Jurassic of the Indo-African Province. *Proc. Malacol. Soc. London, Vol. 22, Pt. 4.*

——— (1940), The Jurassic Lamellibranch Fauna of Kuchh (Cutch). *Pal. Indica, Ser. 9, Vol. 3, Pt. 3.*

——— (1941), Notes on Jurassic Lamellibranchia. VII. On the Identity of *Echinotis* MARWICK with *Meleagrinella* WHITFIELD. *Proc. Malacol. Soc. London, Vol. 24.*

——— (1943), The English Upper Lias and Inferior Oolite Species of *Lima*. *Ibid., Vol. 25, Pts. 5–6.*

——— (1944), On *Pseudolimea* ARKELL. *Ibid., Vol. 26, Pts. 2–3.*

——— (1952), The Jurassic Lamellibranch Fauna of Cutch (Kachh). *Pal. Indica, Ser. 9, Vol. 3, Pt. 4.*

——— and ARKELL, W. J. (1948, 1950), A Survey of the Mollusca of the British Oolite Series. Pts. 1 and 2. *Palaeontogr. Soc. London.*

DECHASEAUX, C. (1936 a), Pectinidés jurassiques de l'Est du Bassin de Paris. *Ann. Paléont., Tom. 25.*

——— (1936 b), Limidés jurassiques de l'Est du Bassin de Paris. *Mém. Mus. roy. d'Hist. nat. Belgique, Sér. 2, Fasc. 8.*

——— (1938), *Oxytoma* jurassiques de Lorraine. *Jour. Conchyl., Vol. 82.*

DIENER, C. (1925), Leitfossilien der Trias. *Berlin.*

DOUGLAS, J. A. and ARKELL, W. J. (1932), The stratigraphical Distribution of Cornbrash: II. The Northeastern Area. *Quart. Jour. Geol. Soc. London, Vol. 88.*

DOUVILLÉ, H. (1912), Classification des Lamellibranches. *Bull. Soc. géol. France, Sér. 4, Tom. 12.*

DUBAR, G. (1948), La Faune domérienne du Djebel Bou-dahar. *Notes et Mém. Serv. géol. Maroc, No. 68.*

DUMORTIER, E. (1874), Études paléontologique sur les Dépots jurassiques du Bassin du Rhône. IV. Lias supérieur. *Paris.*

ERNST, W. (1923), Zur Stratigraphie und Fauna des Lias him nordwestlichen Deutschland. *Palaeontogr., Bd. 65.*

FISCHER, P. (1887), Manuel de Conchyliologie. *Paris.*

FREBOLD, H. (1957), The Jurassic Fernie Group in the Canadian Rocky Mountains and Foothills. *Geol. Surv. Canada, Mem. 287.*

FRECH, F. (1907), Die Leitfossilien der Werfener Schichten und Nachträge zur Fauna des Muscherkalkes, der Cassianer und Raibler Schichten sowie des Rhaet und des Dachsteinkalk (Haupt Dolomit). *Result. wissensch. Erforsch. Balatonsees, Pal. Bd. 1, Teil 1.*

FRENEIX, S. (1958), Contribution à l'Etude des Lamellibranches du Crétacé de Nouvelle-Calédonie. *Sci. de la Terre, Tom. 4, Nos. 3–4.*

GARDET, G. and GÉRARD, C, (1946), Contribution l'Etude paléontologique du Moyen-Atlas septentrional. Lias inférieur—Bathonien. *Notes et Mém. Serv. Maroc, No. 64.*

GOTTSCHE, C. (1878), Ueber jurassische Versteinerungen aus der argentinischen Cordillere. *Palaeontogr., Supple. 3, Lief. 2. Abt. 3.*

GREPPIN, E. (1898–1900), Description des Fossiles du Bajocien supérieur des Environs de Bâle. *Mém. Soc. pal. Suisse, Vols. 25–27.*

HABE, T. (1951–1953), Genera of Japanese Shells. Pelecypoda and Scaphopoda. (in Japanese)

HAYAMI, I. (1957a), Liassic *Bakevellia* in Japan. *Japan. Jour. Geol. Geogr., Vol. 28, Nos. 1–3.*

——— (1957b), Liassic *Gervillia* and *Isognomon* in Japan. *Ibid., loc. cit.*

——— (1957c), On the Occurrence of *Cardinioides* from thi Liassic Kuruma Group in Central Japan. *Trans. Proc. Pal. Soc. Japan, N. S., No. 26.*

——— (1957d), *Radulonectites*, a new Pectinid Genus, from the Liassic Kuruma Group in Central Japan. *Ibid., N. S., No. 27.*

——— (1957e), Liassic *Chlamys*, "*Camptonectes*" and other Pectinids from the Kuruma Group in Central Japan. *Ibid., N. S., No. 28.*

——— (1958a), Liassic *Volsella, Mytilus* and some other Dysodont Species in Japan. *Ibid., N. S., No. 29.*

——— (1958b), A Review on the so-called Liassic "Cyrenoids" in Japan. *Japan. Jour. Geogr., Vol. 29, Nos. 1–3.*

——— (1958c), Some Hettangian Pelecypods from the "*Trigonia*-sandstone" of the Shizukawa Group in Northeast Japan. *Ibid., loc. cit.*

——— (1958d), Supplementary Descriptions of the Liassic Pelecypods in Japan. *Trans. Proc. Pal. Soc. Japan, N. S., No. 30.*

——— (1958e), Taxonomic Notes on *Cardinia* with Description of a new Species from the Lias of Western Japan. *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 11, Pt. 2.*

——— (1959a), Pelecypods of the Mizunuma Jurassic in Miyagi Prefecture with some stratigraphical Remarks. *Trans. Proc. Pal. Soc. Japan, N. S., No. 34.*

——— (1959b), Bajocian Pelecypods of the Aratozaki Formation in Northeast Japan. *Japan. Jour. Geol. Geogr., Vol. 30,* in press.

