

PALAEOGENE FOSSILS OF THE ISLAND OF KYUSHU, JAPAN PART I

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PALAEOGENE FOSSILS OF THE ISLAND OF KYŪSHŪ, JAPAN

PART I

BY

TAKUMI NAGAO

With 5 Plates

INTRODUCTION

In a recent number of the Science Reports (Vol. XI, No. I), I have given a brief account of the Palaeogene deposits of Kyūshū, Japan. These deposits are divisible into a number of complexes, some terrestrial and some marine in origin, containing several important fossiliferous beds among them. Another paper giving summarized information on the stratigraphy of these deposits and the interbedded fossil layers will be published in the near future (Vol. XII, No. 1).

The Palaeogene animal fossils are very numerous at various localities in Kyūshū, but they have not been much studied as yet. Only the following species were previously reported among them:

1. M. YOKOYAMA: "On Some Tertiary Fossils from the Miike Coal-field." Jour. Coll. Sci. Imp. Univ. Tōkyō, Vol. XXVII, 1911, pp. 1-16.

Pentacrinus ariakensis YOK.
Terebratula miikensis YOK.
Perna nishiyamai YOK.
Pholadomya margaritacea (SOW.)
Crassatella fusca YOK.
Venericardia nipponica YOK.
Cardita mandaica YOK.
Venus mitsuiana YOK.
Fusus sp.
Aturia zigzag (SOW.)
Homolopsis japonicus YOK.
Xantholites pentagonalis YOK.
Lamna cf. *cuspidata* AG.

All these species have been obtained from the Manda Group of the Miike coal-field. Moreover, the following four were reported from the Sakasegawa Group of the Amakusa coal-field by Prof. YOKOYAMA:

Lima amaxensis YOK
Crassatella fusca YOK.

Venericardia nipponica YOK.

Pholadomya margaritacea (Sow.)

Of these fossils from the Miike and Amakusa coal-fields, *Aturia zigzag* is believed to be identical with *Aturia yokoyamai* NAGAO. *Fusus* sp. figured by YOKOYAMA is not distinguishable from the specimens of the Okinoshima Beds in the Takashima coal-field. The latter are closely similar to *Pseudoperissolax blakei* (CONRAD) from the Eocene of California, as will be considered more fully in Part II of this paper.

2. H. YABE and S. HANZAWA: "Nummulitic Rocks of the Islands of Amakusa (Kyûshû, Japan)", Sci. Rep. Tôhoku Imp. Univ. Sendai, Japan, Second Ser., Vol. VII, 1925, pp. 73-82.

Nummulites amakusensis-subamakusensis YABE and HANZAWA

Nummulites spp.

Orthophragmina (*Discocyclina*) aff. *pratti* MICHELIN

Orthophragmina (*Asterodiscus*) sp.

These species have been found in the *Nummulites amakusensis-subamakusensis* Zone of the Shiratake Sandstone and the equivalent lowest part of the Kyôragi Shale, both of the Amakusa coal-field.

3. T. NAGAO: "Occurrence of *Orthaulax* in the Palaeogene of Japan." Jap. Jour. Geol. and Geogr., Vol. II, 1924, pp. 13-16.

Orthaulax japonicus NAGAO, the Lower *Orthaulax japonicus* Zone of the Amakusa, Miike, and Takashima coal-fields.

4. S. SHIMIZU: "On Two Species of *Nautiloidea* from the Tertiary of Japan." Sci. Rep. Tôhoku Imp. Univ. Sendai, Japan, Second Ser., Vol. IX, 1926, pp. 25-27.

Nautilus japonicus SHIMIZU, the Okinoshima Beds of the Takashima coal-field and the Kawamagari Beds of the Asakura coal-field.

5. T. NAGAO: "*Aturia yokoyamai*, nov. nom." Ibid., Vol. IX, 1926, pp. 29-32.

Aturia yokoyamai NAGAO, the Kawamagari Beds of the Asakura coal-field and the Ashiya Group of the Fukuoka coal-field.

The original specimens of *Aturia zigzag* of YOKOYAMA were from the Manda Group of the Miike coal-field, as stated above. Prof. YOKOYAMA has, moreover, reported the existence of a specimen of the same species in the Takashima coal-field.

6. M. YOKOYAMA: "Tertiary Fossils from Western Hizen." Jour. Facul. Sci. Imp. Univ. Tôkyô, Sect. II, Vol. II, 1927, pp. 183-190.

Turritella kiiensis YOK.

Scala maculosa (AD. et. RVE.)

Venus (*Mercenaria*) *stimpsoni* GLD.

Chione casinaeformis YOK.

Cardium sagawai YOK.

Lucina (*Phacoides*) *borealis* L.

Venericardia ferruginea (AD.)

Mytilus hirsutus LAM.

- Lima goliath* SM.
- Pecten* sp.
- Ostrea* sp.
- Arca* sp.
- Pectunculus* sp.
- Nucula mirabilis* AD. et RVE.
- Linhia nipponica* YOSH.
- Scutella* sp.
- Heterocyathus* sp.

All these fossils have been obtained from the Nishisonogi Group of the Sakito and Matsushima coal-fields to be described in Part II of this paper. Of these, those specifically determined forms, except *Cardium sagawai* which is new, are believed by him to be identical with the Recent or Neogene species previously known from Japan, and he regarded the marine complex holding these fossils as Pliocene in age. I am, however, inclined to believe the Nishisonogi Group is not younger than Oligocene, as will be discussed later in detail. I have found no form doubtlessly identical with the Neogene or Recent species of Japan, although there are some closely allied to the living ones.

In the present paper, my intention is to describe some Palaeogene fossils of Kyûshû. Part I, here issued, contains those species found in the Amakusa, Miike, and Takashima coal-fields, with the exception of the materials obtained from the Okinoshima and Iôjima Beds of the last named coal-field. Those of the last two complexes, together with the other collections from northern Kyûshû, will be treated in Part II (Vol. XII, No. 1).

The annexed table is here introduced to show the stratigraphical order of the various complexes to be referred to in the following pages.

	Amakusa		Miike		Takashima	
Sakasegawa Group	Sakasegawa Shale	Manda Group	Yotsuyama Sandstone		Iôjima Beds	
	Itchôda Sandstone		Kachidachi Sandstone		Okinoshima Beds	
Hondo Group	Toishi Beds	Ômuta Group	Nanaura Sandstone (Upper <i>Orthaulax japonicus</i> Zone)	Takashima Group	Hashima Beds (Upper <i>Orthaulax japonicus</i> Zone)	
	Kyôragi Shale		Tôka Sandstone			
Miroku Group (Fûkami Sandstone)	Shiratake Sandstone (<i>Nummulites amakusensis-subamakusensis</i> Zone = Lower <i>Orthaulax japonicus</i> Zone)		Komenoyama Beds (Lower <i>Orthaulax japonicus</i> Zone)			Futagojima Beds (Lower <i>Orthaulax japonicus</i> Zone)
	Akasaki Beds		Akasaki Beds			Akasaki Beds.

To be described here are the following 42 species and 1 variety, of which 15 are not specifically determined owing to their bad state of preservation:

Crinoidea.

Pentacrinus ariakensis YOK., the Yotsuyama Sandstone.

Lamellibranchiata.

Nucula (Acila) sp. a, the Tôka Sandstone.

Yoldia sp., the Tôka Sandstone.

Pedalion tomiyasui nov., the Lower *Orthaulax japonicus* Zone.

Unio sp. *a*, the Hashima Beds [?].

Lima amaxensis YOK., the Itchôda Sandstone.

„ „ YOK. var. *kumasoana* nov., the Sakasegawa Group.

„ *eocenica* nov., the Sakasegawa Shale.

„ sp. the Yotsuyama Sandstone.

Anomia sp., the Lower *Orthaulax japonicus* Zone.

Mytilus sp. aff. *M. rigaultii* DESH., the Lower *Orthaulax japonicus* Zone.

Crassatellites fuscus (YOK.), the Sakasegawa and Manda Groups.

Cyrena (Batissa) ponderosa nov., the Lower *Orthaulax japonicus* Zone, the Hashima Beds, and the Toishi Beds.

Venericardia nipponica YOK., the Fukami Sandstone [?], the Sakasegawa and Manda Groups.

„ *mandaica* (YOK.), the Sakasegawa and Manda Groups.

Diplodonta [?] *problematica* nov., the Lower *Orthaulax japonicus* Zone.

