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Early and Middle Triassic Pelecypod-fossils from the Maizuru Zone, Southwest Japan

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Abstract

In the Eo-Triassic epoch, pelecypods played a leading role in the animal fossils of the Maizuru zone, while they were replaced by cephalopods in the transgressive, Meso-Triassic epoch. They amount to 40 species belonging to 15 families in total number, of which only four species are found in the Meso-Triassic. This article treats with the remaining fossils excluding the ones described before. The pelecypod-fauna in this zone has an intimate relation with that of the Ussuri province as formerly pointed out.

Introduction and Acknowledgement

The stratigraphy of the Triassic System in the Maizuru zone was summarized in detail by the writer and others (NAKAZAWA et al, 1958; NAKAZAWA, 1958). The paleontological studies concerning the Upper Triassic pelecypod-fossils were also completed (NAKAZAWA, 1952-56), but the majority of the Lower and Middle Triassic fossils were left undescribed except for *Eumorphotis* aff. *multiformis* (ex aff. var. *rudaecosta*), *Claraia pulchella*, *C. aff. decidens* (NAKAZAWA, 1953). The species of Myophoriidae and Bakevelliidae, which are the members that flourished most in this zone, were recently discussed in two separate papers together with the Permian species (NAKAZAWA, 1959 and 1960). This paper treats with the remaining members of the pelecypod-fossils.

As already discussed in detail in the stratigraphical part, the Lower Triassic deposits of the Maizuru zone are fairly changeable in lithofacies, and three sedimentary facies are recognized in it, that is, the coarse-, the medium-, and the fine-grained facies. The first facies is composed mainly of sandstones and conglomerates of more than 500 meters in thickness; the second one is composed of sandstones and shales of similar thickness, and the third constituted mostly by muddy rocks of lesser thickness. These three facies are arranged zonally from north to south suggesting the uplifting of high land to the north of the Maizuru zone during that time. The fossil-contents represented by pelecypods vary also in accordance with the lithofacies as will be stated briefly in the

following. The coarse-grained facies is characterized by *Neoschizodus-Bakevella* faunule abundant in *Neoschizodus* cf. *laevigatus* and *Bakevella kambei* wherever in the Maizuru zone. On the other hand, the fine-grained facies is marked by *Nuculana-Palaeoneilo* faunule constituted mainly of *Nuculana* spp. α , β , *Palaeoneilo* cf. *elliptica* in KIPARISOVA, *P.* cf. *oviformis* (ЕСК). The latter faunule is also found in the muddy rocks in the coarse-grained facies. Small form of *Neoschizodus* cf. *laevigatus* occurs in the fine-grained facies and *Bakevella kambei* is substituted by *B. okuyamensis* and *narawarensis* in that facies. The marked contrast between the two facies does not indicate a time difference but an environmental one. In the medium-grained facies, the fossil-contents vary locally in spite of the comparatively large number of species, among which "*Pecten*" *ussuricus*, *Pinna muikadaniensis* n. sp., *Nuculana nogamii yakunoensis* n. subsp., and *Mysidioptera circularis* n. sp. are relatively dominant.

It is a noticeable fact that the commonly found species throughout the Maizuru basin, which serve as zone-fossils applicable to the entire basin, occur through the Eo-Triassic epoch, and the Lower Triassic of this zone cannot be subdivided, but is represented by a single faunizone, *Neoschizodus-Bakevella* or *Nuculana-Palaeoneilo*. Nevertheless, *Leptochondria?* *okuyamensis* n. sp. and *Claraia* spp. are confined to the lower part, and *Nuculana nogamii* and *Pinna muikadaniensis* are most probably limited to the upper half in the Yakuno-Oe districts occupying the eastern half of the Maizuru basin. Accordingly the Lower Triassic may be subdivided into two subzones at least in these districts, represented respectively by such fossils as mentioned above. The accurate age of the subdivisions cannot be decided, because ammonoid fossils are only scarcely found, and furthermore, many of the pelecypods are specifically indeterminable as the specimens are considerably deformed secondarily. But the occurrence of *Meekoceras* sp., *Ophiceras* (?) sp., *Pseudosageceras* aff. *multilobatum*, and *Anakashimiritis* (?) sp. from the lower horizon and *Paratirolites* (?) sp. from the upper half suggest the early Eo-Triassic Indian and the late Eo-Triassic Olenekitan epoch (KIPARISOVA and POPOV, 1956) of the two subdivisions.

Succeeding the Lower Triassic strata, the shaly sediments of more than 400 meters in thickness make their appearance. Two faunizones, *Hollandites*-*Danubites* and *Monophyllites*, are distinguishable in them, corresponding to the early Anisian and the latest Anisian, respectively. Pelecypods in these zones are very scarce. They are *Propeamussium* (*Variamussium*) n. sp. and *Nuculopsis* (*Palaeonucula*) sp. of the lower zone, and *Nuculana nogamii* and *Dannella* (?) sp. of the *Monophyllites* zone.

The Maizuru zone has great resemblance to the Kitakami region, Northeast Japan in the lithofacies and in the fossil-assemblages as well. The Lower Triassic System in the two regions shows marked contrast with that of the outer zone of Central and West Japan, since the latter is composed mainly of thin limestone lenses containing *Eumorphotis multiformis*-*Pteria ussurica yabei* fauna. Outside Japan, the Maizuru faunules are intimately related to those of

the Ussuri province, suggesting direct communication between the two as deduced from the annexed table, although the alliance with those of the Himalayas cannot be neglected.

The writer wishes to express his cordial thanks to Prof. S. MATSUSHITA of University of Kyoto for his guidance throughout the present study, and to Messrs. T. SHIKI, D. SHIMIZU, and Y. NOGAMI for their cooperation in the field survey. He is also obliged to Miss T. IMAI for typewriting the manuscript.

Description of Species

Family Amusiidae RIDWOOD

Genus *Entolium* MEEK, 1865

Type: *Pecten demissus* PHILLIPS, lower Malm, Europe

The typical entoliids which flourished in the Jurassic Period have an angulated dorsal margin salient above the hinge-line in the right valve. On the other hand many of the Triassic species have a straight dorsal margin as already noticed by PHILIPPI (1900, p. 97), but the two forms are connected with each other by intermediate forms, and this character may not be a definite criterion of the genus. One of the specimens, which are here compared to *E. discites* (pl. 1, fig. 4), has a slightly angulated dorsal margin like in *E. schlosseri* (WÖHRMANN, 1889, p. 203, pl. 7, figs. 1, 2) from the Karnian of the Northern Alps. The Triassic *Entolium* may be divided into two groups; the one is the group of *discites* provided with a nearly straight dorsal margin, and the other is the group of *quotidianus* (HEALEY) (1908, p. 46, pl. 7, figs. 4-11) characterized by prolonged dorsal extension of the auricles in the right valve. The oldest representatives of the latter group are found in the Anisian, such as *E. tiscaviensis* described by TORNQUIST (1900, pl. 3, fig. 7, *discites*) from the Southern Alps, *E. kellneri* KIRTL (1904, p. 709, textfig. 36) from Salajevo, and *E. sp.* in BITTNER (1901, p. 92, pl. 8, figs. 17, 18) from Bakony, while the former appeared as early as in the Skytic. The group of *quotidianus* is connected with the Jurassic group of *E. cornutum* QUENST. (STASCHE, 1926), and is separable from the group of *E. disciformis* or *demissum*, in the smaller apical angle, fan-shaped outline of the disc rather than orbicular, and stronger dorsal prolongation of the auricles, although the latter group has a similar angulated dorsal margin. Both groups are considered to be derived independently from the group of *discites*. The late Paleozoic genus *Pernopecten* WINCHELL is very similar to the Liassic entoliids (NEWELL, 1937, p. 109), but not a direct ancestor, because it has a large, specialized shell in comparison with the group of *discites*, and the dorsal prolongation of the auricles took place in the left valve contrary to the case of Mesozoic *Entolium*. The writer presumes that the occurrence of the group of *discites* or ancestral group very similar to *discites* goes back to the Permian period.

Table 1. List of the Early and Middle Triassic

Species	Distri- bution	Facies	Range				Remarks
			TIa	TIb	T2a	T2b	
Family Amusiidae							
<i>Entolium</i> cf. <i>discites</i> (SCHL.) sp. α	KI	Mm		×			Germany, Alps, Himalaya, Argentin, Ussuri
" " sp. β	KI	Mm		×			
" " sp. γ	S	Cm		×	?		
<i>E.</i> cf. <i>microtis</i> (BITTNER)	KI,KH, Y?	Ms,Mm	×	×			Alps, Himalaya, China, Ussuri, Spitzbergen
<i>Propeamussium</i> (<i>Varianussium</i>) sp. nov.	Y	Fm				×	
Family Aviculopectinidae							
<i>Eumorphotis</i> aff. <i>maritima</i> KIPARISOVA	F	Cs	○				Himalaya, Ussuri
<i>E.</i> aff. <i>multiformis</i> var. <i>rudaecosta</i> *	Y	Mm	×				Ussuri
<i>E.</i> aff. <i>tenuistriata</i> (BITTNER)	F	Cm	×	→ ?			Himalaya
<i>Claraia</i> aff. <i>decidens</i> DIENER*	KH	Fm	×				Himalaya, Ussuri
<i>C. pulchella</i> NAKAZAWA*	Y	Fm	×				
Family Pectinidae							
" <i>Pecten</i> " <i>ussuricus</i> BITTNER	F,Y,KI, KH	Fm,Mm, Cs	○	×			Ussuri
" <i>P.</i> " aff. <i>sojalis</i> WITTENBERG	KH	Ms	×				Ussuri, Alps
" <i>P.</i> " aff. <i>amuricus</i> BITTNER	F	Fm		×	→ ?		Ussuri
<i>Leptochondria</i> ? <i>minima</i> (KIPARISOVA)	KH	Fs	×				Ussuri
<i>L.</i> ? aff. <i>virgalensis</i> WITTENBURG	KI	Mm		×			Himalaya
<i>L.</i> ? <i>okuyamensis</i> NAKAZAWA n. sp.	KH	Fs,Ms	⊙				
<i>L.</i> ? cf. <i>bittneri</i> (KIPARISOVA)	KH,KI?	Fm	×				Ussuri
Family Limidae							
<i>Mysidioptera circularis</i> NAKAZAWA n. sp.	Y,KI	Fm,Mm	?	○			
Family Myalinidae							
<i>Promyalina minuta</i> NAKAZAWA n. sp.	KH	Ms	×				
" <i>Promyalina</i> " sp. α	F	Cs	×				
" <i>P.</i> " sp. β	My	Cs	×				
" <i>P.</i> " sp. γ	My	Cs	×				
Family Pinnidae							
<i>Pinna muikadaniensis</i> NAKAZAWA, n. sp.	F,KI	Mm	×	○			
Family Pteriidae							
<i>Pteria</i> (s.l.) aff. <i>murchisoni</i> (GEINITZ)	KI	Cm	○				Germany, China
Family Anthracosiidae							
<i>Anodontophora</i> cf. <i>fassaensis bittneri</i> FR.	KH	Fm	×				Alps
<i>A.</i> sp. indet.	KH	Fm	×				
Family Halobiidae							
<i>Daonella</i> ? sp. indet.	KI	Fm				×	

pelecypod-fossils from the Maizuru zone.