——— (1959c), Late Jurassic Isodont, Myacid and other Pelecypods from Makito Area in Central Japan. *Ibid., in press.*

HEALEY, M. (1908), The Fauna of the Napeng Beds or the Rhaetic Beds of Upper Burma. *Pal. Indica, N. S., Vol. 2, Mem., No. 4.*

ICHIKAWA, K. (1954), Late Triassic Pelecypods from the Kochigatani Group in the Sakuradani and Kito Areas, Tokushima Prefecture, Shikoku, Japan. Part 1. *Jour. Inst. Polytec. Osaka City Univ., Ser. G, Vol. 1.*

——— (1958), Zur Taxionomie und Phylogenie der Triadischen "Pteriidae" (Lamellibranch.) mit besondere Berücksichtigung der Gattungen *Claraia, Eumorphotis, Oxytoma* und *Monotis*. *Palaeontogr., Bd. 111, Abt. A.*

JAWORSKI, E. (1929), Eine Lias-Fauna aus Nordwest Mexico. *Mém. Soc. Pal. Suisse, Vol. 48.*

KIMURA, T. (1951), Some Pectinids and a Limid from the Jurassic Torinosu Group in Japan. *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 7, Pts. 6–10.*

——— (1956), Some Pelecypods from the Upper Jurassic Torinosu Group in Kochi Prefecture, Japan. *Jour. Earth Sci. Nagoya Univ., Vol. 4. No. 2.*

KIPARISOVA, L. D. (1952), New Lower Jurassic Fauna near Amur. *Trans. All Soviet Union Sci. Geol. Inst.* (in Russian)

——— (1954), Field illustrated Atlas of characteristic Flora and Fauna of Triassic Period in Maritime Province. (in Russian)

KOBAYASHI, T. (1926), Note on the Mesozoic Formation in Province of Nagato, Chugoku, Japan. *Jour. Geol. Soc. Tokyo, Vol. 33.* (in Japanese)

——— (1935a), Contribution to the Mesozoic Faunas in Japan. *Ibid., Vol. 42.* (in Japanese)

——— (1935b), the geological Structure of Southwestern Japan and its Mesozoic Palaeogeography. *Ibid., Vol. 42.* (in Japanese)

——— (1941), The Sakawa Orogenic Cycle and its Bearing on the Origin of the Japanese

Island. *Jour. Fac. Sci Imp. Univ. Tokyo, Sec. 2, Vol. 5, No. 7.*

——— and ICHIKAWA, K. (1949), *Tosapecten* gen. nov. and other Upper Triassic Pectinidae from the Sakawa Basin in Shikoku, Japan. *Japan. Jour. Geol. Geogr., Vol. 21, Nos. 1-4.*

——— and ——— (1950), On the Upper Triassic Kochigatani Series in Sakawa Basin and its Pelecypod Faunas. *Jour. Fac. Sci. Univ. Tokyo, Ser. 2, Vol. 7, Pts. 3-5.*

——— (1950), Chugoku District in Regional Geology of Japan. *Tokyo.* (in Japanese)

———, KONISHI, K., SATO, T., HAYAMI, I. and TOKUYAMA, A. (1957), On the Lower Jurassic Kuruma Group. *Jour. Geol. Soc. Japan, Vol. 63.* (in Japanese)

——— and MORI, K. (1954), Studies on the Jurassic Trigonians in Japan. Part 2. *Prosogyrotrigonia* and the Trigoniinae. *Japan. Jour. Geol. Geogr., Vol. 25, Nos. 3-4.*

——— and ——— (1955), Op. cit. Part 3. The Vaugoniinae from the Kitakami Mountains in North Japan. *Ibid., Vol. 26, Nos. 1-2.*

KONISHI, K. (1954), Yamaoku Formation (A Jurassic Deposit recently discovered in Okayama Prefecture). *Jour. Geol. Soc. Japan, Vol. 60.* (in Japanese)

KRUMBECK, L. (1905), Die Brachiopoden- und Mollusken-Fauna des Glandarienkalkes. *Beitr. Pal. u. Geol. Oesterr.-Ungarn Orients, Bd. 18.*

——— (1923), Zur Kenntnis des Juras der Insel Timor sowie des Aucellen-Horizontes von Seran und Buru. *Pal. Timor, Lief. 12.*

——— (1924), Die Brachiopoden, Lamellibranchiaten und Gastropoden der Trias von Timor. II. *Ibid., Lief. 13.*

KUHN, O. (1936), Die Fauna des Amalthcentons (Lias delta) in Franken. *Neues Jahrb. f. Min. usw., Beil.-bd. 75 B.*

LAUBE, G. C. (1867), Die Bivalven des Braunen Jura von Balin. *Wien.*

LYCETT, J. (1863), Supplementary Monograph on the Mollusca from the Stonesfield Slate, Great Oolite, Forest Marble, and Cornbrash. *Palaeontogr. Soc. London.*

MARWICK, J. (1935), Some new Genera of the Myalinidae and Pteriidae of New Zealand. *Trans. Roy. Soc. New Zealand, Vol. 65.*

MATSUMOTO, T. (1956), Yebisites, a new Jurassic Ammonite from Japan. *Trans. Proc. Pal. Soc. Japan, N. S., No. 23.*

MEEK, F. B. (1864), Check List of the Invertebrate Fossils of North America. Cretaceous and Jurassic. *Smithsonian Misc. Coll., No. 177.*

——— (1876), A Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country. *U. S. Geol. Surv. Terr.* (HAYDEN), *Rep. 9.*

MORET, L. (1958), Etude paléontologique de Gisements remarquables du Lias inférieur du Massif du Grand-Serre, près Grenoble. *Trav. Lab. Geol. Fac. Sci. Grenoble, Tom. 34.*

MORI, K. (1949), On the Jurassic Formations in the Hashiura District, Province of Rikuzen, Japan. *Japan. Jour. Geol. Geogr., Vol 21.*

MORRIS, J. and LYCETT, J. (1853), A Monograph of the Mollusca from the Great Oolite, chiefly from Minchinhampton and the Coast of Yorkshire. Part 2. Bivalves. *Palaeontogr. Soc. London.*

NEWELL, N. D. (1938), Late Paleozoic Pelecypods: Pectinacea. *Publ. Univ. Kansas, Vol. 10.*

NICOL, D. (1950), Recent Species of the lucinoid Pelecypod *Fimbria*. *Jour. Washington Acad. Sci., Vol. 40, No. 3.*