Macrocallista ariakensis nov., the Lower *Orthaulax japonicus* Zone.

Pitaria sp., the Fukami Sandstone or the Sakasegawa Group.

Cardium miikense nov., the Lower and Upper *Orthaulax japonicus* Zones.

Tellina sp. *a*, the Yotsuyama Sandstone.

„ sp. *b*, the Tôka Sandstone.

Macoma sp. *a*, the Manda Group.

Cultellus [?] *brevis* nov., the Lower *Orthaulax japonicus* Zone.

Corbula subtumida nov., the Lower *Orthaulax japonicus* Zone.

„ (*Cunaecorbula*) *kyûshûensis* nov., the Lower *Orthaulax japonicus* Zone, the Tôka Sandstone, and the Hashima Beds.

Gastropoda.

Turricula sp., the Manda Group.

Nerita subgranulosa nov., the Lower *Orthaulax japonicus* Zone.

Polinices (Neverita) eocenica nov., the Lower and Upper *Orthaulax japonicus* Zones.

„ (*Lunatia* [?]) *uloensis* nov., the Lower *Orthaulax japonicus* Zone.

Rissoina [?] *gemma* nov., the Lower *Orthaulax japonicus* Zone.

Turritella okadai nov., the Lower *Orthaulax japonicus* Zone.

„ *miikensis* nov., the Lower *Orthaulax japonicus* Zone.

„ sp. *a*, the Lower *Orthaulax japonicus* Zone.

- Turritella* sp. *b*, the Lower *Orthaulax japonicus* Zone.
Melania [?] *miikensis* nov., the Lower and Upper *Orthaulax japonicus* Zones.
Faunus nipponicus nov., the Lower *Orthaulax japonicus* Zone.
Cerithiopsis sp., the Lower *Orthaulax japonicus* Zone.
Orthaulax japonicus NAGAO, the Lower and Upper *Orthaulax japonicus* Zones.
Siphonalia sp. *a*, the Lower *Orthaulax japonicus* Zone.
Sycum (*Bulbifusus* [?]) *miikense* nov., the Kachidachi Sandstone.
Turris higoensis nov., the Lower *Orthaulax japonicus* Zone.
Cylichna paupercula nov., the Lower *Orthaulax japonicus* Zone.

DESCRIPTION OF SPECIES

Echinodermata

Crinoidea

Pentacrinidae

Pentacrinus, BLUMENBACH

Pentacrinus ariakensis YOKOYAMA

Pl. XVIII(I), Fig. 17

1911. *Pentacrinus ariakensis* YOKOYAMA: "Some Tert. Moll. Miike Coal-field," *Jour. Coll. Sci., Imp. Univ. Tôkyô*, Vol. XXVII, Art. 20, p. 5, Pl. I, fig. 6.

This species was established by Prof. YOKOYAMA with a few fragments of columns derived from the Manda Group of the Miike coal field. Several similar specimens of fragmental columns were also found in the Yotsuyama Sandstone; they are believed to be specifically identical with the specimen figured by Prof. YOKOYAMA, although less sharply ridged and provided with slightly shallower interspaces between the ridges.

In the present specimens, the surface is perfectly smooth; the diameter and the altitude of the joints are about 5.5 mm. and 1.5 mm. in one of the smaller ones, and about 7.5 mm. and 2.4 mm. in one of the larger ones, respectively. The ridges are more or less rounded and the interspaces between them frequently very shallow. The articular surface is ornamented with the lanceolate, crenate lobes.

Among the present specimens, those with rounded ridges are allied rather to *P. subbasaltiformis* MILLER¹ from the London Clay of England, though they are more acute along the ridges.

Locality and geological horizon: The Yotsuyama Sandstone; the northern foot of Hakama-dake, Tamana-gun, province of Higo.²

¹E. FORBES: "Monograph of the Echinodermata of the British Tertiary," p. 34, Pl. IV, figs. 8-10.

²肥後國王名郡荒尾村袴岳.

MOLLUSCA

Lamellibranchata

Nuculidae

Nucula, LAM.

(Acila, ADAMS.)

Nucula (Acila) sp. a, indet.

There are here a few very imperfect internal and external moulds of *Nucula (Acila)*, which can not serve for a precise comparison with the related species previously reported from Japan.

Shell small, less than 6 or 7 mm. in length, comparatively convex, trigonally ovate, very inequilateral; anterior end truncated; antero-ventral end somewhat produced; postero-dorsal margin nearly straight and the posterior rounded. Pallial line distinct. Anterior teeth about 10 in number, the posterior ones approximately 14.

Locality and geological horizon: The Tôka Sandstone; a point direct northeast of Ôura, Ômuta city, province of Chikugo.¹

Lediidae

Yoldia, MÖLLER

Yoldia sp. a, indet.

Two internal moulds were examined.

Shell small, compressed, transversely oblong; slightly inequilateral, the anterior side being shorter; rounded in front and narrowly so behind; antero-dorsal margin nearly straight and inclined forward, the postero-dorsal indistinctly excavated; ventral margin very broadly arched, ascending gradually to the posterior one. Surface smooth. Exact number of teeth unknown, but counting more than 8 on the anterior part and about 9 on the posterior.

Dimensions:	HEIGHT	LENGTH
	ca. 7 mm.	ca. 12 mm.

The present specimens resemble *Y. tokunagai* YOK.² from the Neogene (the Kamenô Beds) of the Jô-Ban coal-field in outline, but are less elongated, more equilateral and have less numerous

¹筑後國大牟田市大浦.

²M. YOKOYAMA: "Moll. Rem. Middle Part, Jô-Ban Coal-field." *Jour. Coll. Sci., Imp. Univ. Tôkyô*, Vol. XLV, Art. 7, p. 10, Pl. II, figs. 12-18.

teeth and more distinct concentric lines. On the other hand, *Y. laudabilis* YOK.¹ from the Asagai Beds, older than the Kamenô Beds, of the same coal-field, is distinguished from ours by its more diverging, antero- and postero-dorsal margins and more pointed postero-dorsal end.

Locality and geological horizon: The Tôka Sandstone; a cliff direct northeast of Ôura, Ômuta city, province of Chikugo.

Pedalionidae

Pedalion, SOLANDER

Pedalion tomiyasui nov. sp.

Pl. XX (III), Figs. 4-8

Shell rather small, flat, broadly mytiliform, much higher than long; anterior margin concave for the most part and provided with a deep byssal notch; posterior margin evenly and broadly arched, forming an almost continuous curve with the hinge margin; antero-ventral, ventral and postero-ventral margins as a whole, forming a semicircular contour; hinge margin slightly arched, making an angle of about 60° with the anterior. Umbo produced and pointed. Hinge plate displaying moderately deep vertical grooves which are often regularly spaced and usually a little broader, rarely narrower, than the flat interspaces. Surface smooth except for more or less distinct concentric lines of growth.

Dimensions:	LENGTH	HEIGHT
	23 mm.	ca. 33 mm.

The largest one of the specimens measures about 40 mm. along the hinge margin.

A number of more or less imperfect specimens was examined. The present species is easily distinguished from *Perna nishiyamai* YOK.² from the Manda Group of the Miike coal-field by its different shape. *Perna lamarckii* DESH.³ from the Lutetian and Bartonian of France is identical with ours in many features but has a shallower byssal notch and a less produced, broader umbo.

The specific name is dedicated to Mr. A. TOMIYASU, an engineer of the Takashima Coal Mines, now retired.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Kôyagi-jima off Nagasaki, province of Hizen.⁴

¹ M. YOKOYAMA: "Moll. Rem. Lowest Part, Jô-Ban Coal-field." *Id.*, Vol. XLV, Art. 3, p. 22, Pl. IV, figs. 11, 12.

² M. YOKOYAMA: "Some Tertiary Foss. Miike," *Op. cit.*, p. 7, Pl. I, figs. 1a, 1b.

³ G. P. DESHAYES: "Descr. Anim. s. Vert. Paris," Vol. I, p. 57. M. COSSMANN and G. PISSARRO: "Icon. comp. Coq. foss. Eoc. Env. Paris," Vol. I, Pl. XXXIX, fig. 122-1.

⁴ 肥前國西彼杵郡香焼島.

Unioidea

Unio, RETZIUS

Unio sp. a, indet.

Pl. XXII (V), Fig. 5

We have an internal mould which may belong to *Unio*.