Species	Distri- bution	Facies	Range				Remarks
			T1a	T1b	T2a	T2b	
Family Bakevellidae							
<i>Bakevellia (Maizuria) kambei</i> NAK.*	F,My,Y, KH,KI	Cs,Ms, m,Fm	⊙	⊙			
" " <i>kambei dannensis</i> NAKAZAWA.*	F	Fm	○				
" " <i>okuyamensis</i> NAKAZAWA*	Y,KH	Fm,Mn	○	×			
" " cf. <i>okuyamensis</i> NAKAZAWA*	S	Cs		○?			
" " <i>narawarensis</i> NAKAZAWA*	KH	Fm	○				
B. (<i>Neobakevellia</i>) <i>tsuzuradaniensis</i> *	KH	Fm	×				
Family Myophoriidae							
<i>Neoschizodus</i> cf. <i>laevigatus</i> (ZIET.)*	F,My,Y, KH,KI,S	Cs,s-Mm, Fm-s	⊙	⊙			Europe to Far East
<i>N.</i> sp. ind.*	S	Cs		○?			
<i>N.</i> ? <i>shikii</i> NAKAZAWA*	KH	Ms	○				
Family Nuculanidae							
<i>Nuculana (Dacryomya) nogamii</i> , n. sp.	KH,KI	Mm		×	○	
" " <i>nogamii yakunoensis</i> , n. subsp.	Y,KH,KI	Mm	?	○			
" " sp. α	F,My,KI	Cm,Mm	○	×			
" " sp. β cf. <i>N.</i> sp. nov. (KIP.)	My,KH	Cs,Fm	○	?			Ussuri
<i>N.</i> ? sp. indet.	S	Cs		×	?		
Family Ctenodontidae							
<i>Palaeoneilo</i> sp. α cf. <i>elliptica</i> in KIP.	Y,KI,KH	Fm,Mm	○	×			Ussuri
<i>P.</i> sp. β cf. <i>P.</i> ? <i>oviformis</i> (ECK)	F,Y,KI	Fm,Mm	⊙	⊙			Ussuri, Germany
<i>P.</i> sp. γ	KI	Mm		×			
<i>P.</i> sp. δ cf. <i>elliptica praecursor</i> FRECH	KI	Mm		×			Germany, Alps
<i>P.</i> sp. ε	KI	Mm		×			
<i>P.</i> ? sp. indet.	S	Cm		×	?		
Family Nuculidae							
<i>Nuculopsis (Palaeonucula)</i> sp. α	KI	Mm		×			
<i>N.</i> (<i>P.</i>) sp. β	Y	Ms		×			
<i>N.</i> (<i>P.</i> ?) sp. γ	Y	Fm			×		

* : described in other papers.

In the column of distribution, F: Fukumoto district, My: Miharayama district, Y: Yakuno district, KH: Kawashigashi (Ōe district), KI: Kawanishi (Ōe district).

In the column of facies, C: coarse-grained, M: medium-grained, F: fine-grained, s: sandstone, m: muddy rock. Cm: means muddy rock of coarse-grained facies.

In the column of range, T1a: early Eo-Triassic, T1b: late Eo-Triassic, T2a: early early Meso-Triassic (early Anisian), T2b: late early Meso-Triassic (latest Anisian), ⊙: abundant, ○: common, ×: rare or very rare. Symbols with question mark show that exact horizons are uncertain.

Column of remarks: Distribution of identical or intimately related species in the foreign countries.

Entolium cf. discites (SCHLOTHEIM), sp. α

Plate 12, Figures 1, 2

Description:—Shell small, suborbicular, nearly equilateral, weakly inflated, a little higher than the length; test thin; shell-margin of the disc regularly rounded except for straight antero- and posterodorsal margins, which make an apical angle of about 100 degrees with each other; hinge-line straight, slightly shorter than a half of the shell-length; both auricles of subequal size depressed, well defined from the disc, the dorsal margin nearly straight; anterior auricle of the right valve slightly projected forward with a very shallow byssal sinus; posterior one obtusely triangular with rounded posterodorsal corner; the main part of the disc separated from the narrow submarginal portions by very weak sulci radiating from the beak; auricular crura very weak, if present; two internal ridges corresponding to the radial sulci on the outer surface being obscure; resilifer-pit small, subtrigonal; musculature unknown; surface smooth except for fine, close-set concentric growth-lines.

Remarks and Comparison:—Three right valves and several uncertain fragments are at hand. This species is very similar to the cosmopolitan *Entolium discites* (SCHLOTHEIM) in general aspect, but is a little higher than the typical *discites* and the internal ridges are obscure. It is allied to *E. tridentini* (BITTNER) (1901, p. 101, pl. 8, fig. 25) from the Ladinic of Bakony in the sinuated anterior auricle and the weak internal ridges. The auricular situation is also seen in several specimens of *discites* (for example, SALOMON, 1895, pl. 4, fig. 23; ASSMANN, 1915, pl. 31, fig. 22; PHILIPPI, 1903, pl. 4, fig. 9), and it is probable that *tridentini* may be an immature specimen of *discites*.

Occurrence:—Scattered in the dark bluish shale of the lower part of the Oro formation (late Eo-Triassic) at Muikadani (KI 1) and west of Muikadani (KI 8), Gujo, Oe-cho, Kyoto Prefecture, Reg. nos. JM 10655-57.

Entolium cf. discites (SCHLOTHEIM), sp. β

Plate 12, Figures 3, 4

This species represented by a left and a smaller right valve, is closely allied to the preceding species, but is distinguished by the stronger impression of the internal ridges and auricular crura, and by the development of concentric lirae at regular intervals besides the fine, crowded growth-lines. Furthermore, the both valves are sculptured by obsolete radial ribs, which make some resemblance to *E. incognitum* (WÖHRMANN) (1889, p. 204, pl. 7, figs. 3, 4, *filosum*), but the radials are fewer and more obsolete than the latter.

Measurement :—

L (mm.)	H (mm.)	H/L	l (mm.)	l/L	a (degree)
13	14.7	1.13	ca 5.5	0.42	96
ca 11	12	1.09	4.2	0.37	98

L: length, H: height, l: hinge-length, a: apical angle

Occurrence :—Scarce from the lower part of the Oro formation west of Muikadani at Gujo, Oe-cho, Kyoto Prefecture (KI 8), in association with the preceding species, Reg. no. JM 10658.

Entolium cf. discites (SCHLOTH.), sp. ?

Plate 12, Figures 5, 6

A single, incomplete left valve was obtained from the Okadashimo formation of the Shidaka group at Shidaka (S. 2), Maizuru City. It resembles very much *E. cf. discites* spp. α and β described above, but differs from the both in the stronger depression of the wider submarginal portions, from sp. α in having obscure radial striae, and from sp. β in lacking distinct concentric sculptures. The smaller apical angle and the slender outline are similar to those of *E. liscaviensis* (GIEBEL), but they may have been caused by secondary forces. Reg. no. JM 10659.

Entolium cf. microtis (BITTNER)

Plate 12, Figure 7

cf. 1899. *Pecten discites* var. *microtis* BITTNER, p. 24 (272), Pl. 2 (27), Figs. 10-11.

cf. 1948. *Pecten (Entolium) discites* var. *microtis*, Ku, p. 247, Pl. 1, Fig. 15.

The described form is distinguished from *E. cf. discites* in the larger size and very small auricles in comparison with the main body. The hinge-length attains less than one-third of the shell-length. The species is almost identical with *E. microtis*, especially, described by KU from the Skytic of Szechuan in western China but the strict specific identification is difficult as the specimens are too poor.

Occurrence :—Scarce from the lower member of the Hirobatake formation (early Eo-Triassic) at Katsuradani, Hirobatake, Oe-cho (KH 16) and from the lowest part of the Oro formation (late Eo-Triassic) at Ouchidani, Kamiouchi, Fukuchiyama City (KI 4), Reg. nos. JM 10660-661.

Genus *Propeamussium* DE GREGORIO, 1884Type: *Pecten (Propeamussium) ceciliae* DE GREGORIO, Miocene of SicilySubgenus *Variamussium* SACCO, 1897Type: *Amusium cancellatum* E. A. SMITH, Recent, Atlantic Ocean

Propeamussium erected as the subgenus under the genus *Pecten*, is now elevated to the status of genus in the family Amusiidae, although several authors adopt the new family Propeamussiidae. *Varismussium* established by SACCO as the subgenus of *Propeamussium*, is referred to as the infra-subgeneric rank by several authors, such as GRANT and GALE (1931, p. 235) and OYAMA (1944, p. 244). But judging from the original description* of the type-species and allied ones, *Variamussium* is distinguishable from *Propeamussium* in several points, which allow us to separate the two at least subgenerically as stated below. *Variamussium* is small in size (18 mm. high in the type-specimen), provided with more or less distinct byssal notch, and the internal ribs begin at some distance from the beak and reach near the peripheral margin; in general the radial ornaments of the left valve are more developed. On the other hand, *Propeamussium* s. s. is relatively large in size (35 mm. high in the type-specimen); the auricles are small in comparison with the shell-size, and the byssal sinus obsolete; the internal ribs start from the umbonal recess and end at a part far from the peripheral margin.

Propeamussium (Variamussium) n. sp. indet.

Plate 12, Figures 8, 9

Description:—A complete left and a fragmental right valve are available.

Shell small, longitudinally ovate except for auricular portion, higher than the length, moderately convex, equilateral; test thin; hinge-margin straight attaining about 70% of the shell-length; antero- and posterodorsal margins of the disc straight making an apical angle of about a right angle; auricles subequal, well defined from the rest; posterior auricle rectangled triangular, anterior one has a slightly sinuated anterior margin. Surface of the right valve sculptured with very fine, regularly disposed, concentric lirae, and in the left valve narrow but distinct, numerous radial costae are developed making reticulate appearance with the concentric ornaments (pl. 1, fig. 9). The internal ribs starting at a considerable distance from the beak, gradually growing stronger and reaching near the peripheral margin; cardinal and auricular crura not observed.

Remarks and Comparison:—The species is considerably compressed secondarily, and does not represent the original outline. It must be broader in outline with larger apical angle than the illustration. It agrees well with the genus

* The writer could not read the GREGORIO's original description, but the full translation is quoted in GRANT and GALE's paper (op. cit. p. 233).

Propeamussium, especially with the subgenus *Variamussium*, in essential generic or subgeneric characters, and cannot be separated morphologically from the Cenozoic group. *Pecten* (*Variamussium*) *margariticosatus* reported by DIENER from the Noric of the Himalayas (1908, pp. 97 and 131, pl. 18, figs. 1-3) is considered to be the only Triassic species of the true propeamussiids, so far as the writer knows. The Japanese species is easily distinguished from the Himalayan species in ornaments of the left valve. Among the two Jurassic species of Japan, *Propeamussium habukawensis* KIMURA (1951, p. 344, pl. 1, figs. 14, 15) and *Variamussium?* sp. of HAYAMI (1957, p. 125, pl. 20, fig. 18), the former one is more similar to the present species than the latter, but differs in the unequal auricle. The one described above is most probably a new species, although the materials are too poor to propose a new name.

Occurrence:—Obtained from the sandy shale of the lower part of the Waruishi formation, Yakuno group (early Anisian) at Waruishi, Nukada, Yakuno-cho, Kyoto Prefecture (Y 10), Reg. no. JM 10662.

Family Pectinidae

Genus *Pecten* MÜLLER, 1776

"*Pecten*" *ussuricus* BITTNER

Plate 12, Figures 10-13

1899. *Pecten ussuricus* BITTNER, p. 4, pl. 1, fig. 11
 1899. *P. sichoticus* BITTNER, p. 5, pl. 1, fig. 10.
 1938. *P. (Aequipecten) ussuricus*, KIPARISOVA, p. 12, pl. 3, figs. 1-2
 1954. *P. (Eupecten) ussuricus*, KIPARISOVA, p. 12, pl. 3, figs. 1-2

Remarks:—The specimens obtained from the Maizuru basin coincide very well with those of the Ussuri described by BITTNER and KIPARISOVA in all essential characters and definitely identical with that species. KIPARISOVA (1938) pointed out that *P. sichoticus* BITTNER is nothing but the left valve of *ussuricus*. This is also inferred from the byssal ear and the length of the both auricles of the specimens collected from the Maizuru and the Kitakami by the writer.

KIPARISOVA placed the species in *Aequipecten*, and later in *Eupecten*. *Aequipecten* was established as the subgenus of *Chlamys* by FISHER (1887) based on the small Eocene species *Pecten opercularis* as type, which has nearly equalvalved shells sculptured by strong radial ribs and has a larger anterior auricle than the posterior. Having unequal valves and a larger posterior auricle, *ussuricus* is not *Aequipecten*. *Eupecten* was erected by PHILIPPI (1900) as one of the divisions of *Pecten*, and includes many subgenera and sections which are considered to be generic rank in the present classification. TEPPNER (1922) adopted the name as the subfamily of the family Pectinidae. Further revision is needed for using the name as generic or subgeneric rank. "*Pecten*" *ussuricus* belongs most probably to a new genus, although it is included here tentatively in the genus *Pecten*. Furthermore, it is a noticeable fact that the species has sometimes

obscure auricular crura and a pair of internal ridges (pl. 12, figs. 10b, 12), both of which are commonly observed in entoliids. In fact the smooth left valve strongly reminds the writer of that of *Entolium*. It may be probable that *ussuricus* belongs to *Amussiidae*. *Pecten* cf. *ussuricus* figured by MATSUSHITA (1926, pl. 8, fig. 15) from the Skytic Kurotaki limestone in Shikoku is not a *Pecten* but a left valve of *Pleuronectites* by MATSUSHITA (op. cit., pl. 8, figs. 2, 5) in the same locality. *Pecten* cf. *sichoticus* by the same author (ibid., pl. 8, fig. 16) differs considerably from "*sichoticus*" in regularly disposed, fine radial costae of equal strength and in the absence of the submarginal depression. Moreover, both auricles are not clearly defined from the rest. It is allied to the group of "*Pecten*" *alberti* GOLDFUSS which belongs probably to *Leptochondria* BITTNER.