——— (1954), Nomenclatural Review of Genera and Subgenera of Cucullaeidae. *Jour. Pal., Vol. 28, No. 1.*

OYAMA, K. (1943), Conchologia Asiatica. Vol. 1, Pars 1. Familia Limidae. *Tokyo.* (in Japanese)

PHILIPPI, E. (1900 a), Beiträge zur Morphologie und Phylogenie der Lamellibranchier. II. Zur Stammesgeschichte der Pectiniden. *Zeit. deut. geol. Gesell., Bd. 52.*

——— (1900 b), Op. cit. III. *Lima* und ihre Untergattungen. *Ibid., Bd. 52.*

POMPECKJ, J. F. (1901), Ueber Aucellen und Aucellen-ähnlich Formen. *Neues Jahrb. f. Min. usw., Beil-Bd. 14.*

QUENSTEDT, F. A. (1852), Handbuch der Petrefactenkunde. *Tübingen.*

QUENSTEDT, W. (1930), Die Anpassung an die grabende Lebenweise in der Geschichte der Solenomyiden und Nuculaceen. *Geol. u. Pal. Abhandl., N. S., Bd. 18.*

ROLLIER, L. (1911-1918), Fossiles nouveaux ou peu connus des Terrains secondaires (Mésozoiques) du Jura et des contrées environnants. *Mém. Soc. pal. Suisse, Vols. 37-42.*

ROMAN, F. (1921) in RICHE and ROMAN, La Montagne de Crussol. Étude stratigraphique et paléontologique. *Trav. Labor. géol. Fac. Sci. Lyon, N. S., Fasc. 1.*

SATO, T. (1955), Les Ammonites recueillies dans le groupe de Kuruma, Nord du Japon central. *Trans. Proc. Pal. Soc. Japan, N. S., No. 20.*

——— (1956), Corrélation du Jurassique inférieur Japonais en basant sur les Ammonites Fossiles. *Jour. Geol. Soc. Japan, Vol. 62.* (in Japanese)

——— (1957), Biostratigraphie de la Série de Shizukawa (Jurassique inférieur) du Japon septentrional. *Jour. Fac. Sci. Univ. Tokyo, Sec. 2, Vol. 10, Pt. 3.*

SCHENCK, H. G. (1934), Classification of nuculid Pelecypods. *Mus. roy. d'Hist. nat. Belgique, Tom. 10, No. 20.*

SCHMIDTILL, E. (1926), Zur Stratigraphie und Faunenkunde des Doggersandsteins in nordlichen Frankenjura. *Palaeontogr., Bde. 67-68.*

STAESCHE, K. (1926), Die Pectiniden des schwäbischen Jura. *Geol. u. Pal. Abhandl., N. S., Bd. 15.*

STOLICZKA, F. (1870-1871), Cretaceous Fauna of Southern India, Vol. 3. Pelecypoda. *Pal. Indica, Ser. 6, Vol. 3.*

TAMURA, M. (1959 a), Trigoniidae, Ostreidae, Bakevelliidae, Pteriidae, Cardiidae and Astartidae from the Upper Jurassic Sakamoto Formation in Central Kyushu, Japan. *Trans. Proc. Pal. Soc. Japan, N, S., No. 33.*

——— (1959 b), Taxodonta and Isodonta from the Upper Jurassic Sakamoto Formation in Central Kyushu, Japan. *Ibid., N. S., No. 34.*

TATE, R. (1870). On the Palaeontology of the Junction Beds of the Lower and Middle Lias in Glaucestershire. *Quart. Jour. Geol. Soc. London, Vol. 26.*

THEVENIN, A. (1908), Paléontologie de Madagascar. V. Fossiles liasiques. *Ann. Paleont., Tom. 3, Fasc. 3.*

THIELE, J. (1934-1935), Handbuch der systematischen Weichtierkunde. Bd. 2. *Jena.*

TILMANN, N. (1917), Die Fauna des Unteren Lias in Nord- und Mittel-Peru. *Neues Jahrb. f. Min. usw., Beil.-Bd. 41.*

TONI, A. DE (1912), La Fauna liasica di Vedana. 2. Molluschi. *Mém. Soc. pal. Suisse, Vol. 38.*

TRECHMANN, C. T. (1918), The Trias of New Zealand. *Quart. Jour. Geol. Soc. London, Vol. 73.*

——— (1923), The Jurassic Rocks of New Zealand. *Ibid., Vol. 79.*

WAAGEN, L. (1901), Der Formenkreis des *Oxytoma inaequivalvis* SOWERBY. *Jahrb. d. k. k. geol. Reichsanst., Bd. 51.*

WARREN, P. S., (1932), A Lower Jurassic Fauna from Fernie, British Columbia. *Trans. Roy. Soc. Canada. Ser. 3, Vol. 25, Sec. 4.*

WHITFIELD, R. P. (1885), Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. *Mon. U. S. Geol. Surv., Vol. 9.*

WILCKENS, O. (1927), Contributions to the Palaeontology of the New Zealand Trias. *N. Z. Geol. Surv., Pal. Bull., No. 12.*

WILDBORNE, G. F. (1883), Notes on some Fossils, chiefly Mollusca, from the Inferior Oolite. *Quart. Jour. Geol. Soc. London, Vol. 39.*

WOODS, H. (1899-1913), A Monograph of the Cretaceous Lamellibranchiata of England. *Palaeontogr. Soc. London.*

YABE, H. and EGUCHI, M. (1933), *Anabacia cyclitoides*, sp. nov. from Japan with Remarks on the Genus *Anabacia*. *Japan. Jour. Geol. Geogr., Vol. 10.*

YEHARA, S. (1921), On some new Species of *Trigonia* from the Lias of Prov. Nagato and the Cretaceous of Prov. Awa. *Jour. Geol. Soc. Tokyo, Vol. 28.*

——— (1931), Trigoniae in Japan. *Iwanami Lecture Series. Geology and Palaeontology.*

(in Japanese)
YOKOYAMA, M. (1904 a), Jurassic Ammonites from Echizen and Nagato. *Jour. Coll. Imp. Univ. Tokyo, Vol. 19, Art. 20.*
——— (1904 b), On some Jurassic Fossils from Rikuzen. *Ibid., Vol. 18, Art. 6.*
ZITTEL, K. VON (1881–1885), Handbuch der Palaeontologie. I. Abtheilung Palaeozoologie. Bd. 2. *München and Leipzig.*

I. HAYAMI

Lower Liassic Lamellibranch Fauna of the Higashinagano Formation in West Japan

Plate V

Explanation of Plate V

Nuculopsis (*Palaeonucula*) sp. indet. ....p. 40

Fig. 1. Right internal mould (MM 3350), ×3, Loc. 5.