Shell subrhomboidal, moderately convex, attenuated posteriorly, fairly inequilateral; posterior end broken, but evidently obliquely subtruncated judging from the lines of growth; anterior margin narrowly rounded, and the ventral one slightly arched. Umbo broad, with a rounded umbonal ridge. Ornamentation consisting of more or less distinct concentric lines of growth, beside a few tubercles near the umbo and the postero-dorsal part.

Locality and geological horizon: The Hashima Beds; The Futagojima Mine [?], off Nagasaki, province of Hizen.¹

Limiidae

Lima, (BRUG.) CUVIER

Lima amaxensis YOKOYAMA

Pl. XX (III), Fig. 35

1911. *Lima amaxensis* YOKOYAMA: "Some Tert. Foss. Miike," p. 15, Pl. III, fig. 2.

The holotype of this species is from Hangôchi, Amakusa-Shimo-shima.² I have obtained from another locality on the same island an imperfect external cast which is most probably identical with this species, though a little greater in height. The ears are broken in my example; the radial ribs are somewhat undulate, and those on the median part of the shell are much broader than the others.

Localities and geological horizon: The Itchoda Sandstone; Hangôchi, Hondo-machi (the holotype) and Imada, Itchôda-mura (the plesiotype), both in Amakusa-Shimo-shima.³

Lima amaxensis YOK. var. *kumasoana* nov. var.

Pl. XX (III), Figs. 31, 32

I have three imperfect specimens closely allied to the preceding species, but they are more rounded and longer judging from the lines of growth, and are covered with more numerous radial

¹肥前國長崎港外二子島二子島炭坑.

²天草下島本渡町半河内.

³同島一町田村今田.

ribs (about 70). The ribs are more or less undulating, usually as narrow as the interspaces, but sometimes, especially on the median part of the shell, much broader than the interspaces. Moreover, the ribs occasionally become dichotomous toward the margins. The species, however, is, I believe, better regarded as a variety of *L. amaxensis*. In its surface-sculpture, it thus approaches *L. goliath* SM.¹ a recent species of Japan. •

Dimensions :	HEIGHT	LENGTH
(estimation)	ca. 53 mm.	ca. 52 mm.

Localities and geological horizon: The Itchôda Sandstone; Yamaguchi, Hondo-machi, Amakusa-Shimo-shima.² The Sakasegawa Group [?]; the same island, the precise locality being unknown.

***Lima eocenica* nov. sp.**

Pl. XXI (IV), Figs. 1-3

Shell compressed, large, obliquely ovate, higher than long, and considerably inequilateral; antero-dorsal margin nearly straight or slightly concave, the ventral evenly rounded; postero-ventral margin broadly arcuate, passing gradually into the posterior; dorsal margin of the posterior ear short, forming an obtuse angle with the antero-dorsal margin of the valve. Umbo small and pointed. Anterior ear very small. Surface ornamented with fine lines of growth and rude, irregularly spaced concentric ridges, besides fine radiating striae, which are confined to small portions near the anterior and posterior extremities.

Dimensions :	HEIGHT	LENGTH
	ca. 11 mm.	ca. 9.5 mm.

A number of more or less deformed external and internal casts have been obtained. The present species is allied to *L. goliath* SM.,³ a Recent and Neogene species of Japan, but it seems to be more compressed and slightly longer, and has very fine radial striae. As to the surface sculpture, *L. goliath* is very variable, the smooth part of the shell being narrow in some specimens and broad in others, while all the examples of the present form have a considerably broad smooth part, the radiating striae being confined to small portions near the anterior and posterior ends.

Locality and geological horizon: The lowest part of the Sakasegawa Shale; Imada, Itchôdamura, Amakusa-Shimo-shima.

***Lima* sp. indet.**

Pl. XVIII (I), Fig. 1

A very large internal cast of *Lima*, more than 20 cm. in height, has been obtained from the upper part of the Manda Group of the Miike coal-field. It is much larger than any of the specimens of *L. eocenica* nov. The sculpture is unknown except for the concentric lines.

¹M. YOKOYAMA: "Foss. Miura Peninsula," *Op. cit.*, p. 147, Pl. XVI, figs. 7, 8.

²天草下島本渡町字山口.

³M. YOKOYAMA: "Foss. Miura Pen.," p. 147, Pl. XVI, figs. 7, 8; "Moll. Rem. Upperm. Pt. Jô-Ban Coal-f.," p. 26, Pl. III, figs. 1, 4; "Moll. Rem. Mid. Pt. Jo-Ban Coal-f.," p. 19; "Moll. Tert. Chichibu," p. 123, Pl. XIV, fig. 11.

Locality and geological horizon: The Yotsuyama Sandstone; a cliff along a pond of Kunai, Arao-mura, Tamana-gun, province of Higo.¹

Anomiidae

Anomia, LINN.

Anomia sp. indet.

Pl. XXI (IV), Figs. 10, 11, 12, 15

I have a few imperfect specimens of *Anomia*.

Shell small, very convex and sometimes almost hemispheric; variable in outline, but usually suborbicular and occasionally slightly oblique. Umbo inconspicuous. Surface apparently smooth except for crowded lamellose lines, but with a trace of numerous fine radial striae. Test thin.

The largest specimen attains 19 mm. in length and 21 mm. in height.

The present species differs from *A. lischkei* DAUT. and FISCHER,² a living form of Japan, by its more globose, more orbicular, and more smooth shell. *A. primoeva* DESH.³ from the Cuisanian of France seems to be somewhat similar to ours in the external features, but I cannot make a precise comparison between these two species owing to the imperfect preservation of our specimens.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima.⁴

A few specimens probably identical with this species have been obtained from the same horizon exposed at Iwasaki, Aizu-mura⁵ north of Mirokudake.

Mytilidae

Mytilus, (LINNÉ) BOLTEN

Mytilus sp. aff. *M. rigaultii* DESH

Compare:

1864. *Mytilus rigaultii* DESHAYES: "Descr. d. Anim. s. Vert. d. Basin d. Paris," Vol. II, p. 29, Pl. LXXIV, figs. 23, 24.

There are a few imperfect external and internal moulds of *Mytilus* in my collection.

Shell rather small and transversely elongate, moderately inflated along the umbonal ridge; thick in front and attenuated behind; anterior end very short; hinge margin nearly straight, forming a

¹ 肥後國王名郡荒尾村宮内.

² DAUTENBERG and FISCHER: Jour. Conch., Vol. LVI, p. 40; M. YOKOYAMA: "Foss. Up. Musashino," p. 176; M. YOKOYAMA: "Tert. Moll. Shinano and Echigo," p. 15.

³ G. P. DESHAYES: "Descrip. Anim. s. Vert. Bas. Paris.," Vol. II, p. 132, Pl. LXXXV, figs. 10-12, 27.

⁴ 天草上島教良木河内村彌鞆岳.

⁵ 合津村岩崎.

blunt angle with the gently arched posterior one; ventral margin slightly concave and the postero-ventral narrowly rounded. Umbo inflated, almost terminal; umbonal ridge rounded and somewhat curved. Surface ornamented with numerous delicate, dichotomous radial ribs and slightly or much narrower grooves in alternation; ribs below the umbonal ridge very fine and crowded; concentric lines fine, but occasionally distinct. Posterior half of the inner margin finely crenulated.

Dimensions:	LENGTH	HEIGHT
	ca. 27 mm.	ca. 13 mm.

The present specimens are apparently allied in outline to *M. rigaultii* DESH. from the Lutetian and Bartonian of France, but an accurate comparison between these two forms must be postponed until other better specimens are brought for examination.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Ipponmatsu, Ginsuimura, Miike-gun, province of Chikugo.¹

Crassatellitidae

Crassatellites, KRUEGER

Crassatellites fuscus (YOKOYAMA)

Pl. XVIII (I), Figs. 7, 7a

1911. *Crassatella fusca* YOKOYAMA: "Some Tert. Foss. Miike," *Op. cit.*, p. 8, Pl. II, figs. 1-3, 5, 6; Pl. II, fig. 4.

The syntypes of this species are from the Manda Group of the Miike coal-field and the Sakasegawa Group of the Amakusa coal-field. The present species is one of the most common fossils in these two coal-fields. Figured here, is a well preserved small specimen from the Miike coal-field; it is trapezoidal in shape owing to the nearly vertical truncation of the posterior end.