Occurrence:—Found through the fine- to coarse-grained facies in the Fukumoto, Yakuno and Oe districts, although small in number. Rather common in the early Eo-Triassic, but rare in the late Eo-Triassic, when the species becomes smaller in size. Reg. nos. JM 10640-646.

"*Pecten*" aff. *sojalis* WITTENBURG

Plate 12, Figures 15 a, b

cf. 1899. *Pecten* ex aff. *alberti*, BITTNER, p. 6, pl. 12, fig. 3 (not figs. 1, 2, 4-10)

cf. 1908. *Pecten sojalis* WITTENBURG, p. 21, pl. 1, fig. 6.

cf. 1938. *Pecten* aff. *sojalis*, KIPARISOVA, p. 257, pl. 5, figs. 14-17.

Description:—Shell small in size, nearly equilateral, a little convex, subcircular in outline except for auricles, the height nearly equal to the length; hing-line straight, a little shorter than the shell-length; both auricles nearly equal in size as well as in outline, and acutely pointed; surface entirely smooth.

Measurement;—

Reg. no.	L (mm.)	H (mm.)	l (mm.)	a (degree)
JM 1065a	6.0	7.0	4.8	90
JM 1053b	6.4	6.7	5.0	95
JM 10654	5.3	5.2	4.0	95

Comparison:—This species is very similar to *Pecten* aff. *sojalis* WITTENBURG described by KIPARISOVA from the Skytic of Ussuri. The latter species was distinguished from *sojalis* from the Werfen beds of Tirol by the oblique shape and the shorter hinge-length. The Japanese species is almost identical with the Ussuri's although slightly differs in the smaller apical angle and probably in the less convex shell.

Occurrence:—Rare from the lower member of the Hirobatake formation (early Eo-Triassic) at Okuyama, Oe-cho, Kyoto Prefecture (KH 26 and 29), Reg. nos. JM 10653-654.

“*Pecten*” aff. *amuricus* BITTNER

Plate 12, Figure 14

cf. 1899. *Pecten amuricus* BITTNER, p. 5, pl. 2, figs. 23-28

1958. *Pecten* sp. indet., NAKAZAWA, p. 261 (list)

A right? internal mould was procured from the blue, calcareous sandy shale of the undivided Fukumoto group at Ōkuradani, Fukumoto, Aita-cho, Okayama Prefecture (F 25). The shell is small, nearly flat, equilateral, and fan-shaped. Hinge-line is long and straight, slightly shorter than the length. Auricles are acutely protruded towards both extremities. The surface is covered by numerous, fine radial ribs; they amount 25 in number in the preserved portion which occupies the two-thirds of the disc. The species resembles very much the right valve of “*Pecten*” *amuricus* BITTNER from the Skytic of Ussuri in the fan-shaped, flat disc, the protruded auricles and the radial ornament, although the shell has been severely deformed. But the present species is much smaller and the position of the maximum length is probably located higher than *amuricus*.

Pecten amuricus var. reported by ONUKI (1956, p. 109), ONUKI and BANDO (1959, p. 23) from the southern Kitakami massif differs from *amuricus* in the subcircular disc, the more numerous radial ribs and relatively slender auricles, and is believed to be specifically distinct from the latter.*

The stratigraphical position of the species from Fukumoto is uncertain, but estimated as the late Eo-Triassic or the earliest Meso-Triassic. Reg. no. JM 10770.

Family Aviculopectinidae

Genus *Eumorphotis* BITTNER, 1901

Eumorphotis aff. *maritima* KIPARISOVA

Plate 12, Figures 25-28

cf. 1938. *Eumorphotis maritima* KIPARISOVA, p. 222, pl. 2, figs. 3, 6-8, 13

Description:—Shell moderate in size, inequivalve, inequilateral. Left valve fairly convex; anterior auricle a little convex, demarcated from the rest by a distinct depression; posterior one large, wing-shaped, gradually flattened from the main body; its posterior margin nearly straight and posterodorsal bending very weak; surface covered by numerous, relatively fine radial ribs consisting of three or more orders; primary and secondary radials of more than twenty in total number becoming nearly equal in strength through the growth, intercalating two or more, finer radials in each interspaces; in some cases, all radials growing uniform in strength (pl. 12, fig. 27). Right valve almost flat; anterior auricle deeply incised below; surface sculptured by fine, close-set radial ribs which are relatively stronger on the auricles. Growth-wrinkles developing at

* The writer thanks Dr. Y. ONUKI of Tohoku University for his courtesy in examining the specimens kept at Tohoku University.

irregular intervals on the both valves; growth-lines obsolete. Ligament-pit and musculature are unknown.

Remarks and Comparison:—This species resembles *Eumorphotis tenuistriata* (BITTNER) (1898, p. 711, pl. 15, fig. 7) from the Skytic of Bokhara in the numerous fine radial ornaments, but the stronger radial ribs are more numerous in this species, and the radials have not a tendency to disappear in the full grown stage as in the case of *tenuistriata*. It is more allied to *E. maritima* from Ussuri, especially in the specimens possessing relatively uniform radial ornaments, but the radial ribs seem to be slightly stronger and the left valve is flatter than *maritima*.

Occurrence:—Common from the fine-grained sandstone of the lower part of the Kusano formation (early Eo-Triassic) at Kojindani, Fukumoto, Aita-cho, Okayama Prefecture (F 10), Reg. nos. JM 10679–685.

Eumorphotis aff. *tenuistriata* (BITTNER)

Plate 12, Figures 29 a, b

cf. 1898. *Pseudomonotis tenuistriata* BITTNER, p. 711, pl. 15, fig. 7

An incomplete left valve accompanied by fragmental auricular portion of the counter valve is available. The fairly tall outline (ca 34 mm. high and 25 mm. long) is of secondary one. The radial ribs consists of about 10 weak primaries and slightly finer interstitial riblets of two or three in number in each interspaces on the disc, but are not differentiated on the auricles. These radials grow equal in strength, then become obsolete near the peripheral margin, where the concentric wrinkles are developed instead of the radials. Concerning the ornaments and the outline, the present species is intermediate between *E. tenuistriata* and *E. telleri* (BITTNER) (1898, p. 711, pl. 15, figs. 11–15) from the Lower Triassic of Bokhara in India, and especially resembles the former species. But the definite comparison is impossible because of the poor materials.

Occurrence:—Obtained from the upper part of the Kusano formation? at Kojindani, Fukumoto, Aita-cho, Okayama Prefecture (F 12), Reg. no. JM 10686.

Genus *Leptochondria* BITTNER, 1891

Leptochondria (?) *minima* (KIPARISOVA)

Plate 12, Figures 16, 17

1899. *Pecten* (*Leptochondria*?) ex aff. *alberti*, BITTNER (part), p. 6, pl. 2, figs. 1, 2, 4?, 5–10

1907. *Pecten* (*VELOPECTEN*) cf. *alberti*, FRECH, p. 35, pl. 4, fig. 8

1938. *Pecten* (*VELOPECTEN*) *minimus*, KIPARISOVA, p. 246, pl. 4, figs. 10, 12, pl. 3, fig. 11

1954. *Pecten* (*VELOPECTEN*) *minimus*, KIPARISOVA, p. 12, pl. 3, figs. 3–7

Description:—Two left external moulds were procured. Shell small, slightly inequilateral, subcircular in outline with the height nearly equal to the length, moderately convex; umbo weak, hardly salient above the hinge-margin; subequal

auricles depressed but not clearly defined from the disc, having no byssal sinus, and obtusely triangular in shape; surface covered by numerous, very fine radial striae on the ventral half, which are hardly seen by the naked eye, and in addition weak concentric folds discernible at irregular intervals.

Remarks and Comparison:—The figured specimens are identical with *Pecten* (*Velopecten*) *minimus* KIPARISOVA, especially, with var. *laevis* in all external features. *Velopecten*, i.e., *Eopecten* (subjective synonym) differs from *Leptochondria* (Type, *L. aeolichs* BITTNER, Noric of Anatolia) in its much larger size, less symmetrical outline, more or less wavy radial ribs and more unequal auricles of the left valve. COX (1948, p. 121, footnote; 1952, p. 29) referred to *Leptochondria* as a distinct genus, although several authors treated it as a synonym of *Velopecten* (SALOMON, 1900, p. 356; DIENER, 1923, p. 65) or *Pleuronectites* (TORNQUIST, 1900, p. 136). The species under consideration may be referred to *Leptochondria*, although it has not been ascertained whether the species has a ligament of *Aviculopecten*-type or not, which is one of the characteristic feature of the genus.

Occurrence:—Obtained from the Member II of the Narawara formation (early Eo-Triassic) south of Okuyama, Oe-cho, Kyoto Prefecture (KH 4), Reg. no. JM 10674.

Leptochondria (?) aff. *virgalensis* WITTENBURG

Plate 12, Figures 18 a-b

cf. 1909. *Pecten* (*Leptochondria*) *albertii* GOLDFUSS var. *virgalensis* WITTENBURG, p. 8, pl. 3, fig. 4.

Description:—Shell small, about 9 mm. long and 8 mm. high, gently convex, expanded posteroventrally; auricles depressed, but not clearly marked from the main body; anterior auricle relatively small, posterior one weakly sinuated posteriorly; hinge-line about 6 mm. long and straight; surface covered by numerous fine radial ribs of more than 60 in number; the radials are somewhat differentiated into two or three orders, although not so distinct, and make a lattice ornament together with growth-lines and wrinkles.

Remarks and Comparison:—This species is quite similar to *Pecten* (*Leptochondria*) *albertii* var. *virgalensis* described by WITTENBURG from the lower Triassic of the Salt-Range in outline, numerous radial ribs, and small size. The latter species differs from *albertii* s.s. not only in the fine, numerous radials, but also in the relatively broader outline and posteroventral expansion of the shell. Furthermore, according to WITTENBURG the right valve is similar to the left except for a little weaker radial ornaments, while that of *albertii* differs considerably from the counter valve (Wurm, 1914). Consequently, the species is here treated as a distinct species. The specimen described differs slightly from the Salt-Range species in the development of the radials on the auricular portion and in the more differentiated radial sculptures.

Occurrence:—Only a left valve collected from the lower part of the Oro formation of the Yakuno group (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Prefecture (KI 1), Reg. no. JM 10668.

Leptochondria (?) cf. *bittneri* (KIPARISOVA)

Plate 12, Figures 22-24

- cf. 1899. *Pseudomonotis* cf. *multiformis*, BITTNER, p. 10, pl. 2, figs. 11-14
 cf. ?1913. *Pseudomonotis tenuistrata*, DIENER, p. 44, pl. 5, fig. 11
 cf. ?1913. *Pseudomonotis multiformis*, DIENER, p. 44, pl. 5, fig. 13
 cf. 1938. *Pecten* (*Velopecten*) *bittneri* KIPARISOVA, p. 243, pl. 4, figs. 5-9, 11, 13

Several left valves in the collection have been severely deformed, and the accurate comparison is very difficult. The shell is 5-13 mm. high, 6-10 mm. long, and presumably higher than long. The radial ribs, which covers the whole surface, consist of three or rarely four orders; 10-14 primaries and alternating secondaries begin at the umbonal region, and the secondaries grow nearly as strong as the primaries towards the periphery, in addition, one or two interstitial striae are inserted in each intervals.

This species resembles very much "*Velopecten*" (= *Leptochondria*?) *bittneri* KIPARISOVA in the general shape and the characteristic ornaments, although accurate comparison is almost impossible.

Occurrence:—Occurred in the laminated sandy shale of the Narawara formation (the Member IV?, early Eo-Triassic) at Okuyama, Oe-cho, Kyoto Prefecture (KH 2), Reg. nos. JM 10670-673.

Leptochondria (?) *okuyamensis*, new species

Plate 12, Figures 19-21

1953. *Pseudomontis* (*Claraia*) sp. indet., NAKAZAWA, p. 266, pl. 2, fig. 11
 1958. *Claraia okuyamensis* NAKAZAWA, pp. 284, 285 (list)

Description:—Shell very small, oval, highly inequivalve; the length ranging from 5 to 8 mm., and nearly equal to the height. Left valve rather strongly inflated, subequilateral; umbo subcentral, a little salient above the hinge-margin; anterior auricle depressed, rectangled triangular, well defined from the disc, provided with no byssal sinus, and fairly larger than the posterior auricle; the latter is very small, truncated posteriorly with a rounded postero-ventral extremity, and is not clearly marked from the main body. Right valve slightly convex; anterior auricle deeply notched below; posterior one small and obsolete. Surface of the both valves quite smooth.