Nuculana (*Dacryomya*) *toriyamae* HAYAMI, n. sp, ...p. 41

Fig. 2. Left internal mould (MM 3353), paratype, ×2, Loc. 5.

Fig. 3. Clay cast of left external mould (MM 3352), holotype, ×2. Loc. 8. (TORIYAMA coll.)

Parallelodon infraliassicus HAYAMI, n. sp. ....p. 42

Fig. 4. Left internal mould (MM 3355), paratype, ×1, Loc. 5.

Fig. 5. Fift internal mould (MM 3356), paratype, ×1.5, Loc. 5.

Fig. 6. Left internal mould (MM 3357), paratype, ×2, Loc. 5.

Parallelodon cf. *infraliassicus* HAYAMI ....p. 43

Figs. 7 a, b. Gypsum cast of right external mould and internal mould of the same specimen (MM 3359), ×1.5, Loc. 5.

Parallelodon (?) *subnavicellus* HAYAMI, n. sp. ....p. 44

Figs. 8 a, b. Right internal mould and clay cast of external mould of the same specimen (MM 3360), holotype, ×1, Loc. 5.

Grammatodon toyorensis HAYAMI, n. sp. ....p. 45

Fig. 9. Left internal mould (MM 3361), holotype, ×2, Loc. 5.

Fig. 10. Left internal mould (MM 3362), paratype, ×2, Loc. 5.

Fig. 11. Left internal mould, exhibiting the dentition (MM 3364), ×2, Loc. 5.

Fig. 12. Clay cast of left external mould (MM 3363), paratype, ×2, Loc. 5.

Modiolus magatama HAYAMI, n. sp. ....p. 46

Fig. 13. Left valve (MM 3366), holotype, ×2, Loc. 3.

Oxytoma cf. *cygnipes* (YOUNG and BIRD) ....p. 48

Fig. 14. Left external mould (MM 3371) and internal mould of *Rimirhynchia* sp., ×1. Loc. 5.

Oxytoma kobayashii HAYAMI, n. sp. ....p. 49

Fig. 15. Left internal mould (MM 3372), holotype, ×2, Loc. 9.

Fig. 16. Left valve (MM 3373), paratype, ×2. Loc. 9. (KOBAYASHI coll.)

Fig. 17. Right internal mould (MM 3374), paratype, ×2. Loc. 9.

Oxytoma inequivalve (SOWERBY) ....p. 50

Fig. 18. Left valve (MM 3376), ×2, Loc. 4.

Fig. 19. Left valve (MM 3375), ×2, Loc. 9.

Meleagrinella japonica HAYAMI, n. sp. ....p. 47

Fig. 20. Right internal mould (MM 3370), paratype, ×2, Loc. 8.

Fig. 21 a, b. Left internal mould and clay cast of the same external mould (MM 3368), holotype, ×2, Loc. 8.

Fig. 22. Left internal mould (MM 3369), paratype, ×2, Loc. 3.

Chlamys textoria (GOLDFUSS) ....p. 52

Figs. 23 a–c. Internal and external moulds of right valve (MM 3379) and gypsum cast of the latter, ×1.2, Loc. 5.

Fig. 24. Internal mould of right valve (MM 3383), ×1.5, Loc. 5.

Fig. 25. Gypsum cast of right external mould (MM 3380), ×1.5, Loc. 5.

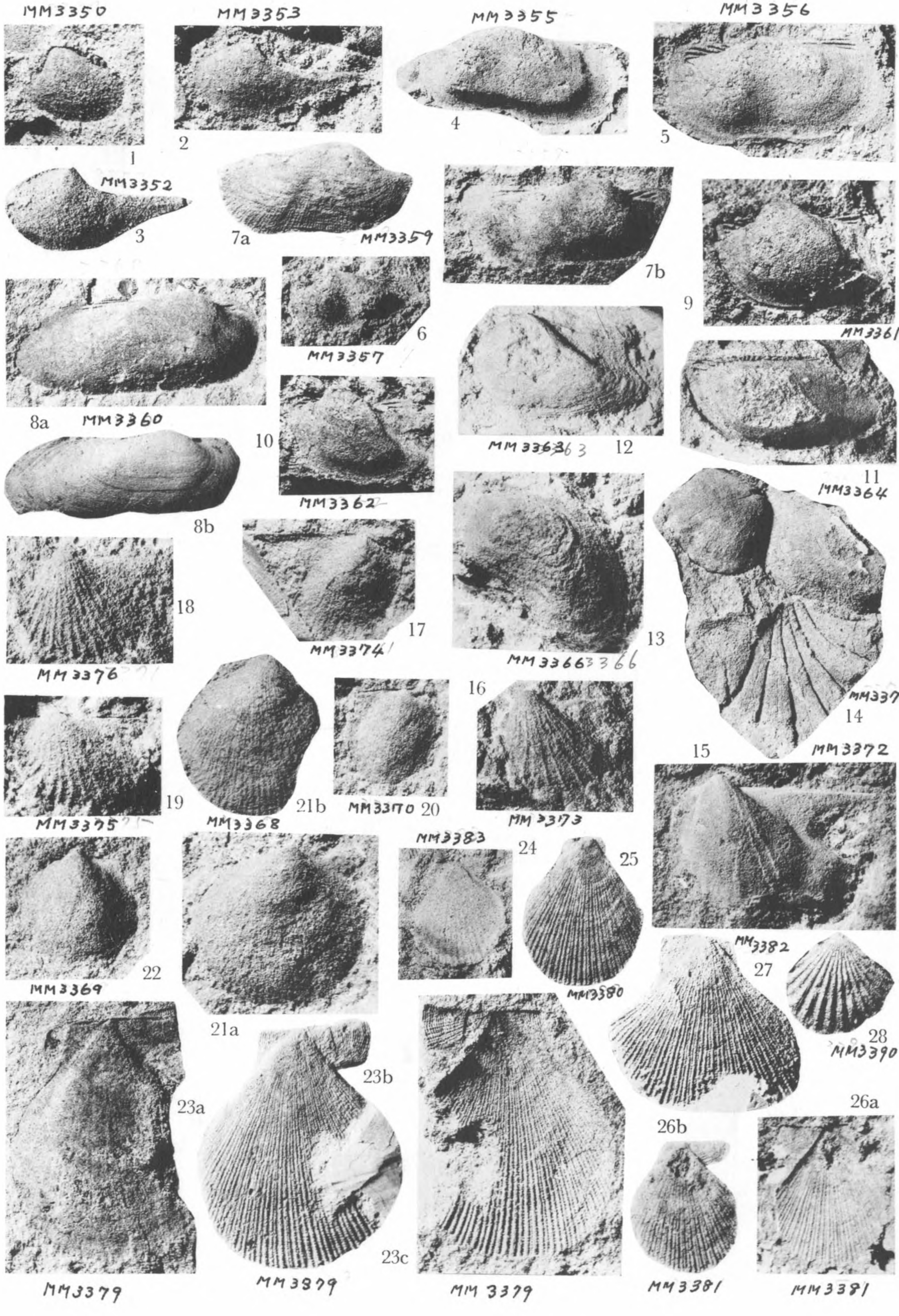
Figs. 26 a, b. Right external mould (MM 3318) and its gypsum cast, ×1.5, Loc. 5.