Localities and geological horizons: The Manda Group; the Manda Mine,² the Yotsuyama Mine,³ a point direct east of Kôda near the Kachidachi Mine,⁴ and Tôka,⁵ all four in the Ômuta city, province of Chikugo. The Itchôda Sandstone; Sakasegawa, Sakasegawa-mura,⁶ Imada, Itchôda-mura, and Yamaguchi, Hondo-machi, all three in Amakusa-Shimo-shima.

¹筑後國三池郡銀水村一本松.

²萬田坑.

³四山坑.

⁴勝立坑附近高田.

⁵大牟田市稻荷.

⁶天草下島坂瀬川村坂瀬川.

Cyrenidae

Cyrena, LAMARCK

(Batissa, GRAY.)

Cyrena (Batissa) ponderosa nov. sp.

Pl. XX (III), Figs. 10, 30; Pl. XXI (IV), Fig. 21; Pl. XXII (V), Figs. 16-19

Shell variable in shape from rotundate-pentagonal to subtrigonal, very inflated, a little higher than long; frequently slightly inequilateral, anterior side being usually longer; anterior extremity somewhat produced and the posterior extremity truncated almost vertically; anterior margin sinuated at about its middle part and the posterior one slightly convex; ventral margin evenly rounded. Umbones not eroded, prominent, inflated, curved much inward and slightly forward, and approximate; umbonal ridge rounded but rather distinct, extending from the umbo to the postero ventral end. Lunule cordate, pouting, bounded by broad and shallow depressions; postero-dorsal area behind the umbonal ridge flattened, with two narrow radial depressions. Surface ornamented with fine lines of growth and regularly and distantly spaced, narrow, elevated concentric ribs; the lines of growth and the ribs wavy on the lunule. Test thick. Hinge of the left valve with three diverging cardinal teeth; the middle one broadest and the posterior one slender and very oblique; anterior lateral tooth long and strong, the posterior one slender, and both finely corrugated.

Dimensions:	LENGTH	HEIGHT	THICKNESS (one valve)
	48 mm.	50 mm.	20 mm.
	23	24	8

The present species resembles *C. (B.) subtrigonalis* KRAUSE¹ from the Melawi Group (Eocene) of West Borneo, but differs from it in having its umbo broader, and the umbonal ridge less distinct. In the latter species the postero-dorsal area is provided with two narrow ridges separated by a broad, shallow interspace, but in the former with two narrow grooves. Our species is also allied to *C. (B.) borneensis* BÖTTG.² from the Eocene of Borneo, but is more inflated and subpentagonal and has a more distinct umbonal ridge.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Takesaki, Kôyagi-jima, province of Hizen³ (several specimens). The Toishi Beds; the Shinyama Mine, Oniki-mura, Amakusa-Shimo-shima⁴ (one specimen). The middle part of the Hashima Beds; the Hashima Mine,⁵ Hashima, the Futagojima Mine, Futago-jima,⁶ and the Kakize Mine,⁷ Takashima, all these three islets lying off Nagasaki, province of Hizen.

¹ P. G. KRAUSE: "Ueber Tert. Cret. Alt. Ablager. West-Borneo," p. 192, Pl. XIII, figs. 1-10; K. MARTIN; "Die Fauna der Melawigruppe," p. 294, Pl. XV, figs. 4-7.

² O. BÖTTGER: "Die Eocänformation von Borneo und ihre Versteinerungen," p. 35, Pl. VI, figs. 52-55; Pl. VII, fig. 57; P. G. KRAUSE: *Op. cit.*, p. 199.

³ 長崎港外香焼島竹崎.

⁴ 天草下島鬼貫村新山坑.

⁵ 端島坑.

⁶ 二子島坑.

⁷ 蠟瀬坑.

Carditidae

Venericardia, LAM.

Venericardia mandaica (YOKOYAMA)

Pl. XX (III), Figs. 11-19; Pl. XXI (IV), Figs. 6, 8, 9

1911. *Cardita mandaica* YOKOYAMA: "Some Tert. Foss. Miike." *Op. cit.* p. 9, Pl. II, figs. 8-11.

The syntypes of the species were obtained from the Manda Group of the Miike coal-field. A number of specimens were subsequently collected from the Kachidachi Sandstone exposed at different localities in this coal-field and a few from the Sakasagawa Group of Amakusa-Shimo-shima. All the specimens in my collection are more inflated, higher, and have a more prominent umbo than the syntypes. On a close examination, however, I believe that they are specifically identical with those figured by Prof. YOKOYAMA, there being some transitional forms linking these two extremities.

As the Amakusa specimens are better preserved, the specific description mainly based on them, is here written:

Shell rather small, often very convex; trigonally and obliquely ovate, usually as high as long, but sometimes longer than high, considerably inequilateral; anterior end rounded and the posterior subtruncated slightly obliquely; antero-dorsal margin more or less deeply excavated beneath the umbo, and the postero-dorsal one long, and somewhat arcuate; ventral margin broadly and evenly convex. Umbo prominent, inflated, curved much inward and moderately forward, with a rounded, more or less indistinct umbonal ridge. Lunule deeply excavated, and broad cordiform; escutcheon ill developed. Ornamentation consisting of 20-22 radial ribs and concentric incremental lines of growth. Ribs more or less rugose, narrow, elevated, and acute near the umbo; broad, low and rounded near the ventral margin; 6-7 on the posterior part of valve crowded, almost straight, narrow; those on the anterior part distant, curved, and tuberculated. Lines of growth elevated, with a few periodic growth ridges. Test thick. Posterior left cardinal tooth broad, elongated, and very oblique.

Dimensions:	LENGTH	HEIGHT	THICKNESS
	28 mm.	32 mm.	14 mm. (one valve)
	23	23	10 (")
	20	21	19
	21	20	17

A few external casts [Pl. XX (III), figs 15-19] from Sakasagawa-mura, Amakusa-Shimo-shima, are rather compressed, transversely elongated, and have small umbones and no periodic growth ridges, like the syntypes, but these features of the former may be attributed to their different state of preservation.

Localities and geological horizons: The Kachidachi Sandstone; the Yotsuyama Mine, Chayano-hara south of Miike-machi,¹ and two points direct west and east of the Kachidachi Mine,² all in Ômuta city, province of Chikugo.

¹三池郡三池町字茶屋原.

²勝立坑.

The Itchôda Sandstone; Yamaguchi, Hondo-machi, Amakusa-Shimo-shima.

The Sakasegawa Group?; Ushibuka-machi¹ on the same island.

The Itchôda Sandstone; Sanshûnoô, Sakasegawa-mura² (a few doubtful specimens).

Venericardia nipponica YOKOYAMA

Pl. XXI (IV), Fig. 7; Pl. XXII (V), Figs. 2, 20

1911. *Venericardia nipponica* YOKOYAMA: "Some Tert. Foss. Miike." *Op. cit.*, p. 8, Pl. III, figs. 5a, 5b.

The syntypes of this species are from the Manda Group of the Miike coal-field and the Sakasegawa Group of the Amakusa coal-field. This fossil is one of the most common forms in these two coal-fields, and is especially abundant in the Kachidachi Sandstone and the Itchoda Sandstone.

I have obtained numerous specimens also from these two formations. Among the specimens in my collection, the shape of the shell is somewhat variable, some examples being obliquely ovate, very inequilateral and much longer than high, and others subequilateral and rotundate in outline. Moreover, not a few of them are provided with crowded, fine, but prominent concentric lines near the margin, where the radial ribs are more or less obsolete in this case.

Localities and geological horizons: The Manda Group; the Yotsuyama Mine, a point east of the Kachidachi Mine, and the Manda Mine, all these three in Ômuta city, province of Chikugo.

The Sakasegawa Group; Itchoda, Itchoda-mura,³ and Sakasegawa, Sakasegawa-mura, both in Amakusa-Shimo-shima. The Sakasegawa Group or the Fukami Sandstone; the sea-coast south of Shimotsu-fukae⁴ on the western coast of the same island.

Diplodontidae

Diplodonta, BRONN.

Diplodonta [?] *problematica* nov. sp.

Pl. XXII (V), Figs. 3, 4

Shell moderately convex, suborbicular, almost equilateral, slightly longer than high; anterior end rounded and the posterior subtruncated; antero-dorsal margin concave in front of umbo, relatively long, sloping forward, and making an angle about 130° with the almost straight postero-dorsal margin; postero-ventral, ventral and antero-ventral margins forming as a whole a semicircular curve. Umbo small, pointed, not prominent. Surface with crowded, narrow, concentric incremental lines. Test rather thin.