Remarks and Comparison:—This species was reported as *Claraia okuyamensis* in the preceding paper (NAKAZAWA, 1958), but it differs considerably from *Claraia* in having equilateral outline of the left valve, subcentral umbo, much smaller size, and larger anterior auricle than the posterior contrary to *Claraia*.

In these respects the present species probably belongs to *Leptochondria* rather than to *Claraia*, although the hinge-characters could not be clarified. In the complete lack of surface sculptures it differs from any species of *Leptochondria* except for a smooth variety of *L. ? minima* (KIPARISOVA) (var. *laevis*, 1938, p. 274, pl. 5, fig. 3). The form described is distinguished from *laevis* in the more unequal auricles. *Pseudomonotis* (*Claraia*) sp. described by the writer (1953) is most probably a right valve of *okuyamensis* described here.

Occurrence :—Common in the lower member of the Hirobatake formation (early Eo-Triassic) at Okuyama, Oe-cho (KH 16, 26, 28, 30) and Bessho, Fuku-chiyama City (KH 31), and in the lower part of the Narawara formation at Okuyama (KH 2?, 3, 30), Reg. nos. JM 10675–678.

Family Limidae

Genus *Mysidioptera* SALOMON, 1895

Mysidioptera circularis, new species

Plate 13, Figures 1–7

Description :—Shell moderate in size, subcircular, fairly convex, equivalve, a little inequilateral, slightly longer than the height; umbo moderate, nearly orthogyrous, lying at about anterior two-fifths of the shell-length; lunule deeply excavated from the main body, making a very obtuse angle with the hinge-margin; ligament-area relatively narrow and forming a distinct ridge at the junction with the lunule; ligament-pit not accurately known owing to bad state of preservation. Musculature unknown; hinge edentulous; surface covered by growth-wrinkles irregular in strength and numerous, very fine, thread-like radial costate which are variable in strength and usually discernible only in the later growth-stage.

Observation and Comparison :—Owing to the severe secondary deformation, reconstruction of the accurate shape is difficult. The ligamental characters are also not sufficiently known, but the reference to *Mysidioptera* of this species is almost unquestionable from the striking resemblance of the external features between the two. In the subcircular outline, the described species forms a distinct group in *Mysidioptera* together with *M. salomoni* (TOMMASI), *M. cassiana* BITTNER, *M. rotunda* BROILI, *M. obscura* BITTNER, etc.. In the relatively narrow ligament-area and very obtuse angulation between the lunular part and the ligament-area, the species has great alliance with *M. cassiana* BITTNER (1895, p. 178, pl. 20, figs. 1, 1a), *M. salomoni* TOMMASI (BITTNER, *ibid.*, p. 179, pl. 20, figs. 2, 3), *M. bittneri* BROILI (1904, p. 187, pl. 22, fig. 12) and *M. obliqua* BROILI (*ibid.*, p. 187, pl. 22, figs. 13, 14) from the Karnian of Southern Alps. *M. cassiana* and *obliqua* differ from the Japanese species in lacking radial ornament; *salomoni* is distinguishable in the shorter ligament-area than the lunule and *bittneri* in the more acute angulation between the lunule and ligament-area. *M. silvatica*

FRECH (1904, p. 14, textfig. 13) from the Anisian of Bakony is another comparable species, but differs in the broader outline and the stronger radial ornament. There is a left internal mould, which has an alate posterior auricle (pl. 2, fig. 7). This form is similar to *M. dieneri* FRECH (1907, p. 82, textfig. 15) from Dachstein-Dolomit of Bakony, but distinguished by radial ribs near the ventral margin. The specimen is considered to be a varietal form of the species described above.

Occurrence:—Common from the undivided Yakuno group (Eo-Triassic) north of Kamiyakuno Station, Yakuno-cho (Y 38); rare from the lower part of the Oro formation (late Eo-Triassic) at Muikadani (KI 1, 8), Gujo, Oe-cho and at Kamiouchi, Fukuchiyama City (KI 6), Reg. nos. JM 10692-702.

Family Pteriidae

Genus *Pteria* SCOPOLI, 1777

Pteria aff. *murchisoni* (GEINITZ)

Plate 13, Figures 8, 9

cf. 1888. *Gervilleia murchisoni* GEINITZ, EBERT, p. 237, textfig.

cf. 1928. *Avicula murchisoni*, SCHINDEWOLF, p. 17, textfigs. 1-3.

cf. 1948. *Avicula* cf. *murchisoni*, KU, p. 241, pl. 1, figs. 4-5.

1958. *Pteria?* sp., NAKAZAWA, p. 280 (list).

Description:—Shell relatively small, pteriod, a little inequivalve, the right valve less convex; 19 mm. high and 26 mm. long in the greatest specimen; umbo locating at about anterior one-third of the shell-length, a little salient above the hinge-margin in the left, but almost leveled with the latter in the right; umbonal angle varying between 35 and 45 degrees (generally 40 degrees); anterior auricle small, rounded anterodorsally and hardly separated from the main body; posterior auricle large, depressed, slightly protruded backward intersecting with the dorsal margin at about a right angle; ligament-area seemingly narrow but the ligament-pit could not be clarified; a weak lateral tooth running subparallel with the hinge-margin in each counter valve; in the left valve a weak, granular cardinal tooth probably present. Surface nearly smooth except for weak growth wrinkles; test thin.

Remarks and Comparison:—Externally the species resembles very much *Bakevellia* (*Maizuria*) *kambei* NAKAZAWA (1959, p. 204, pl. 4, figs. 1-12, textfig. 7) from the lower Triassic of the Maizuru zone, but the test is thinner, the dentition is less developed, the ligment is not multivincular but probably alivincular, and the resemblance is merely superficial. Among the species of *Pteria*, *P. murchisoni* (GEINITZ) from the Buntsandstein of Germany, especially described by EBERT and *P. cf. murchisoni* reported from China by KU are most similar to this species, but they are distinguishable from the present species in the smaller size and lack in dentition.

Occurrence:—Common from the sandy shale of the Ichio formation (early Eo-Triassic) at Gujo, Oe-cho, Kyoto Prefecture (KI 15), Reg. nos. JM 10688-691.

Family Myalinidae

Genus *Promyalina* KITTL, 1904

Type: *Promyalina Hindi* KITTL (1904, p. 176, pl. 22, fig. 8 and textfigs. 29-31)

When KITTL established the genus, he stated that "Am nächsten schliesst sich *Promyalina* an *Myalina* an, die Gestalt ist jedoch weniger dreieckig, der Schlossrand nicht längsgestreift und zeigt die linke Klappe ein vorderes Ohr, welche Eigenschaft *Myalina* abgeht, aber auf der rechten Klappe von *Myalinoptera* FRECH erscheint." NEWELL (1942, p. 63) pointed a close affinity between the Triassic Myalinas, such as *M. schamarae* BITTNER (1889, p. 19, pl. 4, figs. 20-25), *M. vetusta* BENECK by BITTNER (ibid., p. 17, pl. 4, figs. 17-19), *M. putiatinensis* KIPARISOVA (1938, p. 261, pl. 6, figs. 10-12) and *M. platynotus* WHITE (GIRTY, 1927, pl. 30, figs. 32-33), and the Carboniferous *Selenimyalina* NEWELL (1942, type, *Myalina meliniformis* MEEK & WORTHEN), and later (1955, p. 26) referred them to *Promyalina*, which differs from the former only in lacking a trigonal tooth in the left valve and was considered by him to be derived from that genus.

It is noteworthy that the type-species of *Promyalina* has an anterior auricular lobe in the left and not in the right. If this is true, the group of *schamarae*, that has no anterior lobe in both valves, may be separated subgenerically from *Promyalina* s.s., and is considered to be more intimately related to *Selenimyalina* than the latter is.

Promyalina minuta, new species

Plate 13, Figure 10

1958. *Selenimyalina?* sp. β (part), NAKAZAWA, p. 284 (list).

Description:—A single right valve is available for study. Shell very small, roundly quadrate, considerably higher than the length, 11.8 mm. high and 8 mm. long, acline except for the umbonal portion, gently convex; umbonal carina obscure; umbo terminal, small, a little pointed forward and not salient above the dorsal margin; dorsal margin slightly convex continuing to the broadly rounded posterior margin with regularly rounded posterodorsal corner; anterior margin making a weak sigmoidal curve. Hinge probably edentulous; ligament-area very narrow and not accurately known; surface entirely smooth.

Remarks and Comparison:—The specimen is very small, impressed in the sandy matrices, and the ligament- and hinge-characters are not sufficiently known. But in the characteristic outline, the species is considered to represent a dwarf form of *Promyalina*. In the small size and well rounded, acline outline this is distinguished from any other Triassic "*Myalinas*" included by NEWELL in *Promyalina* enumerated above, and rather similar to the type-species *hindi*, but the anterior sinuation below the beak is weaker and the shell is much smaller. As the left valve is not found, it is not sure whether the species belongs to *Promyalina* s.s. or to the group of *schamarae*, although the latter case is most

probable. *Mytilus* (?) *punctus* ICHIKAWA (1954, p. 50, pl. 7, figs. 9, 10) from the upper Triassic in Japan is similar to the present species in the small and quadrate shape, but differs in the prosocline shell and the straight dorsal margin. Externally the described species is most allied to *Selenimyalina quadrata* NEWELL (1942, p. 64, pl. 2, figs. 3a, b) from the Missourian of Kansas, but is much smaller in size.

Occurrence:—Obtained from the lower member of the Hirobatake formation of the Yakuno group (early Eo-Triassic) at Katsuradani, Oe-cho, Kyoto Prefecture (KH 9), Reg. no. JM 10707.

“*Promyalina*” sp. β

Plate 13, Figure 11

1958. *Selenimyalina*? sp. β (part), NAKAZAWA, pp. 272, 273.

A right valve obtained from the middle member of the Gannosudani formation at Yuradani, Oya-cho, Hyogo Pref. (MY 3) is similar to the preceding species in the small, roundly quadrate shell, but distinguished in the broader outline and the more slender and more acutely protruded umbo. It differs from typical *Promyalina* in the absence of an anterior auricular projection, and from *Selenimyalina* in the edenturous hinge. Probably it belongs to the group of *schamarae*. Specific identification is impossible, because it is not clear whether the specimen retains the original shape. Reg. no. JM 10708.

“*Promyalina*” sp. γ

Plate 13, Figure 12

A left internal mould in association with the preceding differs from that species in the fan-shaped outline made by nearly straight dorsal and anterior shell-margins and in the more oblique shell. Nevertheless, the two fall into the same species, if the difference is superficial one caused by secondary deformation. Reg. no. JM 10709.

“*Promyalina*” sp. α

Plate 13, Figure 13

1958. *Selenimyalina* sp. α , NAKAZAWA, p. 268 (list).

Description:—Shell moderate in size, mytiliform, moderately inflated, about 35 mm. long and 31 mm. high; dorsal margin straight continuing into broadly rounded posterior margin with no angulation; anterior margin only slightly arched forward, ventral one regularly rounded; umbonal keel running almost linear with the obliquity of 50 degrees; ligament-area very narrow and neither groove nor internal ridge being seen. Surface covered by weak growth-lines.

Remarks and Comparison:—In its oblique outline this is rather similar to *Mytilus* (?) *eduliformis* var. *praecursor* RENZ (1904, p. 20, textfigs. 23–25). But judging from the associating fossils the specimen is considered to suffer from secondary deformation, and the shape must be less oblique. It is more comparable to *Myalina* (= *Promyalina* ?) *blezingeri* PHILIPPI (1899, p. 63, textfigs. 1, 2) from the German Muschelkalk, *M.* (= *P.* ?) *putiatinensis* KIPARISOVA and *Promyalina tommasi* var. *obtusa* (SALOMON) described by COX (1924, p. 72, pl. 1, figs. 17a, b) from the Karnian of Trans Jordan. The present species is different from the first species in the more rounded posterodorsal corner, from the second in the broader outline, and from the last in the more obtuse inflexion of the anterior margin. The exact generic position is uncertain, because the ligament area is not preserved so well. If the ligament area is actually provided with no grooves, the species may belong to *Mytilus*.

Occurrence:—Occurred in the sandy shale of the Kusano formation (early Eo-Triassic) at Kusano, Aita-cho, Okayama Pref. (F 10), Reg. no. JM 10710.