Fig. 27. Gypsum cast of left external mould (MM 3382), ×1.2, Loc. 3.

"*Aequipecten*" sp. indet. ....p. 57

Fig. 28. Gypsum cast of right (?) external mould (MM 3390), ×1, Loc. 5.

All specimens illustrated here are kept in the Geological Institute, University of Tokyo.


MM3350
1
MM3353
2
MM3355
4
MM3356
5
MM3352
3
7a
MM3359
7b
9
MM3361
6
MM3357
8a
MM3360
8b
10
MM3362
12
11
MM3364
18
MM3376
17
MM3374
13
MM3366
14
MM3371
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MM3372
19
MM3375
21b
MM3368
MM3370
20
16
MM3373
22
MM3369
21a
MM3383
24
25
MM3380
MM3382
27
28
MM3390
23a
23b
23c
MM3379
MM3379
MM 3379
26a
26b
MM3381
MM3381

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Plate VI

Explanation of Plate VI

"*Aequipecten*" *toyorensis* HAYAMI, n. sp. .... p. 55

Figs. 1a, b. Right internal mould and gypsum cast of the same external mould (MM 3384), holotype, ×2, Loc. 5.

Fig. 2. Clay cast of left external mould (MM 3385), paratype, ×2, Loc. 5.

Fig. 3. Right internal mould (MM 3386) paratype, ×2, Loc. 5.

Fig.4. Right internal mould (MM 3388), ×1, Loc. 6, 7

Fig. 5. Juvenile right internal mould (MM 338[illegible]), paratype, ×2, Loc. 5.

Entolium cf. *calvum* (GOLDFUSS) .... p. 57

Figs. 6a, b. Left internal mould and clay cast of the same external mould (MM 3392), ×1.5, Loc. 5.

Fig. 7. Right internal mould (MM3391), ×1.2, Loc. 5.

Fig. 8. Fragmental right internal mould (MM 3393), ×1.2, Loc. 3.

Fig. 9. Left internal mould (MM 339[illegible]), ×1.2, Loc. 3.

Entolium sp. indet. .... p. 60

Fig. 10. Right internal mould (MM 3398), ×1.5, Loc. 9. (KOBAYASHI coll.)

Entolium cf. *lunare* (ROEMER) .... p. 59

Fig. 11. Left internal mould (MM 3396), ×1, Loc. 3.

Entolium (?) sp. indet. .... p. 60

Fig. 12. Left internal mould (MM 3399), ×1.5, Loc. 5.

Fig. 13. Clay cast of left external mould (MM 3400), ×1.5, Loc. 5.

Plicatula subcircularis HAYAMI, n. sp. .... p. 60

Fig. 14. Left internal mould (MM 3401), holotype, ×1, Loc. 5.

Fig. 15. Clay cast of left external mould (MM 3402), paratype, ×1.2, Loc. 5.

Fig. 16. Right internal mould (MM 3403), ×1, Loc. 5.

Plicatula praenipponica HAYAMI, n. sp. .... p. 61

Fig. 17. Left internal mould (MM 3407), paratype, ×1, Loc. 5.

Fig. 18. Clay cast of left external mould (MM 3409), ×1, Loc. 5.

Figs. 19a, b. Left internal mould and gypsum cast of the same external mould (MM 3406), holotype, ×1.2, Loc. 5.

"*Lima*" sp. indet. .... p. 62

Fig. 20. Left valve (MM 3410), ×2, Loc. 9. (KOBAYASHI coll.)

Plagiostoma kobayashii HAYAMI, n. sp. .... p. 63

Fig. 21a. Gypsum cast of right external mould (MM 3411), holotype, ×1, Loc. 5.

Fig. 21b. Postero-dorsal part of the same specimen, ×3.

Fig. 22. Gypsum cast of right external mould (MM 3413), ×1, Loc. 5.

Fig. 23. Right internal mould (MM 3412), paratype, ×1, Loc. 5.

Plagiostoma matsumotoi HAYAMI, n. sp. .... p. 64

Fig. 24. Right internal mould (MM 3417), paratype, ×1, Loc. 5.

Fig. 25. Left intarnal mould (MM 3414), holotype, ×1, Loc. 3.

Plagiostoma sp. indet. .... p. 65

Fig. 26. Right valve (MM 3420), ×1.5, Loc. 9. (KOBAYASHI coll.)

Ctenostreon sp. indet. .... p. 68

Fig. 27. Clay cast of right external mould (MM 3427), ×1, Loc. 5.