¹天草下島牛深町.

²坂瀬川村三集尾.

³一町田村一町田.

⁴下津深江.

Dimensions:	LENGTH	HEIGHT	THICKNESS
	20 mm.	17 mm.	6 mm. (one valve)

As the hinge is not visible in all the specimens, the reference of the present species to *Diplodonta* admits of some doubt. If it belong to this genus, however, then it resembles *D. semiaspera* PHIL.,¹ a recent species of Japan, but is less convex, more equilateral, and more distinctly angulated at the postero-dorsal end. It is also allied to *D. japonica* PILS.,² but is less convex and has its umbo more prominent. *D. cycloides* BELL.³ from the Eocene of Egypt is allied to ours, but it seems to be more inequilateral.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima. A few specimens.

Cardiidae

Cardium, LINN.

Cardium miikense nov. sp.

Pl. XVIII (1), Figs. 5, 6

Shell rather small, inflated; subquadrate, nearly equilateral, rather longer than high; anterior end rounded, the posterior truncated vertically; ventral margin very broadly arcuate, forming a continuous curve with the anterior margin, and sustaining an obtuse angle with the posterior. Umbo very prominent, much incurved, with a rounded but distinct umbonal ridge extending to the postero-ventral end; postero-dorsal area behind the ridge somewhat flattened. Ornamentation consisting of radial ribs and grooves in alternation; ribs about 22, subequal, sharp and elevated, usually fairly rounded on top, but rarely acute; grooves deep, and nearly equal in width to the ribs themselves.

Dimensions:	HEIGHT	LENGTH
	ca. 16 mm.	ca. 17 mm.
	ca. 20 mm.	ca. 20 mm.

There are a few imperfect specimens of this species. The ribs are generally eroded, but they are smooth, and covered only with numerous fine concentric lines judging from some external moulds. The present species is similar to *C. breveri* GABB⁴ from the Tejon and Domengine Groups of California, but is less sharply truncated posteriorly, and possesses a less prominent umbonal ridge and narrower ribs. R. B. NEWTON⁵ once figured an allied specimen, under the name *C. cfr. obliquum* LAM., from the Upper Lutetian of Nigeria, Africa, but this African form is relatively shorter and has more numerous ribs than ours.

¹G. DUNKER: Index Moll., p. 218; M. YOKOYAMA: "Foss. Miura Pen.," p. 131, Pl. X, figs. 2, 3.

²H. A. PILSBRY: "Cat. Mar. Moll. Japan," p. 132, Pl. III, figs. 6, 7; M. YOKOYAMA: "Foss. Miura Pen.," p. 131, Pl. X, fig. 4.

³P. OPPENHEIM: *Op. cit.*, p. 147, Pl. XIII, figs. 4-6; Pl. XVI, figs. 1, 7.

⁴W. M. GABB: "Paleontology of California," Vol. I, p. 173, pl. XXIV, fig. 155; G. H. ELDRIDGES and R. ARNOLD: "The Santa Clara Valley, etc., Pl. XXVI, fig. 5.

⁵R. B. NEWTON: "Eocene Moll. Nigeria," p. 74, Pl. VII, figs. 6-9.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Komenoyama¹ and Miike-machi, province of Chikugo; Kanayama,² Fumoto-mura, Tamana-gun, province of Higo. The Upper *Orthaulax japonicus* Zone; Ôura, Ômuta city.

Veneridae

Macrocallista, MÖRCH.

Macrocallista ariakensis nov. sp.

Pl. XVIII (I), Fig. 16; Pl. XX (III), Figs. 26-29

Shell small, relatively compressed; transversely elongate, trigonally ovate, somewhat variable in the relative height and length; much inequilateral, posterior side being about twice as long as the anterior; posterior end narrowly rounded, the anterior evenly convex; antero-dorsal margin concave in front of umbo; postero-dorsal margin long, almost straight, making an angle of about 120°-130° with the antero-dorsal margin; ventral margin very broadly convex. Umbo small, not prominent, curved inward and forward. Lunule lanceolate, excavated, and bordered by a ridge; escutcheon not well developed; pallial line faint, with a short trigonal sinus; inner margin of valve smooth. Surface ornamented with narrow concentric ridges and grooves in alternation, beside fine lines of growth. Test rather thin.

Dimensions:	HEIGHT	LENGTH
	22 mm.	24 mm.
	17	22
	14	20

Several specimens were examined; none of them shows the hinge, but they most probably belong to *Macrocallista*. The present species is similar to *M. stantoni* WARING³ from the Martinez Group of California, from which, however, it differs by a smoother sculpture and slightly arcuated postero-dorsal margin. *Venus mitsuiana* YOK.⁴ (whose dentition was not described) from the Manda Group of the Miike coal-field is easily distinguished from ours by its more arched postero-dorsal margin and less prominent umbo.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima; Akase,⁵ Uto-gun, province of Higo; Ipponmatsu, Ginsui-mura, and Miike-machi, Miike-gun, province of Chikugo.

A few imperfect specimens most probably referable to this species were obtained from the same horizon at Takesaki, Kôyagi-jima, off Nagasaki, province of Hizen.

¹三池町字米山.

²王名郡府本村金山.

³C. A. WARING: "Stratigr. a Faun. Relat. Martinez to Chico and Tejon," p. 77, Pl. XIV, figs. 1, 6; R. N. NELSON: "Pal. Martinez Eoc. Calif.," p. 413, Pl. LII, figs. 7, 8.

⁴M. YOKOYAMA: "Some Tert. Foss. Miike," p. 10, Pl. I, figs. 5a, 5b.

⁵肥後國宇土郡網田村赤陳頁.

Pitaria, RÖMER (em. by Dall)**Pitaria** sp. indet.

Pl. XXI (IV), Figs. 19, 20

I have two internal moulds which probably belong to *Pitaria*.

Shell rather large, transversely ovate, inequilateral; anterior end somewhat produced and narrowly rounded, and the posterior evenly convex; ventral margin broadly arcuated; postero-dorsal margin long and slightly arched. Surface displaying fine lines of growth.

The present specimens seem to be identical with a species very common in the Takashima and Asakura coal-fields and to be described in the second part of this paper, which will follow in the near future.

Locality and geological horizon: The Sakasegawa Group or the Fukami Sandstone; the sea coast south of Shimotsu-fukae, Amakusa-Shimo-shima.

Tellinidae**Tellina**, LAM.**Tellina** sp. indet. *a*

Pl. XVIII (I), Fig. 9

There are two moulds, one external and one internal.

Shell moderately convex; transversely elongate, inequilateral, the posterior side being a little shorter; anterior margin well rounded, and the posterior truncated; ventral margin broadly arcuate, ascending to the posterior; antero-dorsal margin scarcely arched and sloping down very gently, the postero-dorsal one nearly straight, and slightly steeper in inclination than the antero-dorsal. Umbo pointed, not prominent, with a faint umbonal ridge.

Dimensions:	HEIGHT	LENGTH
	13 mm.	19 mm.

The present specimens somewhat resemble *T. nitidula* DKR.¹ from the Recent and Neogene of Japan, and *T. sejugata* YOK.² from the Neogene of Japan, but differ from the first of these by the shell being less elongated and the posterior margin more broadly rounded, and from the second by the ventral margin being more arched and the antero- and postero-dorsal margins less diverging.

Locality and geological horizon: The Yotsuyama Sandstone; Kunai, Arao-mura, Tamana-gun, province of Higo.

¹G. DUNKER: "Moll. Jap.", p. 27, Pl. III, fig. 14; LISCHKE: *Op. cit.* Vol. I, p. 129, and Vol. II, p. 113, Pl. X, figs. 10, 11; BRAUNS: "Geol. Env. Tôkyô," p. 39; S. TOKUNAGA: "Foss. Env. Tôkyô," p. 42, Pl. II, fig. 30; M. YOKOYAMA: "Foss. Miura Pen.," p. 112, Pl. VII, fig. 15.

²YOKOYAMA: "Moll. Rem. Jô-Ban," p. 14, Pl. II, figs. 9-11. M. YOKOYAMA: "Tert. Moll. Shinano and Echizen," p. 12.

Tellina sp. indet. *b*

I have a few internal and external casts of *Tellina* which are allied to the preceding species. The former are, however, transversely more elongated and more equilateral than the latter, rather approaching *T. vestaloides* YOK.,¹ a living species of Japan.