Family Pinnidae

Genus *Pinna* LINNÉ, 1758

Pinna muikadaniensis, new species

Plate 13, Figures 14–17

Description:—Shell relatively small, elongately fan-shaped, a little inflated; test thin; hinge-line straight and very long making a rectangle with the broadly rounded postero-ventral margin; antero-ventral margin straight, rather abruptly rising up to posteroventral margin; median parting distinct but weak in the umbonal half and obsolete in the rear part, deviating towards the antero-ventral side; apical angle 35 degrees or so. Surface ornamented with concentric folds irregular in strength and fine close-set radial striae starting about 10 mm. apart from the beak, both of which make a reticulate sculpture; the radials increasing in number by insertion and attaining 20 in number on the dorsal side and less numerous on the anteroventral side, and they fade away at the rearmost portion from the beak, where the concentric folds are developed (Pl. 13, figs. 14, 17).

Remarks and Comparison:—All specimens at hand are incomplete or fragmental. Absence of distinct angulation along the medial parting is partly caused by subsequent flattening. Fragmental specimen reported by YEHARA (1927, p. 171, pl. 16, fig. 17) from the lower Triassic Tao formation in Shikoku differs from this species in the coarser ribs and weaker concentric ornaments. The writer could not find any other comparable Triassic species.

Occurrence:—Common in the lower part of the Oro formation of the Yakuno group (late Eo-Triassic) at Gujo, Oe-cho (KI 1, 10) and at Kamiouch Fukuchiyama City (KI 4, 6); rare from the Kusano formation (early Eo-Triassic) at Kusano, Fukumoto, Aita-cho, Okayama Prefecture (F 11), Reg. nos. 10711–714.

Family Anthracosiidae

Genus *Anodontophora* COSSMANN, 1897*Anodontophora* cf. *fassaensis bittneri* FRECH

Plate 13, Figures 19-21

cf. 1901. *Myacites Fassaensis* WISS. var. *brevis* BITTNER, p. 48, pl. 9, figs. 13-17cf. 1907. *Anodontophora fassaensis* mut. *Bittneri* FRECH, p. 41, pl. 7, figs. 1 a, b

Description:—Shell small, roundly trapezoidal, a little longer than high, moderately inflated, 9-15 mm. long and 7.3-11 mm. high; umbo slightly prosogyrous, situating a little anterior to the middle; posterior area delimited from the main body by a rounded, obscure carina which arcuates with the convex side backward; lunule not accurately known; edenturous, muscular impression not observable; surface almost smooth, only sculptured by weak growth-lines.

Comparison:—The species is very similar to *Anodontophora fassaensis bittneri* from the lower Triassic of Bakony, especially to FRECH's figures in all external features except for the smaller size and a little stronger posterior carina. It differs from BITTNER's specimens in the more symmetrical outline and more broadly arcuate ventral margin.

Occurrence:—Rare from the Member II (KH 7) and IV? (KH 2) of the Narawara formation south of Okuyama, Oe-cho, Kyoto Prefecture, Reg. nos. JM 10703-705.

Anodontophora sp. indet.

Plate 13, Figure 22

There are several specimens possessing a trigonal outline in association with the preceding species. In the external shape it resembles *Neoschizodus*, such as *N. laevigatus* (ZIET.), but is readily distinguished by the edenturous hinge and the lack of myophorous buttress in the interior. In this respect the present species is allied to *A. myophorioides* MANSUY (= *A. trapezoidalis* MANSUY) (1919, p. 13, pl. 2, fig. 13) from the Karnian of Tonkin, but is much smaller in size and the posterior area is narrower.

Occurrence:—Rare from the Member IV? of the Narawara formation, south of Okuyama, Oe-cho, Kyoto Prefecture (KH 2), Reg. no. JM 10706.

Family Halobiidae

Genus *Daonella* MOJSISOVICS, 1874*Daonella* (?) sp. indet.

Plate 13, Figure 18

The species is represented by several fragmental impressions in the sandy shale of the upper part of the Oro formation at Hanzaka, where *Monophyllites*

cf. *sphaerophyllus* was discovered. This form certainly belongs to Halobiidae by the distinctive radial ornaments and in the thin, flat shell, but so fragmentary that the generic position cannot be decided. Reg. no. JM 10768.

Family Nuculanidae

Genus *Nuculana* LINK, 1807

Subgenus *Dacryomya* AGASSIZ, 1840

Nuculana (Dacryomya) nogamii, new species

Plate 13, Figures 23-27

Description:—Shell medium in size, moderately inflated, equivalve, elongate transversally, and falcated posteriorly with narrowing rostrum; maximum length lying a little below the midheight; umbo incurved, opistogyrous, situating a little anterior to median; anterodorsal margin slightly convex, sloping down to strongly convex anterior margin; ventral margin broadly arcuate provided with no sinus; posterodorsal one moderately concave, terminating with rather acutely rounded posterior end. Posterior area delimited by a rounded, concave carina passing from the umbo to the posterior extremity; lunule perhaps absent; escutcheon narrow bordered by weak ridge. Surface sculptured with feeble, nearly concentric threads, which fade away at the marginal carina and are counted 6-7 in each 1 mm. interval. In the type-specimen hinge consisting of a convex anterior row of 15 denticles and a concave posterior row of the same number, which meet below the umbo in an obtuse angle, and are interrupted there by a small internal chondrophore directed anteroventrally. Adductor scars relatively small and distinctly impressed just below the end of both series of denticles; pallial line probably entire. In the internal mould a shallow depression is seen, running from the umbo towards the posteroventral corner and delimiting the rostrum.

Remarks and Comparison:—The specimens from the Maizuru can hardly be separated from those collected by the writer from the Middle Triassic Rifu formation near Sendai, Northeast Japan. The latter has a distinct, simple pallial impression. Concentric sculptures of the described species are somewhat variable in strength in individuals. They run nearly parallel to the growth-lines. However, it becomes clear that the concentric striae intersect the growth-lines with a very acute angle on the posterior half, when examined by magnifying glass. They also wave slightly at some places. This species is somewhat similar to the upper Triassic *Nuculana yunnanensis* REED (1927, p. 206, pl. 17, figs. 20, 21) from Tonkin, but differs in the more robust rostrum and shorter length. This is most allied to *N. aff. becki* (PHILIPPI) reported by KIPARISOVA (1938, p. 246, pl. 1, fig. 13) from the Skyto-Anisic of the Ussuri region, but is distinguished by a much larger size and weaker sculptures.

Occurrence:—Rare from the lowest part of the Oro formation at Kamiouchi,

Fukuchiyama City (KI 4) and at Gujo, Oe-cho (KI 8); from the uppermost part of the Oro (latest Anisian) at Hanzaka, Oro, Fukuchiyama City (KI 15), and from the upper member of the Hirobatake formation (late Eo-Triassic) at Hirobatake, Oe-cho (KH 5), Reg. nos. JM 10460-463.

Nuculana (Dacryomya) nogamii yakunoensis, new subspecies

Plate 14, Figures 1-3, 4?

This species is closely allied to the preceding, especially to the immature individuals. It differs from the species in the smaller size (5-8.8 mm. high and 8-12 mm. long), less arched posterodorsal margin, stronger and more strongly waving concentric sculptures, and probably less anteriorly located umbo. The concentric costae are counted 8 to 10 in number in 2 mm. interval about 2 mm. apart from the beak, while those of *nogamii* 12 to 13 in number. It is similar to *Nuculana semicrenulata* (TRECHMANN) (1917, p. 191, pl. 21, fig. 20) from the Karnian of New Zealand in the characteristic ornaments on the posterior half, but differs in the smaller size and more anteriorly located umbo.

Occurrence:—Common from the undivided Yakuno group north of Kamiyakuno Station (Y 38); rare from the lower part of the Oro formation (late Eo-Triassic) at Gujo (KI 6, 8, 10) and at Ichio (KI 11), Reg. nos. JM 10464, 10715-718.

Nuculana (Dacryomya) sp. α

Plate 14, Figures 5-9

1958. *Nuculana* aff. *excavata*, NAKAZAWA, pp. 272, 273, 284 (list)

Description:—Shell small, moderately inflated, equivalve, inequilateral, expanded anteriorly and falcate posteriorly; the maximum length lying under the midheight of the shell; the length hardly exceeding one and a half of the height; beak opisthogyrous, lying at about two-fifths of the length from the anterior end; posterior area marked by rounded marginal carina; escutcheon short, deeply impressed. Hinge consisting of a slightly convex anterior row of 9-10 (rarely 13) denticles and a slightly concave posterior row of the same number; internal ligament-pit present; anterior and posterior adductor-scars well impressed; pallial line usually not preserved but presumably entire. In the internal mould a shallow depression radiating from the umbo near to the postero-ventral corner, but the ventral margin not sinuated there. Surface entirely smooth.

Comparison:—In relatively short outline the present form resembles *Nuculana (Dacryomya) silicea* COX (1949, p. 17, pl. 1, fig. 2) from the upper Triassic of Peru, *Nuculana wissmanni* BITTNER (1895, p. 148, pl. 18, fig. 11) from the Karnian of the Southern Alps, but differs from the first species in the more anterior

position of the umbo and the absence of the posteroventral sinuation of the ventral margin, and from the latter species in the quite smooth shell. Short forms of the described species (pl. 14, figs. 7, 8) are very similar to *N. (?) excavata* (GOLDFUSS) (1838, p. 153, pl. 124, figs. 14a-c) from the Muschelkalk of Germany, in the subcentral position of the beak, but the umbo is less prominent and the similarity has been caused partly by secondary deformation. The striking resemblance with *Palaeoneilo sakuradaniensis* ICHIKAWA (1954, p. 43, pl. 1, figs. 1, 2) from the lower Karnian of Shikoku is superficial, because the described species has a distinct internal chondrophore below the beak.

Occurrences:—Rare from the Gannosudani formation at Otani (MY 9), Yabucho, Hyogo Prefecture; the Kyogakubo formation at Miyanooku (F 21) and Kyogakubo (F 4), Fukumoto, Aita-cho, Okayama Prefecture; the Ichio formation at Oro, Oe-cho, Kyoto Prefecture (KI 7); Eo-Triassic, Reg. nos. JM 10719-726, 10730.

Nuculana (Dacryomya?) sp. β cf. *Leda* sp. nov. in KIPARISOVA

Plate 14, Figures 10-11, 16 (No. 4)

cf. 1938. *Leda* sp. nov. indet., KIPARISOVA, p. 244, pl. 1, figs. 16 a, b

Shell small, 6 to 8 mm. long and 3.5 to 5 mm. high, and L/H ratio is about 1.7. Umbo situates at about anterior one-third of the shell-length. Anterior and posterior denticles are counted 8-10 and 9-12, respectively. The species is distinguishable from the preceding in the longer shape and the more anterior position of the beak resulting in the posterior prolongation of the shell. Surface is entirely smooth. It is almost identical with *Leda* (= *Nuculana*) sp. nov. ind. described by KIPARISOVA from the lower to middle Triassic in the Ussuri, and seems to differ only slightly in the stronger muscular impression.

Occurrence:—Rare from the middle member of the Gannosudani formation (early? Eo-Triassic) at Gannosudani, Yabucho, Kyoto Prefecture (MY 1); the lower part of the Narawara formation (early Eo-Triassic) of Okuyama, Oe-cho, Kyoto Prefecture (KH 2, 4), Reg. nos. JM 10727-729, 10732-2, 4, 15, 17.

Nuculana (?) sp. indet.

Plate 14, Figures 12 a-c

A single right valve is available for study. Shell small, 9.4 mm. long and 5.7 mm. high, gently convex; umbo moderate and situated at a little anterior to the center; anterior half expanded and the posterior one prolonged. More than 5 anterior and posterior denticles observable, but unfortunately umbonal part of the hinge not preserved. Accordingly its generic reference to either *Nuculana* or *Palaeoneilo* is uncertain, although the external shape suggests that the species belongs probably to the former genus. The present species shows intermediate

outline between *N. sp. α* and *N. sp. β*, but differs from the two in having fine, regularly disposed concentric sculptures clearly seen by magnifying glass (pl. 3, fig. 12c). In this point, the species is similar to *N. (D.) nogamii* and its subspecies *yakunoensis* described above, but the sculptures are not wavy.

Occurrence:—Obtained from the Shidaka formation (Eo-Triassic?) at Shidaka, Maizuru City, Kyoto Prefecture (S 1), Reg. no. JM 10731.