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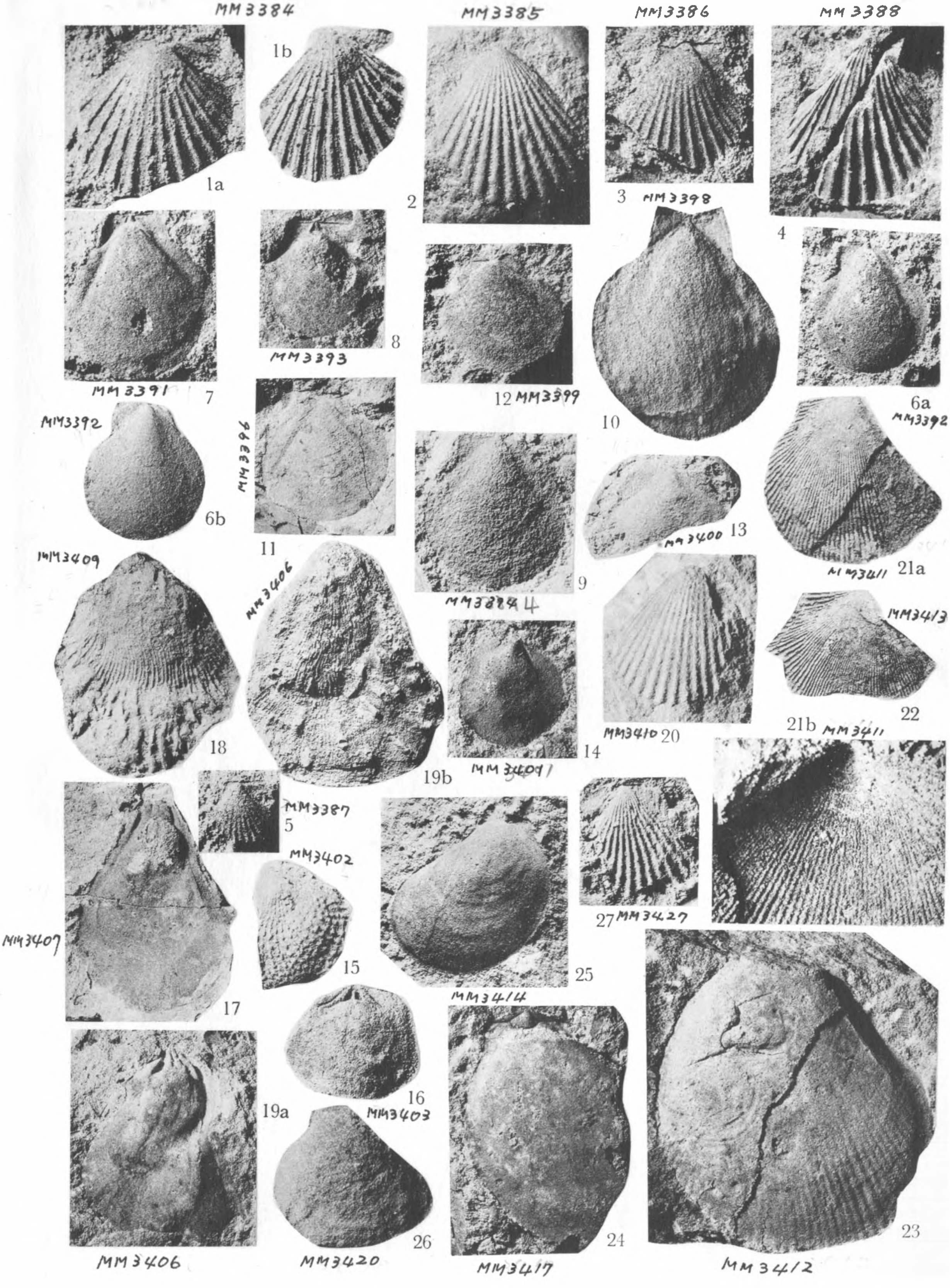

MM3384
1a
1b
MM3385
2
MM3386
3
MM3388
4
MM3398
10
MM3391
7
MM3393
8
12 MM3399
6a
MM3392
6b
MM3396
11
9
MM3400 13
MM3392
MM3411 21a
MM3409
18
MM3406
19b
14
MM3410 20
MM3413
22
21b MM3411
MM3387
5
MM3402
15
MM3407
17
25
MM3414
27 MM3427
16
MM3403
19a
26
24
23
MM3406
MM3420
MM3417
MM3412

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Plate VII

Explanation of Plate VII

Plagiostoma matsumotoi HAYAMI, n. sp. ....p. 64

Fig. 1. Right internal mould (MM 3416), paratype, ×1, Loc. 5.

Fig. 2. Gypsum cast of left external mould (MM 3415), paratype, ×1, Loc. 5.

Fig. 3. Postero-dorsal part of left external mould (MM 3418), ×3, Loc. 5.

Antiquilima nagatoensis HAYAMI, n. sp..p. 66

Figs. 4a, b. Left internal mould and gypsum cast of the same external mould (MM 3421), holotype, ×1, Loc. 5.

Fig. 4c. Postero-ventral part of the same specimen, ×3, Loc. 5.

Ctenostreon japonicum HAYAMI, n. sp. ....p. 67

Figs. 5a, b. Right internal mould and gypsum cast of the same external mould (MM 3424), holotype, ×1, Loc. 5.

Fig. 6. Gypsum cast of right external mould (MM 3425), paratype, ×1, Loc. 5.

Liostrea toyorensis HAYAMI, n. sp. ....p. 68

Fig. 7. Left internal mould (MM 3428), holotype, ×1, Loc. 5.

Fig. 8. Right internal mould (MM 3430), paratype, ×1, Loc. 5.

Lopha sazanami HAYAMI, n. sp. ....p. 69

Fig. 9. Right internal mould (MM 3431), paratype, ×1, Loc. 5.

Fig. 10. Right external mould (MM 3433), paratype, ×1, Loc. 5.

Fig. 11. Gypsum cast of right external mould (MM 3432), holotype, ×1, Loc. 5.