Dimensions :	HEIGHT	LENGTH
	10 mm.	15 mm.
	11	17
	13	20

Localities and geological horizon : The Tôka Sandstone ; Tôka and Ôura, Ômuta city, province of Chikugo.

Macoma, LEACH**Macoma** sp. indet. *a*

Three imperfect external moulds and casts were examined.

Shell short, somewhat convex, slightly inequilateral, posterior side being shorter; anterior end well rounded and the posterior truncated; ventral margin broadly convex, ascending rather rapidly toward the posterior one; antero-dorsal margin scarcely arched, passing gradually into the anterior; postero-dorsal margin nearly straight and steeply inclined. Surface covered with crowded, rather distinct concentric lines.

Dimensions :	HEIGHT	LENGTH
(estimated)	25 mm.	33 mm.

The present specimens are very imperfect, but are somewhat similar to *M. dissimilis* MART.,² a living and Neogene species of Japan.

Locality and geological horizon : The Yotsuyama Sandstone ; the northern foot of Hakamadake, Tamana-gun, province of Higo.

Solenidae**Cultellus**, SCHUMACHER**Cultellus** [?] *brevis* nov. sp.

Pl. XXII (V), Fig. 1

Shell small, compressed; transversely elongate, rather short and straight; dorsal and ventral margins subparallel except near the ends; anterior and posterior ends narrowly rounded. Umbo small, not conspicuous, situated at about a third the length from the anterior end. Surface smooth except for fine lines of growth.

¹M. YOKOYAMA: "Foss. Miura Peninsula." *Jour. Coll. Sci. Imp. Univ. Tôkyô*, Vol. XXXIX, Art. 6, p. 114, Pl. VII, figs. 2, 5.

²H. A. PISERY: "Cat. Mar. Moll. Japa," p. 125; S. TOKUNAGA: *Op. cit.*, p. 45, Pl. III, fig. 2; LISCHKE: *Jap. Meerseconch*, Vol. II, p. 115, Pl. IX, figs. 15-17; BRAUNS: *Op. cit.*, p. 39; M. YOKOYAMA: "Foss. Miura Pen.," p. 116, Pl. VII, figs. 19, 20; M. YOKOYAMA: "Moll. Rem. Upperm. Jô-Ban," p. 20.

Dimensions :	LENGTH	HEIGHT
	35 mm.	13 mm.

I have a few imperfect specimens, none of which show the internal features. If the present species really belong to *Cultellus*, then it is allied to *C. izumoensis* YOK.,¹ a rather common form of the Neogene of Japan, although easily distinguishable from the latter by a much shorter shell, and by an umbo more remote from the anterior end.

Locality and geological horizon: The Upper *Orthaulax japonicus* Zone; Koyagi-jima, off Nagasaki, province of Hizen. A few doubtful specimens have been obtained from the Lower *Orthaulax japonicus* Zone at Takesaki on the same island.

Corbulidae

Corbula, BRUG.

Corbula (s. s.) *subtumida* nov. sp.

Pl. XXII (V), Figs. 6, 7

Shell small, trigonal; convex especially near the ventral margin; subequivalve, and slightly inequilateral, the anterior side being longer; anterior part convex and rounded along the margin, and the posterior part produced, attenuated and obliquely truncated at the end; antero-dorsal margin arched and the postero-dorsal concave in front of umbo, sloping very steeply downward; ventral margin broadly arcuated, ascending posteriorly, and forming a blunt angle with the posterior margin. Umbo rather prominent, inflat, curved much inward and slightly forward, with a posterior umbonal ridge which is somewhat indistinct near the umbo, but fairly prominent near the postero-ventral end; the postero-dorsal area behind the ridge sometimes compressed. Surface ornamented with narrow, more or less irregularly spaced, distinct concentric ribs and grooves in alternation; both ribs and grooves finer near the umbo than on the lower part of the shell. Test rather thick.

Dimensions :	HEIGHT	LENGTH	THICKNESS
	8 mm.	12 mm.	5 mm. (left valve)

All the specimens from Amakusa and the Uto Peninsula are apparently eroded on the surface and do not show any sculpture, but I have one example from Kôyagi-jima, off Nagasaki, in which ornamentation is preserved.

The present species closely resembles *C. tomulata* HANNA² from the La Jolla Formation (Middle Eocene) of California, but is more convex at the umbonal region and has a more prominent, smaller umbo and a more excavated postero-dorsal margin.

Localities and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Uto-gun, and Mirokudake, Amakusa-Kami-shima, both in the province of Higo; Takesaki, Kôyagi-jima off Nagasaki, province of Hizen; Ipponmatsu, Ginsui-mura, Miike-gun, province of Chikugo (a doubtful specimen).

¹M. YOKOYAMA: "On some Fossil Moll. from Neogene of Izumo," p. 5, Pl. II, fig. 1; M. YOKOYAMA: "Moll. Rem. Uppermost Pt. Jô-Ban," p. 18, Pl. V, figs. 2, 3.

²M. A. HANNA: "An Eocene Invertebrate Fauna from the La Jolla Quadr." *Univ. Calif. Pub. Bull. Geol.*, Vol. XVI, p. 297. Pl. XLIX, figs. 1-5, 11, 14.

(Cunaecorbula, COSSMANN)

Corbula (Cunaecorbula) kyushuensis nov. sp.

Pl. XX (III), Figs. 22-25; Pl. XXI (IV), Figs. 16-18

Shell relatively large, triangular; subequivalve and almost equilateral or slightly inequilateral, the posterior side being sometimes a little longer; rather high, but variable in the relative height and length; moderate in convexity, but usually flattened near the ventral margin; antero- and postero-dorsal margins nearly straight, subequal in inclination, and sloping steeply downward; anterior end rounded and the posterior truncated a little obliquely; postero-ventral end bluntly pointed; ventral margin very broadly arched. Umbo inflated and prominent, curved moderately inward and slightly backward; inclined forward; the posterior umbonal ridge distinct, sharp, extending from the umbo to the postero-ventral end; the postero-dorsal area behind the ridge flat or some times slightly excavated, nearly perpendicular to the plane of the shell. Surface ornamented, with regular concentric ribs and grooves in alternation besides fine concentric lines. Test rather thin

Dimensions :	HEIGHT	LENGTH	THICKNESS OF ONE VALVE
	7.5 mm.	13.0 mm.	3 mm.
	12	18	4

Most of the specimens before me are eroded on the surface and the sculpture is not preserved except for the fine lines of growth. A few examples, however, are ornamented with concentric ribs and grooves.

The present species is similar in various points to *C. parilis* GABB¹ from the Middle Eocene of California, but differs from the latter by a more sharp umbonal ridge and by the absence of the radiating striae on the surface. It is very distantly similar to *C. venusta* GLD.,² a recent and Neogene form of Japan, but is greater in height and more convex; it has also a more sharp umbonal ridge and a more convex ventral margin.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone: Akase, Ôda-mura, Uto-gun, province of Higo; Takesaki, Kôyagi-jima, off Nagasaki, province of Hizen; Miike-machi, Miike-gun, province of Chikugo; Ipponnatsu, Ginsui-mura, the same province.

¹ W. M. GABB: "Paleontology of California," Vol. I, p. 150, Pl. XXIX figs. 239, 239a. M. A. HANNA: *Op. cit.*, p. 295, Pl. XLIII, figs. 7-11, 13.

² M. YOKOYAMA: "Foss. Miura Pen.," *Op. cit.*, p. 107, Pl. VII, figs. 4-7.

GASTROPODA

Trochidae

Turricula, DALL.

Turricula sp. indet.

Pl. XVIII (1), Fig. 10

I have only a deformed external cast of this specimen which is not sufficient for a specific determination.

Shell turbinate, with a high spire. Whorls 6 or 7 in number, each angulated at a little above the mid-point of its depth, sloping above and nearly vertical below the angle; ornamented with two spiral rows of low, round tubercles; the upper one lying on the angle and more prominent than the lower, and the lower one situated along the lower margin.

Body whorl large, biangulated, each angle bearing a row of tubercles; the interspace between the two angles flattened and vertical; the lower angle rounded; base convex, ornamented with about five, closely nodulous, spiral ribs narrower than the interspaces; columella regularly arcuated. Tubercles prominent, spirally elongated and rather distant.

About 37 mm. in height.

This species is identical in many features with *T. crumpii* (PILS.),¹ a recent and Neogene form of Japan. In the present one, however, the whorls seem to be less convex, the sutures shallower, and the infrasutural necklace of beads less distinct than in *T. crumpii*.