Family Ctenodontidae

Genus *Palaeoneilo*, HALL, 1870

Palaeoneilo sp. α cf. elliptica in KIPARISOVA

Plate 14, Figures 13–15, 16 (part), 17, 18

cf. 1954. *Palaeoneilo* (?) *elliptica* GOLDFUSS, KIPARISOVA, p. 19, pl. 9, figs. 2 a, b.

Description:—Shell small, oval, strongly elongated transversally, about 1.8 times as long as high; posterior extremity lying below the midheight; umbo hardly salient above the hinge-margin ending with the orthogyrous or a little prooogyrous beak, situating at less than anterior one-third of the shell-length; escutcheon very narrow demarcated by a linear, rounded carina radiating from the umbo; lunule small, strongly depressed and delimited by a sharp concave ridge; hinge consisting of slightly concave anterior row of 8 to 10 denticles and a straight posterior row of 25 to 30 minute ones. Surface nearly smooth except for very weak growth-lines; muscular impression not preserved in all specimens.

Comparison:—In the smooth shell and the elongate, slender outline the species resembles *Palaeoneilo praeacuta* KLIPSTEIN (BITTNER, 1838, p. 143, pl. 16, figs. 32–35), *P. cf. praeacuta* TRECHMANN (1917, p. 190, pl. 21, fig. 22), *P. lunaris* BÖHM (1903, p. 40, pl. 4, fig. 18), and *P. elliptica* (GOLDF.) (1838, p. 153, pl. 124, figs. 16a–c; BITTNER, 1895, p. 142, pl. 19, figs. 26–31). It differs from the first two species in the lack of the submarginal depression and the lesser convexity, from the second in the less anterior position of the umbo, and from the third in the less elongate shape. The present species is particularly allied to *P. (?) elliptica* reported by KIPARISOVA from the *Flemingites* beds of Ussuri, and is only slightly different in a little more posteriorly located umbo than the latter. The Japanese species as well as the Ussuri's differs from the typical European *P. elliptica* in the broader posterior half of the shell and the lower position of the posterior extremity.

Occurrence:—Common from the lower member of the Yakuno group at Chigono, Shimoyakuno (Y 5); rare from the undivided Yakuno group north of Kamiyakuno Station (Y 38); rare from the lower part of the Oro formation at Muikadani (KI 1, 8), Sakaigawa (KI 10) and Kamiouchi (KI 4); rare from the Member II and common from the Member IV of the Narawara formation south of Okuyama (KH 3, 17); Eo-Triassic, Reg. nos. JM 10733–741.

Palaeoneilo sp. β cf. *P.* (?) *oviformis* (ECK)

Plate 14, Figures 16 (part), 25-27

cf. 1872. *Nucula oviformis* ECK, p. 87, Taf. 1, Fig. 9, 9 a

cf. 1915. *Nucula oviformis*, PAULCKE, p. 212.

cf. 1938. *Nucula oviformis*, KIPARISOVA, p. 210, pl. 1, figs. 5, 6.

1958. *Palaeoneilo* sp. β , NAKAZAWA, pp. 268, 280, 285, 289.

Description:—Shell very small, trigonally oval, fairly convex, 4 to 6 mm. long and 3 to 4 mm. high; umbo comparatively prominent, orthogyrous, lying a little posterior to one-third of the length from the anterior end; lunule and escutcheon present; anterior and posterior adductor scars usually well impressed in the internal mould, and connected by an entire pallial line; hinge consisting of a little convex anterior row of 6 to 8 (rarely exceeding 10) denticles and a gently convex posterior one of 18 to 25 (usually 20), which become minute under the beak and form a well rounded series.

Comparison:—This species is readily distinguished from the other lower Triassic species of *Palaeoneilo* in the Maizuru zone by the vaulted shell, the trigonally ovate outline, and the distinct muscular impression. *P. ledaeformis* KIPARISOVA (1938, p. 242, pl. 1, figs. 14a-c) from Ussuri is somewhat similar to this species, but different in the more protracted and contracted posterior half and in the less convex shell. Externally, *Nucula oviformis* ECK described from Germany and Ussuri resembles very much present species. ECK distinguished *oviformis* from *Nucula* (= *Palaeoneilo*) *elliptica* GOLDFUSS in the rounded and shorter posterior half. Unfortunately, the details of the hinge-character have not been stated by him as well as later authors, and it is not sure whether the species belongs to *Nucula* or *Palaeoneilo*, although the writer is inclined to refer it to the latter genus. If the latter case is true, the species described above is most allied to *oviformis*, if not identical, although the muscular impression seems to be stronger than *oviformis*.

Occurrence:—Abundant from the undivided Fukumoto group at Dan, Aita-cho, and the Kyogakubo formation south of Okuyama, Oe-cho (KH 3, 4); the Honodani formation at Oyugo, Yakuno-cho (Y 34); Eo-Triassic, Reg. nos. JM 10742-748.

Palaeoneilo sp. γ , new species?

Plate 14, Figures 19-21

Description:—Shell small, elongate laterally, quadrately ovate, a little convex, 10 to 11 mm. long and 5 to 6.7 mm. high; umbo located at anterior one-third of the shell-length; broadly arcuate ventral margin rather abruptly rising up to posterior margin making truncated posterior extremity. Taxodont denticles only partly preserved.

Comparison:—This is closely allied to *P.* sp. α cf. *elliptica*, but differs in the

expanded posterior half and truncated posterior margin as mentioned above. In the external shape the species is similar to *P. iwaiensis* ICHIKAWA (1954, p. 181, pl. 17, figs. 1, 2) from the upper Triassic of Iwai near Tokyo, and *P. whitechurchii* HEALEY (1908, p. 8, pl. 1, figs. 9a-c) from the Napeng beds of Burma, but the shell is less convex and the denticles are probably more numerous than *iwaiensis*, and smaller in size, slender in the posterior half than the Napeng species.

Occurrence:—Rare from the lower part of the Oro formation (late Eo-Triassic) at Kamiouchi, Fukuchiyama City (KI 4), at Sakaigawa (KI 2) and Muikadani (KI 1, 8), Gujo, Oe-cho, Kyoto Prefecture, Reg. nos. JM 10749-753.

Palaeoneilo sp. δ cf. *elliptica praecursor* (FRECH)

Plate 14, Figure 22

cf. 1904. *Ctenodonta elliptica* var. *praecursor* FRECH, p. 12, textfigs. 9 a, b
cf. 1938. *C. elliptica* var. *praecursor*, KIPARISOVA, p. 211, pl. 1, figs. 7, 8

This elongate and slender form resembles very much *P.* cf. *elliptica* described above and *P. elliptica* (GOLDFUSS), but is more allied to its subsp. *praecursor* in the short anterior part. The species differs from the latter variety in the more broadly rounded anterior margin and more anterior position of the beak.

Occurrence:—Rare from the lower part of the Oro formation at Muikadani, Gujo, Oe-cho, Kyoto Prefecture (KI 1, 8), Reg. nos. JM 10754-756.

Palaeoneilo sp. ϵ

Plate 14, Figures 23, 24

In the considerably short and tall shape, the species resembles *P. tenuilineata* KLIPSTEIN (BITTNER, 1895, p. 135, pl. 16, figs. 19-24), *P. faba* WISSMANN (BITTNER, *ibid.*, p. 135, pl. 16, fig. 17) and *P.* (?) *prinadae* KIPARISOVA (1938, p. 243, pl. 1, figs. 9-12; 1954, p. 20, pl. 10, figs. 2, 3). But all specimens in hand were severely deformed secondarily, and the exact outline can not be stated. It is possible that these may be the deformed form of other species described above such as sp. α or γ , although could not be confirmed.

Occurrence:—Rarely found in the lower part of the Oro formation at Muikadani (KI 1, 8) and Ichio (KI 11), Reg. nos. JM 10757-759.

Palaeoneilo (?) sp. indet.

Plate 14, Figures 28, 29

There are two specimens at hand, which are generically indeterminable owing to the ignorance on the hinge-characters. The two exhibit different shapes from each other caused probably by later crushing, and is considered to fall into the

same species. They resemble *P.* sp. δ , but differ in the more vaulted anterior portion of the shell and the position of the umbo which lies more posteriorly than the latter.

Occurrence:—Obtained from the Okadashimo formation (late? Eo-Triassic) at Shidaka, Maizuru City (S 3), Reg. nos. JM 10762–3.

Family Nuculidae

Genus *Nuculopsis* GIRTY, 1911

Subgenus *Palaeonucula* QUENSTEDT, 1930

Nuculopsis (*Palaeonucula*) sp. α

Plate 14, Figures 30–32

Description:—Shell very small, roundly trigonal, prolonged anteriorly, moderately inflated, about 1.3 times as long as high; umbo slightly opisthogyrous, lying at posterior one-third or one-fourth of the length; antero- and postero-dorsal margin nearly straight; ventral margin broadly arched; lunule and escutcheon depressed and demarcated from the flank by acutely rounded carina. Hinge consisting of anterior 12 denticles and posterior 9, which are interrupted by a short trigonal internal chondrophore slightly directed posterodorsally under the beak; two adductor scars weakly impressed in the internal mould.

Surface covered by close-set regular, concentric costae, which becomes weaker on the lunule and escutcheon.

Measurement;—

Reg. no.	L (mm.)	H (mm.)	D (mm.)	U (mm.)
JM 10764	4.8	3.7	3.0	3.7
JM 10763	6.0	4.8	3.5	4.0

L: length, H: height, D: thickness, U: position of beak from anterior end

Comparison:—This is similar to the genus *Nuculoma* COSSMANN (Type, *Nucula castor* D'ORBIGNY) in the development of concentric sculptures, but differs in the less oblique and broader chondrophore, less prosogyrous umbo and in the much smaller size. In these respects, it belongs to *Nuculopsis* (*Palaeonucula*). In the small and trigonal outline the present species resembles "*Nucula*" *goldfussi* (ALBERTI) (GOLDFUSS, 1838, p. 152, pl. 124, figs. 13a, b) from the lower and middle Triassic of Europe and the Ussuri, but is distinguished from the same in the longer outline. It is most similar to *Nuculopsis* (*Palaeonucula*) *expansa* (WISSMANN) (BITTNER, 1895, p. 140, pl. 17, figs. 26–33) from the St. Cassian in the general outline as well as in the dentition, but is different in the stronger concentric sculptures. It may be a new species, although the materials are insufficient.

Occurrence:—Rare from the lower part of the Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho (KI 1) and at Kamiouchi, Fukuchiyama City (KI 4), Kyoto Prefecture, Reg. nos. JM 10763–765.

Nuculopsis (Palaeonucula) sp. β

Plate 14, Figures 33, 34

Several specimens obtained from the middle portion of the Hōnōdani formation (late? Eo-Triassic) at Nukada, Yakuno-cho (Y 9) seem to differ from the preceding in the larger size (8 to 10 mm. long and 7 to 8 mm. high), the more symmetrical outline and the stronger muscular impressions. Specific identification is almost impossible, since the external feature is unknown. Reg. nos. JM 10766a, b.

Nuculopsis sp. γ

Plate 14, Figure 35

A single, right internal mould is available for study, which has been severely deformed. The specific determination is impossible, because of the bad state of preservation. The material is elongated laterally, 9.3 mm. long and 6 mm. high, and fairly protruded anteriorly. The umbo lies at about posterior one-third of the length. Two adductor scars are strongly impressed; posterior denticles of 11 in number make a concave series, while 13 anterior denticles make a slightly convex series; these denticles become minute near the both sides of the trigonal chondrophore, which is directed anteroventrally. Surface is supposed to be sculptured by weak concentric costae judging from the internal mould.

Occurrence:—Lower part of the Waruishi formation in association with the early Anisian ammonoids, Reg. no. JM 10767.

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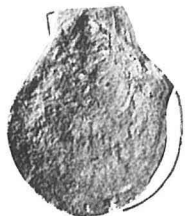
Plate 12

Explanation of Plate 12.