Prosogyrotrigonia inouyei (YEHARA)..p. 70

Fig. 12. Clay cast of left external mould (MM 3437), ×1, Loc. 3.

Fif. 13. Left internal mould (MM 3436), ×1.5, Loc. 5.

Fig. 14. Clay cast of left external mould (MM 3438), ×1.5, Loc. 3.

Praeconia cf. *tetragona* (TERQUEM) ....p. 71

Fig. 15. Left internal mould (MM 3444), ×1.5, Loc. 5.

Fig. 16. Right internal mould (MM 3445), ×1.5, Loc. 5.

Astarte a sp. indet..p. 73

Fig. 17. Right internal mould (MM 3447), ×3, Loc. 5.

Oxytoma inequivalve (SOWERBY) ....p. 50

Fig. 18. Right valve (MM 337[illegible]), ×2, Loc. 9.

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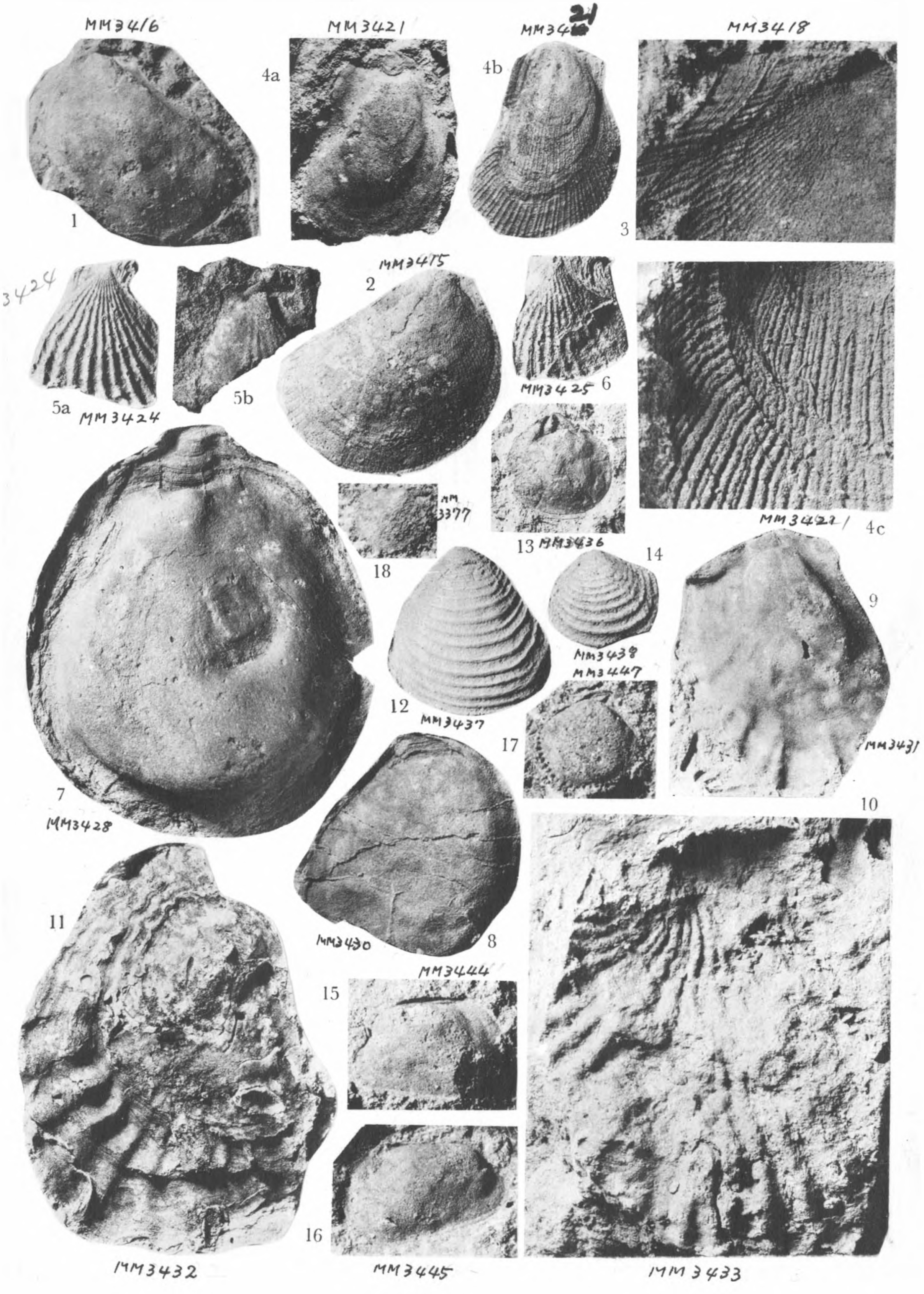
MM3416
1
MM3421
4a
4b
MM3418
3
MM3424
5a
5b
MM3415
2
MM3425
6
13 MM3436
MM3377
18
4c
14
MM3438
9
12
MM3437
MM3447
17
MM3431
10
7
MM3428
11
MM3430
8
MM3444
15
16
MM3432
MM3445
MM3433

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Plate VIII

Explanation of Plate VIII

Cardinia orientalis HAYAMI, n. sp. ....p. 70

Fig. 1. Right internal mould (MM 3439), holotype, ×1, Loc. 3.

Praeconia cf. *tetragona* (TERQUEM) ....p. 71

Fig. 2. Clay cast of left external mould (MM 3444), the same specimen as on Pl. III, fig. 15, ×2, Loc. 5.

Fig. 3. Left internal mould with impression of exterior of *Sphaeriola nipponica* (MM 3443), ×1, Loc. 5.

Fig. 4. Gypsum cast of fragmental mould of left valve (MM 3442), ×1, Loc. 5.

Astarte b sp. indet. ....p. 73

Figs. 5a, b. Left internal mould and clay cast of the same external mould (MM 3448), ×3, Loc. 5.

Lucina (s. l.) *hasei* HAYAMI, n. sp. ....p. 76

Fig. 6. Clay cast of right external mould (MM 3457), paratype, ×2. Loc. 5.

Figs. 7a, b. Left internal mould and clay cast of the same external mould (MM 3455), holotype, ×3, Loc. 1.