Locality and geological horizon: The Yotsuyama Sandstone; the northern foot of Hakamadake, Tamana-gun, province of Higo.

Neritidae

Nerita, ADANSON

Nerita (s.s.) *subgranulosa* nov. sp.

Pl. XIX (II), Fig. 14; Pl. XXI (IV), Fig. 4

Shell small, semiglobose with a very small, depressed spire; a little higher than broad. Last whorl very large and inflated; posterior part fairly flattened, the median very convex and rounded,

¹ PILSBRY in *Nautilus*, VI, p. 105, Pl. II, fig. 3; Catalogue Mar. Moll. Japan, p. 97, Pl. XI, fig. 4. M. YOKOYAMA: "Foss. Miura Pen., p. 90, Pl. V, figs. 27, 28.

and the anterior somewhat flattened. Aperture large and rounded; anterior margin rounded and the posterior margin more or less straight, reaching to the level of the spire; inner lip (columellar area) flattened, with a number of small, moderately raised granules, and denticulated along the greater part of the straight margin; inner surface of the outer lip can not be observed. Surface ornamented with narrow, round, elevated spiral ribs and grooves in alternation; ribs regularly granulated, 18 in number on the early part of the body-whorl and counting 25 near the aperture, new ones appearing in the grooves on the median part of the shell; these interstitial ribs are very narrow at first but become gradually broader.

Dimensions :	HEIGHT	BREADTH
	10 mm.	12.5 mm.

Seven specimens were examined.

The present species is similar to *N. granulosa* DESH.¹ from the Thanetian and *N. namnetica* VASSEUR² from the Auversian and Priabonian of Europe, but is distinguished from these foreign forms by its different sculpture. *N. triangulata* GABB³ from the Middle Eocene of California is also closely akin to ours, but has a shell more sharply triangulated and the ribs less distinctly granulated. Among the living Japanese species, *N. albicilla* LINN.⁴ resembles ours very distantly.

Localities and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Uto-gun, province of Higo; Ipponmatsu, Ginsui-mura, Miike-gun, province of Chikugo; Takesaki, Kōyagi-jima, province of Hizen.

Naticidae

Polynices, MONTE.

(Neverita, RISSO)

Polynices (Neverita) eocenica nov. sp.

Pl. XVIII (I), Figs. 2, 3

Shell small, rather thick, and short, consisting of 6 1/2 whorls; spire small, scarcely projecting, conical, and somewhat channeled. Body whorl very large, occupying almost the entire shell, ventricose, well rounded, but faintly compressed at sides; base convex; umbilicus deep, almost covered by a solid, large, broad callus, whose end is rounded and thickened but not grooved; aperture semilunar; inner lip oblique and slightly curved. Surface ornamented with dense, wavy lines of growth.

¹ G. P. DESHAYES: "Descr. Anim. sans vert. Paris," Vol. III, p. 16; M. COSSMANN and G. PISSARRO: "Iconograph. comp. Coq. Foss. Eoc. Paris," Pl. V, fig. 38-3.

² J. BOUSSAC: "Etudes Paléontologiques sur le Nummulitique Alpin," p. 268, Pl. XVII, figs. 6-9.

³ W. M. GABB: "Paleont. Calif.," Vol. II, p. 170, Pl. XXVII, figs. 52, 52a. M. A. HANNA: *Op. cit.*, p. 301, Pl. XLVI, figs. 11, 12, 16, 17. R. ARNOLD: "Paleontology of the Coalinga District," *U. S. Geol. Surv., Bull.* no. 396, p. 14, Pl. IV, figs. 12, 12a.

⁴ G. W. TRYON: *Man. Conch.*, Vol. X, p. 19, Pl. II, figs. 21-26. H. A. PILSBRY: "Cat. Jap. Moll.," p. 87.

The present species resembles *N. secta* GAEBB¹ from the Tejon Group of California, but has no transverse groove on the callus. On the other hand, it is allied to *N. cfr. calvimontana* DESH.² from the Eocene (Lutetian) of Nigeria, Africa, but is more conical.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima; Ipponmatsu, Ginsui-mura, Miike-gun, and Miike-machi, province of Chikugo; Takesaki, Kôyagi-jima, province of Hizen. The Upper *Orthaulax japonicus* Zone; Ôura, Ômuta city, province of Chikugo.

(**Lunatia**, GRAY.)

Polinices (*Lunatia* [?]) **utoensis** nov. sp.

Pl. XXII (V), Figs. 21, 22

Shell small, consisting of 4 1/2 whorls; each whorl evenly convex, roundly shouldered, with its posterior part more or less flattened and nearly horizontal; suture distinct, not canaliculated. Body whorl large and ventricose; aperture partly broken, but probably semilunar or ovate; outer lip simple; inner lip oblique; umbilicus and callus unseen. Growth lines rather distinct and oblique.

A few specimens were examined, one of which is figured here.

This species is distinguished from the preceding one by its convex whorls and more distinct shoulder. As the callus and umbilicus are not visible in the present form, its subgeneric position is uncertain. It is externally allied to *N. (Naticina) debilis* BAY.³ from the Upper Mokattum Beds of Egypt, but is more ventricose.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Uto-gun; Mirokudake, Amakusa-Kami-shima.

Rissoinidae

Rissoina, D'ORB.

Rissoina [?] **gemma** nov. sp.

Pl. XX (III), Figs. 20, 21

Shell small (*ca.* 14 mm. high and 6 mm. wide), conical, consisting of 7 or 8 whorls; sutures distinct and canaliculated; each whorl relatively low, flat and ornamented along its upper margin with granules which are elongated vertically and soon become obsolete lower down. Last whorl rounded at the periphery; aperture broken but probably oval; outer lip and anterior extremity not well preserved, but apparently without canal. Base convex, and ornamented with two spiral grooves near

¹ W. M. GAEBB: "Paleontology of California," Vol. I, p. 10, Pl. XXIX, figs. 220, 220a.

² R. S. NELSON: "Eocene Moll. Nigeria," p. 55, Pl. V, figs. 16, 17.

³ P. OPPENHEIM: *Op. cit.*, p. 275, Pl. XXII, fig. 5.

the periphery and about eight narrow spiral lines on the other portion; lines of growth crowded, and strongly sinuated near the periphery.

There are two imperfect specimens in my collection whose both anterior and posterior extremities are not preserved. Under this condition, the reference of this species to *Rissoina* is somewhat doubtful. I am acquainted with no species previously reported from Japan that is similar to the present form.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura, Uto-gun, province of Higo.

Turritellidae

Turritella, LAM.

Turritella okadai nov. sp.

Pl. XVIII (I), Figs. 8, 14, 15; Pl. XIX (II), Figs. 5, 6, 10-13, 16

Shell large, high-turreted, many whorled and spirally ribbed. Spire high, acute, rather rapidly increasing in diameter downward; whorls small in height and separated by deep sutures, slightly convex, but usually angulated at a little above the mid-point of its depth, and often pagoda-shaped owing to the presence of a flattened upper surface; spiral ribs on the upper whorls usually three in number, of which the first or uppermost one lies on the upper surface and is generally a little narrower than the second, the second very prominent, sharp, lying on the shoulder itself, and the third, often the least developed of the three, being situated a little above the lower margin. Ribs very prominent and sharp on the lower whorls, sometimes three in number but frequently four, the finer fourth rib appearing between the second and third ribs; the first rib sometimes being a little more prominent than the second, and then the infrasutural portion of the whorl being almost horizontal; besides these, another still finer rib is frequently intercalated between the lowest rib and the next above. Body whorl large and convex; base flatly convex, with numerous, fine, crowded spiral striae, of which one stria near the periphery is slightly more prominent than the others; aperture rounded; columella concave and smooth, with rather thick callosity. Lines of growth sometimes very rugose, sinuated, running backward from the upper margin, abruptly swinging forward on the second rib, and again recurving on the third.

The present species somewhat resembles *T. (Haustator) praesincta* CONRAD from the Claiborn Eocene of North America. I am not well acquainted with this species, but it seems to have a different ornamentation from the Japanese form judging from the figure of a specimen of this species illustrated by M. COSSMANN¹ in his "Essais de Paléontologie." A young specimen of our species is similar to *T. saishuensis* YOK.² from the Neogene deposits of Japan, but is easily distinguished from it by the different sculpture on the surface.