- Figs. 1, 2. *Entolium* cf. *discites* (Schloth.), sp. α p. 254
1. Right internal mould, $\times 1$, lower part of the Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 1), Reg. no. JM 10655.
 2. Right external cast, $\times 1.5$, loc. and hor. ditto, Reg. no. JM 10656.
- Figs. 3, 4. *Entolium* cf. *discites* (Schloth.), sp. β p. 254
3. Clay-cast from left? external mould, $\times 1.3$, lower part of the Oro formation west of Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 8), Reg. no. JM 10658a.
 4. Rubber compound cast from left external mould, $\times 1.1$, loc. and hor. ditto, Reg. no. JM 10658b.
- Figs. 5, 6. *Entolium* cf. *discites* (Schloth.), sp. γ p. 255
5. Rubber compound cast from left external mould, $\times 1.3$, Okadashimo formation of Shidaka group (late Eo-Triassic?) at Shidaka, Maizuru City (S 2), Reg. no. JM 10659.
 6. Internal mould of the same, $\times 1$.
- Fig. 7. *Entolium* cf. *microtis* (Bittner)p. 255
- Internal mould of right? valve, $\times 1$, lower member of Hirobatake formation (early Eo-Triassic) at Katsuradani, Hirobatake, Oe-cho, Kyoto Pref. (KH 16), Reg. no. JM 10660.
- Figs. 8, 9. *Propeamussium* (*Variamussium*) n. sp. ind.....p. 256
8. Right (a) and a fragmental external mould of left valve (b), $\times 1.5$, lower part of Waruishi formation (early Anisian) at Waruishi, Nukada, Yakuno-cho, Kyoto Pref. (Y 10), Reg. no. JM 10662.
 9. Enlargement of (b) in the preceding figure, $\times 3$.
- Figs. 10-13. "*Pecten*" *ussuricus* Bittner.....p. 257
10. Gypsum cast from left external mould (a), and internal mould (b), $\times 1$, undivided Fukumoto group at Dan, Aita-cho, Okayama Pref. (F 36), Reg. no. JM 10640 a, b.
 11. Clay cast from left external mould, $\times 1$, Kyogakubo formation (Eo-Triassic) at Kojindani, Fukumoto, Aita-cho, Okayama Pref. (F 12), Reg. no. JM 10641a, b.
 12. Rubber compound cast from right internal mould, $\times 1.6$, lower part of Oro formation at Kamiouchi, Fukuchiyama City (KI 4), Kyoto Pref., Reg. no. JM 10642.
 13. External mould of right valve, $\times 1$, lower part of Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 1), Reg. no. JM 10643.
- Fig. 14. "*Pecten*" aff. *amuricus* Bittnerp. 259
- Right? internal mould, $\times 1.7$, undivided Fukumoto group at Okuradani, Fukumoto, Aita-cho, Okayama Pref. (F 25), Eo-Triassic?, Reg. no. JM 10770.
- Figs. 15a, b. "*Pecten*" aff. *sojalis* Wittenburgp. 258
- Internal mould of two left valves, $\times 1$, lower member of Hirobatake formation (early Eo-Triassic), at Okuyama, Oe-cho, Kyoto Pref., Reg. no. JM 10653.



1 × 1



2 × 1.5



3 × 1.3



4 × 1.1



5 × 1.3



6 × 1



7 × 1



8 × 1.5



9 × 3



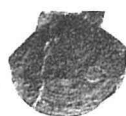
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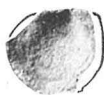
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16 × 1.5



17 × 1.3



18 × 1.5



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19 × 1.8



20 × 1.1



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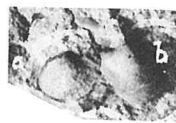
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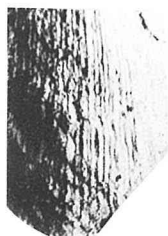
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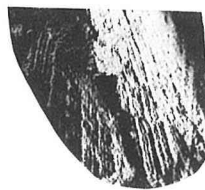
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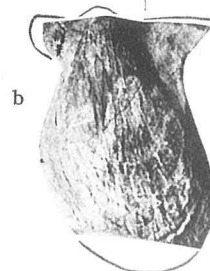
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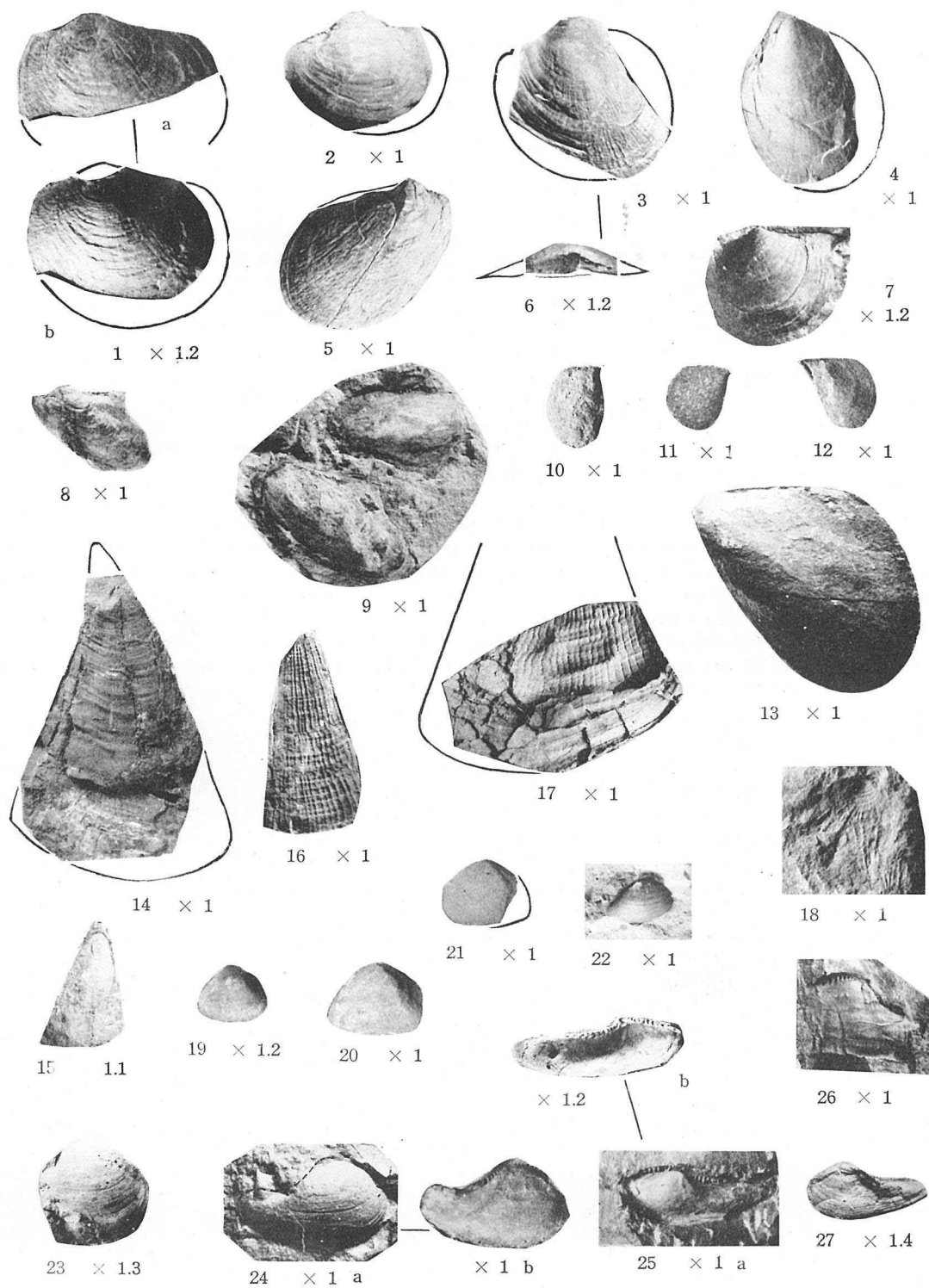
29 × 1

- Figs. 16, 17. *Leptochondria* (?) *minima* Kiparisova.....p. 260
 16. Clay cast from left external mould, $\times 1.5$, Member II of Narawara formation (early Eo-Triassic) south of Okuyama, Oe-cho, Kyoto Pref. (KH4), Reg. no. JM 10674a.
 17. Left external mould, $\times 1.3$, loc. and hor. ditto, Reg. no. JM 10674b.
- Figs. 18a, b. *Leptochondria* (?) aff. *virgalensis* Wittenburgp. 261
 Rubber compound cast from left external mould (a), $\times 1.5$ and fragmental internal mould of the same (b), $\times 1$, lower part of Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 1), Reg. no. JM 10668.
- Figs. 19-21. *Leptochondria* (?) *okuyamensis*, new speciesp. 262
 19. Left internal moulds, $\times 1.8$, a: holotype, lower member of Hirobatake formation (early Eo-Triassic) southwest of Miyagatake, Bessho, Fukuchiyama City (KH 31), Reg. no. JM 10663a, b.
 20. Left (c, d) and right (e) internal moulds, $\times 1$, loc. and hor, ditto, Reg. no. JM 10663c-d.
 21. Right internal mould, $\times 1.5$, loc. and hor. ditto, Reg. no. JM 10664a.
- Figs. 22-24. *Leptochondria* (?) cf. *bittneri* (Kiparisova)p. 262
 22. Left internal mould, $\times 1$, Member IV? of Narawara formation (early Eo-Triassic) at Okuyama, Oe-cho, Kyoto Pref. (KH 2), Reg. no. JM 10670.
 23. Rubber compound cast of left valve, $\times 1.2$, loc. and hor. ditto, Reg. no. JM 10672.
 24. Left Internal moulds of cf. *bittneri* (a) and *Bakevella okuyamensis* (b), $\times 1$, loc. and hor. ditto, Reg. no. JM 10673a, b.
- Figs. 25-28. *Eumorphotis* aff. *maritima* Kiparisovap. 259
 25. Left internal mould, $\times 1$, Kusano formation (early Eo-Triassic) at Kojindani, Fukumoto, Aita-cho, Okayama Pref. (F 10), Reg. no. JM 10679.
 26. Right internal mould, $\times 1$, loc. and hor. ditto, Reg. no. JM 10680.
 27. Gypsum cast from left external mould, $\times 1.5$, showing uniform radial ornament, loc. and hor. ditto, Reg. no. JM 10683.
 28. Clay cast from left external mould, $\times 1$, showing somewhat idfferentiated ornament, loc. and hor. ditto, Reg. no. JM 10681.
- Figs. 29a, b. *Eumorphotis* aff. *tenuistriata* (Bittner)p. 260
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Plate 13

Explanation of Plate 13.

- Figs. 1-7. *Mysidioptera circularis*, new speciesp. 263
- 1a, b. Left internal moule (a) and clay cast from external mould (b), $\times 1.2$, holotype, lower part of Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 1), Reg. no. JM 10699.
2. Left internal mould, $\times 1$, loc. and hor. ditto, Reg. no. JM 10700.
- 3, 6. Left external mould, lateral view (3), $\times 1$, and dorsal view (6), $\times 1.2$, undivided Yakuno group (Eo-Triassic) north of Kamiyamuno Station, Yakuno-cho, Kyoto Pref. (Y 38), Reg. no. JM 10694.
4. Clay cast from right external mould, $\times 1$, loc. and hor. ditto, Reg. no. JM 10692.
5. Right internal mould, $\times 1$, loc. and hor. ditto, Reg. no. JM 10698.
7. Left internal mould, \times ca. 1.2, loc. and hor. ditto, Reg. no. JM 10697.
- Figs. 8, 9. *Pteria* (s.l.) aff. *murchsoni* (Geinitz).....p. 264
- Ichio formation (early Eo-Triassic) at Gujo, Oe-cho, Kyoto Pref. (KI 15).
8. Left external mould, $\times 1$, Reg. no. JM 10688a.
9. Left (a) and right (b) internal moulds, $\times 1$, Reg. no. JM 10689a, b.
- Fig. 10. *Promyalina minuta*, new speciesp. 265
- Right Internal mould, $\times 1$, holotype, lower member of Hirobatake formation (early Eo-Triassic) at Katsuradani, Hirobatake, Oe-cho, Kyoto Pref. (KH 9), Reg. no. JM 10707.
- Fig. 11. "*Promyalina*" sp. β p. 266
- Left external mould, $\times 1$, Gannosudani formation (early? Eo-Triassic) at Yuradani, Oya-cho, Hyogo Pref. (MY 3), Reg. no. JM 10708.
- Fig. 12. "*Promyalina*" sp. γ p. 266
- Left internal mould, $\times 1$, loc. and hor. ditto, Reg. no. JM 10709.
- Fig. 13. "*Promyalina*" α p. 266
- Left internal mould, $\times 1$, Kusano formation (early Eo-Triassic) at Kojindani, Fukumoto, Aita-cho, Okayama Pref. (F 10), Reg. no. JM 10710.
- Figs. 14-17. *Pinna muikadaniensis*, new speciesp. 267
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15. Internal mould of apical portion, $\times 1.1$, loc. and hor. ditto, Reg. no. JM 10713.
16. External mould, showing reticulate ornament, $\times 1$, hor. ditto, Kamiochi, Fukuchiyama City (KI 4), Reg. no. JM 10714.
17. Right external mould, $\times 1$, showing ornament of full grown stage, hor. ditto, Muikadani, Gujo, Oe-cho (KI 1), Reg. no. JM 10712.
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- Uppermost part of Oro formation (latest Anisian) at Hanzaka, Oro, Fukuchiyama City (KI 15), Reg. no. JM 10768, $\times 1$.