Fig. 8. Clay cast of right external mould (MM 3456), paratype, ×2, Loc. 5.

Fimbria sp. indet. ....p. 74

Fig. 9. Clay cast of external mould (MM 3449), ×2, Loc. 5.

Sphaeriola nipponica HAYAMI, n. sp. ....p. 74

Fig. 10. Gypsum cast of right internal mould (MM 3451), paratype, ×1, Loc. 5.

Fig. 11a, b. Left external mould and clay cast of the same specimen (MM 3452), paratype, ×1.2, Loc. 5.

Fig. 12a, b. Right internal mould and clay cast of the same specimen (MM 3450), holotype, ×1.2, Loc. 5.

Fig. 13. Clay cast of left external mould (MM 3453), paratype, ×1.2, Loc. 5

Cardium (s. l.) *naganoense* HAYAMI, n. sp. ....p. 77

Figs. 14a, b. Right internal mould and clay cast of the same external mould (MM 3461), holotype, ×1.2, Loc. 5.

Fig. 15. Left internal mould (MM 3462), paratype, ×1.2, Loc. 5.

Protocardia onoi HAYAMI, n. sp. ....p. 77

Fig. 16. Left internal mould (MM 3464), paratype, ×2, Loc. 5.

Fig. 17. Clay cast of left external mould (MM 3463), holotype, ×2, Loc. 5.

Fig. 18. Clay cast of left external mould (MM 3465), paratype, ×1.5, Loc. 5.

Pleuromya sp. indet. ....p. 78

Fig. 19. Left internal mould (MM 3467), ×2, Loc. 3.

Genus and species indet. b ....p. 79

Fig. 20. Right internal mould (MM 3468), ×1, Loc. 5.

Genus and species indet. a ....p. 78

Fig. 21. Right internal mould (MM 3469), ×1, Loc. 5.

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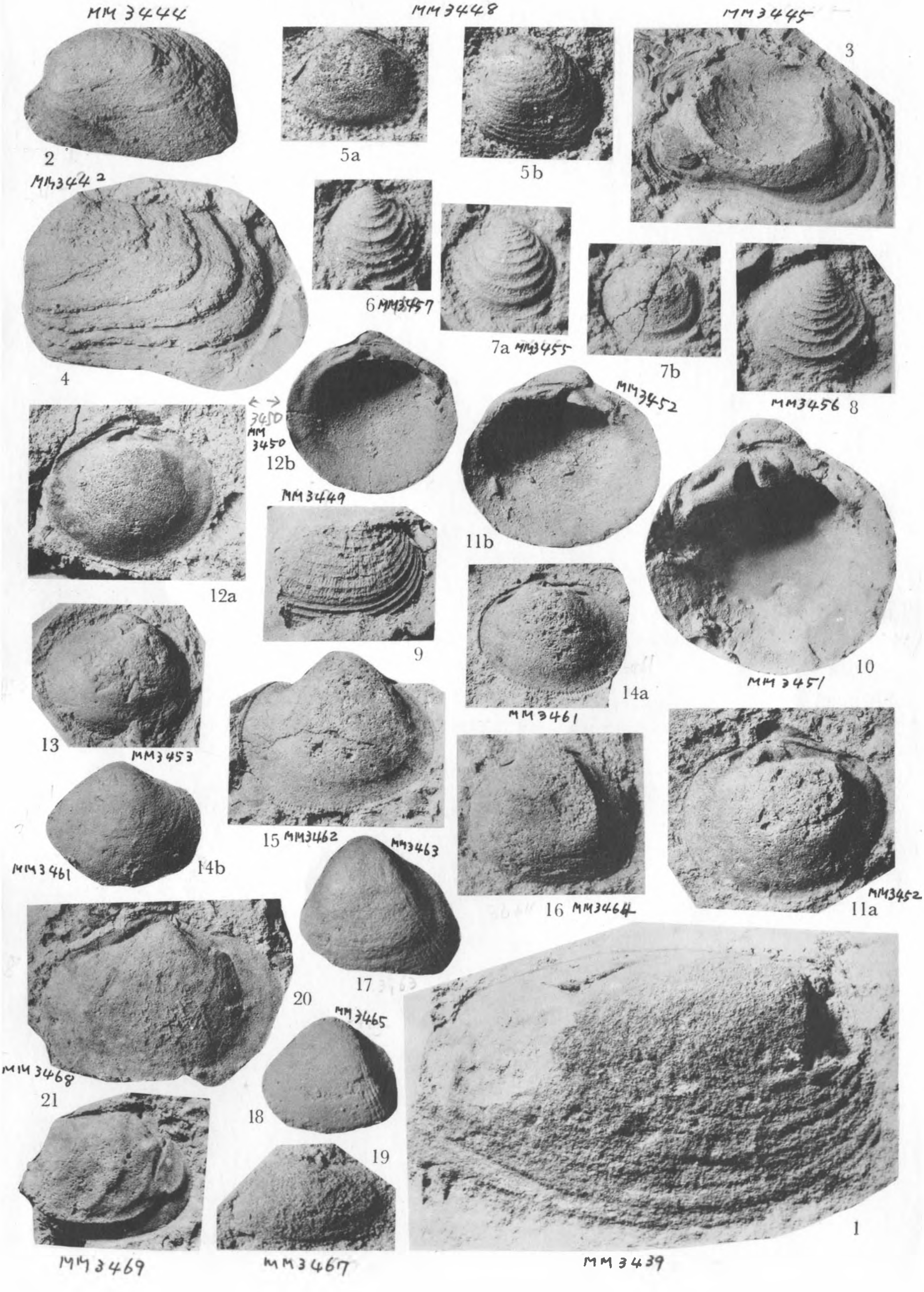
MM 3444
2
MM 3448
5a
5b
MM 3445
3
MM3442
4
6 MM3457
7a MM3455
7b
MM3456 8
12b
MM 3450
MM3452
11b
10
MM 3451
12a
MM3449
9
14a
MM3461
13
MM3453
15 MM3462
16 MM3464
11a
MM3452
MM3461
14b
MM3463
17
20
MM 3468
21
MM 3465
18
19
1
MM 3469
MM 3467
MM 3439