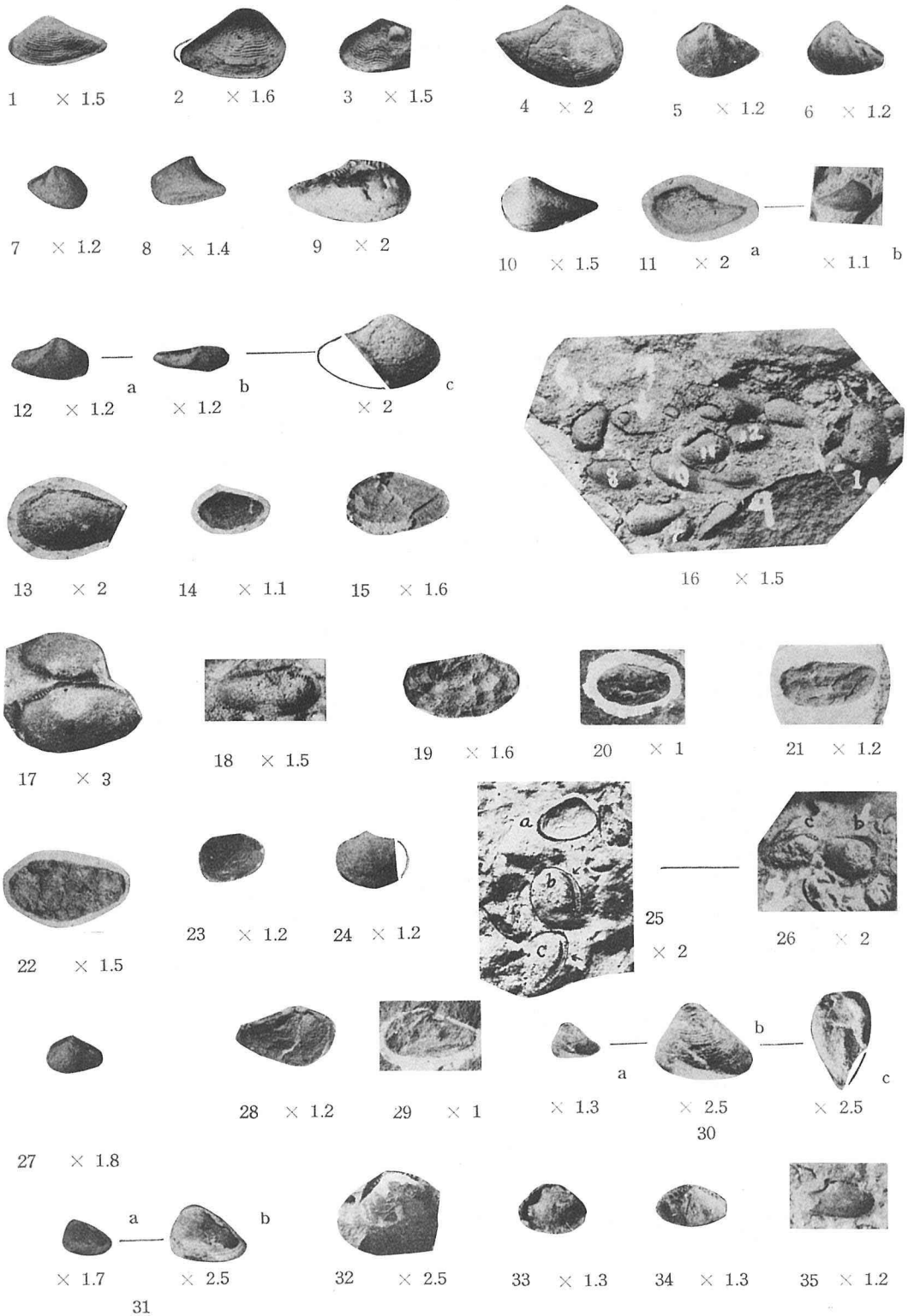


- Figs. 19-21. *Anodontophora* cf. *fassaensis bittneri* Frechp. 268
19. Left internal mould, $\times 1.2$, Member IV? of Narawara formation (early Eo-Triassic) at Okuyama, Oe-cho, Kyoto Pref. (KH 2), Reg. no. JM 10705.
- 20, 21. Left internal mould, $\times 1$, Member II of Narawara formation (early Eo-Triassic) south of Okuyama, Oe-cho, Kyoto Pref. (KH 7), Reg. nos. JM 10703, 4.
- Fig. 22. *Anodontophora* sp. indet.p. 268
- Right internal mould, $\times 1$, Member IV? of Narawara formation at Okuyama, Oe-cho, Kyoto Pref. (KH 2), Reg. no. JM 10706.
- Figs. 23-27. *Nuculana (Dacryomya) nogamii*, new speciesp. 269
23. Rubber compound cast from right external mould, $\times 1.3$, uppermost part of Oro formation (latest Anisian) at Hanzaka, Oro, Fukuchiyama City (KI 15), Reg. no. JM 10462.
- 24a, b. Clay cast from right external mould (a), and internal mould (b), holotype, $\times 1$, lower part of Oro formation (late Eo-Triassic) at Kamiouchi, Fukuchiyama City (KI 4), Reg. no. JM 10460a.
- 25a, b. Left internal mould (a), $\times 1$, and rubber compound cast from the same (b), $\times 1.2$, the same block as the preceding, Reg. no. JM 10460b.
26. Left internal mould, $\times 1$, loc. and hor. same as fig. 23, Reg. no. JM 10461.
27. Clay cast from left external mould, $\times 1.4$, loc. and hor. ditto, Reg. no. JM 10463.

Plate 14

Explanation of Plate 14.

- Figs. 1-4. *Nuculana (Dacryomya) nogamii yakunoensis*, n. subsp.....p. 270
1. Rubber compound cast from left external mould, holotype, $\times 1.5$, undivided Yakuno group (Eo-Triassic) north of Kamiyakuno Station, Yakuno-cho, Kyoto Pref. (Y 38), Reg. no. JM 10715.
 2. Rubber compound cast from right external mould, $\times 1.6$, loc. and hor. ditto, Reg. no. JM 10716.
 3. Rubber compound cast from left external mould, $\times 1.5$, loc. and hor. ditto, Reg. no. JM 10717.
 - ?4. Left external mould, $\times 2$, lower part of Oro formation (late Eo-Triassic) at Kusunokidani, Gujo, Oe-cho, Kyoto Pref. (KI 8), Reg. no. JM 10464.
- Figs. 5-9. *Nuculana (Dacryomya) sp. α* p. 270
- 5, 6. Left internal moulds, $\times 1.2$, upper part of Gannosudani formation (late ? Eo-Triassic) at Otani, Yabu-cho, Hyogo Pref. (MY 9), Reg. no. JM 10719 (fig. 5) and JM 10721 (fig. 6).
 7. Right internal mould, $\times 1.2$, upper part of Kyogakubo formation (late Eo-Triassic) at Miyanoooku, Fukumoto, Aita-cho, Okayama Pref. (F 21), Reg. no. JM 10724.
 8. Clay cast from left external mould, $\times 1.4$, Ichio formation (early Eo-Triassic) at Tenneiji, Sakanashi, Fukuchiyama City (KI 7), Reg. no. JM 10725.
 9. Right internal mould, $\times 2$, umbonal portion broken off to show hinge and ligament, undivided Fukumoto group at Dan, Aita-cho, Okayama Pref. (F 36), Reg. no. JM 10730.
- Figs. 10, 11a, b. *Nuculana (Dacryomya) sp. β* cf. *Leda* sp. nov. in KIPARISOVAp. 271
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 - 11a, b. Left internal (a, $\times 2$) and external mould (b, $\times 1.1$), Member II of Narawara formation (early Eo-Triassic) south of Okuyama, Oe-cho, Kyoto Pref. (KH 4), Reg. no. JM 10728.
- Figs. 12a-b. *Nuculana (?) sp. indet.*.....p. 271
- Right internal mould, lateral view (a) and dorsal view (b), $\times 1.2$, and clay cast from external mould (c), $\times 2$, Shidaka formation (late Eo-Triassic?) at Shidaka, Maizuru City (S 1), Reg. no. JM 10731.
- Fig. 16. *Nuculana sp. β* (4), *Palaeoneilo sp. α* (7, 8, 10, 11?) and *P. sp. β* (1?, 5, 12), $\times 1.5$, showing occurrence of these fossils, Member IV of Narawara formation south of Okuyama (KH 3a), Reg. no. JM 10732.
- Figs. 13-15, 17, 18. *Palaeoneilo sp. α* cf. *elliptica* in Kiparisova.....p. 272
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 14. Right external mould, $\times 1.1$, lower part of Oro formation (late Eo-Triassic) at Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 1), Reg. no. JM 10738.
 15. Right external mould, $\times 1.6$, hor ditto, Kamiouchi, Fukuchiyama City, Kyoto Pref. (KI 4), Reg. no. JM 10737.
 17. Internal mould of a pair of valves, $\times 3$, Member II of Narawara formation (early Eo-Triassic) south of Okuyama, Oe-cho, Kyoto Pref. (KH 17).
 18. Right internal mould, $\times 1.5$, contained in the same block as fig. 16, Reg. no. JM 10732-6.



- Figs. 19–21. *Palaeoneilo* sp. γ , n. sp.?p. 273
19. Left external mould, $\times 1.6$, lower part of Oro formation (late Eo-Triassic) west of Muikadani, Gujo, Oe-cho, Kyoto Pref. (KI 8), Reg. no. JM 10752.
 20. Left external cast, $\times 1$, hor. ditto, Sakaigawa, Gujo, Oe-cho, (KI 2), Reg. no. JM 10749.
 21. Right external mould, $\times 1.2$, hor. ditto, west of Muikadani, Gujo, Oe-cho (KI 8), Reg. no. JM 10753.
- Fig. 22. *Palaeoneilo* sp. δ p. 274
- Right external mould, $\times 1.5$, loc. and hor. ditto, Reg. no. JM 10755.
- Figs. 23, 24. *Palaeoneilo* sp. ε p. 274
23. Right internal mould, $\times 1.2$, lower part of Oro formation, Kamiouchi, Fukuchiyama City, Kyoto Pref. (KI 4), Reg. no. JM 10758.
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- Figs. 25–27. *Palaeoneilo* sp. β cf. *P. (?) oviformis* (Eck)p. 273
25. Rubber compound cast from right external (1) and right internal moulds, $\times 2$, Upper part of Kyogakubo formation (late Eo-Triassic) at Miyannku, Fukumoto, Aita-cho, Okayama Pref. (F 24), Reg. nos. JM 10742.
 26. Two right internal moulds of b and c in the preceding figure $\times 2$.
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- Left (Fig. 28, 1.2) and right (Fig. 29, $\times 1$) external moulds, Okadashimo formation (late Eo-Triassic?) at Shidaka, Maizuru City (S 3), Reg. nos. JM 10762, 3.
- Figs. 30–32. *Nuculopsis (Palaeonucula)* sp. α p. 275
30. External cast of univalved specimen, lateral view (a, $\times 1.3$; b $\times 2.5$) and anterior view (c, $\times 2.5$), lower part of Oro formation (late Eo-Triassic) at Kamiouchi, Fukuchiyama City, Kyoto Pref. (KI 4), Reg. no. JM 10763.
 31. Internal mould and a part of external cast of univalved specimen, lateral view (a, $\times 1.7$; b, $\times 2.5$), ahor. ditto, Muikadani, Gujo, Oe-cho (KI 1), Reg. no. JM 10764.
 32. Right internal mould, $\times 2.5$, loc. and hor. same as fig. 31, Reg. no. JM 10769.
- Figs. 33, 34. *Nuculopsis (Palaeonucula)* sp. β p. 276
- Two right internal moulds, $\times 1.3$, middle part of Honodani formation (late ? Eo-Triassic) at Nukada, Yakuno-cho, Kyoto Pref. (Y 9), Reg. no. JM 10766a, b.
- Fig. 35. *Nuculopsis* sp. γ p. 276
- Right internal mould, $\times 1.2$, lower part of Wasuishi formation (early Anisian) at Waruishi, Nukada, Yakuno-cho, Kyoto Pref. (Y 10), Reg. no. JM 10766.

All illustrated specimens are kept in Geological and Mineralogical Institute, University of Kyoto. K. NAKAZAWA photo.