The specific name is dedicated to Mr. I. OKADA, chief engineer of the Mitsubishi Mining Company now retired, to whom I am much indebted for various advantages during the study of the Palaeogene deposits of Kyûshû.

¹ Vol. IX, Pl. VII, fig. 13.

² M. YOKOYAMA: "On some Fossil Shells from the Island of Saishu," p. 3, Pl. I, fig. 2.

Localities and geological horizon: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima [?]; Fukuregi,¹ Fukuregi-mura, Amakusa-Shimo-shima; Akase, Ôda-mura, Uto-gun, province of Higo; Ipponmatsu (Ginsui-mura), Komenoyama, Chayanohara, and Miike-machi (frequent), all these four in Miike-gun, province of Chikugo; Takesaki, Kôyagi-jima, province of Hizen; Kanayama, Fumoto-mura, Tamana-gun, province of Higo (one doubtful specimen).

Turritella miikensis nov. sp.

Pl. XIX (II), Figs. 4, 7, 8, 15

Shell high turreted, narrow, with the apical angle less than 20°, composed of numerous whorls, and spirally ribbed; each whorl low, convex, angulated above the middle, with the upper surface flattened and sloped; spiral ribs four in number on each whorl, of which the lowest one is not prominent except on the body whorl, the uppermost one usually weaker than the two middle ones, and the second rib from above very strong, prominent, and sharp, lying on the angle of the whorl; interspaces between ribs concave and smooth. Base of the body whorl flatly convex and smooth; aperture subquadrate.

This species resembles *T. facialis* MENKE,² a living form of Japan, but is distinguished from it by having the whorl more prominently angulated and provided with stronger second and third ribs. *T. nipponica* YOK.³ from the Neogene of Japan is allied to ours, but usually five-ribbed and more flat. On the other hand, the present one is similar to *T. diastrophæ* COSSM. and PISS.⁴ from the Ranikot Series of India, but in the latter the spire is higher, and the whorls are five ribbed.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Miike-machi, Miike-gun, province of Chikugo (rather common).

Turritella [?] sp. indet. *a*

Pl. XIX (II), Fig. 9; Pl. XX (III), Fig. 33

There are a few very imperfect specimens in my collection, which are distinguished from the preceding one in the ribbing; namely, in the present species, spiral ribs on the spire-whorl are two in number, nearly equal in strength, very prominent, sharp, narrow and acute on top; the interspaces between these ribs are as broad as one half the depth of the whorl, deeply concave, and smooth, but often provided with a fine median stria. The whorl is rather low and flat. The sutures are narrow, and not channeled. The lines of growth are crowded, fine, and bisinuated. The last whorl is comparatively small, being three-ribbed, the lowest rib lying on the angular periphery; the base flat, smooth; the aperture is partly broken, but probably quadrate.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Akase, Uto-gun and Kanayama, Tamana-gun, province of Higo; Ipponmatsu, Ginsui-mura, Miike-gun, province of Chikugo.

¹ 天草下島福運木村福運木.

² TRYON: Manual Conch., Vol. VIII, p. 197, Pl. LIX, figs. 26, 27.

³ M. YOKOYAMA: "Foss. Miura Pen.," p. 71, Pl. IV, figs. 16-19; "Moll. Rem. Mid. Pt. Jô-Ban," pp. 5, 13, Pl. III, figs. 4, 5; "Moll. Rem. Upper. Pt.," p. 13, Pl. II, fig. 8.

⁴ M. COSSMANN and G. PISSARRO: "The Mollusca of the Ranikot Series," Pt. I, p. 61, Pl. VI, figs. 16, 17.

Turritella sp. indet. *b*

Pl. XX (III), Fig. 34

I have only a very imperfect specimen which can be distinguished from the preceding two species.

Shell turreted, high; apical angle about 20° ; whorls more than ten in number, each almost flat and somewhat concave along the lower margin; suture distinct; surface ornamented with about 8 fine, subequal, almost equidistant spiral ribs; of the ribs the fifth and sixth from above are slightly more prominent and are separated from each other by an interspace broader than the others and bearing another fine spiral stria.

The present specimen resembles *T. kiiensis* YOK.¹ from the Neogene of Kii and Tôtomi, but has no finer interstitial striae between the ribs, except but one cited above.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Mirokudake, Amakusa-Kami-shima.

Melaniidae**Melania**, LAM.**Melania** [?] **miikensis** nov. sp.

Pl. XVII (I), Figs. 11-13; Pl. XXI (IV), Fig. 13

Shell conical, acuminate; spire high, composed of more than ten whorls, usually eroded at the apical part. Each of the upper whorls flat or slightly concave; ornamented with a prominent spiral keel near the upper margin and two narrow spiral striae near the lower margin; each lower whorl pagoda-shaped, increasing rapidly in diameter downward, being flat at the sides and bluntly angulated at the shoulder; the posterior part narrowly flattened, and slightly inclined outward. Body whorl rather short and broad, provided with two fine spiral striae near the periphery; the lower stria more distinct than the upper, and lying on the periphery itself; base scarcely convex, ornamented with a few very narrow spiral striae on its upper portion; inner lip concave; outer lip and canal unseen. Lines of growth crowded, fine, and prominently sinuated.

The present form resembles *M. melaviensis* MARTIN² from the Melawi Group (Eocene) of West Borneo, but is distinguishable from it by the smoother whorls, bearing less numerous and decidedly finer spiral striae.

Localities and geological horizons: The Lower *Orthaulax japonicus* Zone; Ipponmatsu, Ginsui-mura, province of Chikugo; Takesaki, Kôyagi-jima, province of Hizen (not rare). The Upper *Orthaulax japonicus* Zone; Ôura, Ômuta city, province of Chikugo (common).

¹M. YOKOYAMA: "Tert. Foss. Kii," p. 52, Pl. VI, figs. 9, 10; M. YOKOYAMA: "Tert. Moll. Southern Totomi," p. 343, Pl. XXXIX, figs. 3, 4.

²K. MARTIN: "Die Fauna der Melawigruppe," p. 304, Pl. XVI, figs. 19-22; P. G. KRAUSE: "Ueber tertiäre, cretaceische u. ältere Ablagerungen aus West-Borneo," p. 214, Pl. XII, figs. 4, 5.

Melanopsidae

Faunus, MONTFORT

Faunus (s. s.) **nipponicus** nov. sp.

Pl. XXI (IV), Figs. 5, 5a, 5b

Shell thick, turreted, subulate, with a high spire; apical part broken, but its angle probably about 20°; each whorl relatively low, very faintly convex, and perfectly smooth except for fine, sinuous lines of growth; suture linear, distinct. Body whorl short, slightly longer than one half the spire, subglobose, contracted anteriorly, evenly arched at the periphery; aperture very short, roundly ovate, oblique, with its anterior extremity notched and the posterior angle free; outer lip with a posterior sinus, sinuated just in front of the suture which is here much curved ventrally; columella distinctly excavated, thickly callous, twisted and truncated anteriorly.

Dimensions :	HEIGHT	BREADTH
(estimated)	ca. 35 [?] mm.	ca. 16 mm.

We have a few specimens of this species, which is closely allied to *F. lamarckii* (DESH.)¹ from the Lutetian of France, but differs from it in the spire-whorls being broader, lower, and slightly convex, and the apical angle probably larger. The Japanese form is distinguished from *F. dutemplei* (DESH.)² from the same stage of France by the convex, and not carinated, body whorl.

Localities and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura (the type) and Mirokudake, Amakusa-Kami-shima, province of Higo.

Cerithiidae

Cerithiopsis, FORBES and HANLEY**Cerithiopsis** sp. indet.

Pl. XXI (IV), Figs. 22, 22a

There are only a few imperfect specimens in my collection.

Shell small, turreted, high, composed of whorls separated by deep sutures; each whorl moderately convex, with the lower margin excavated, and decussated by spiral riblets and transverse ribs. Spiral riblets 8 in number, narrow, subequal, more or less elevated and sharp; the lowest one situated at the lower margin; interspaces between the riblets concave, nearly equal to, or a little broader than, the riblets themselves; transverse ribs about 20 in number on the penultimate whorl, slightly recurved,

¹G. P. DESHAYES: *Op. cit.*, Vol. II, p. 472, Pl. XXXI, figs. 25, 26. See also M. COSSMANN and G. PISSARRO: *Iconogr. Comp. Coq. foss.*, Vol. II, Pl. XVIII, fig. 117-1.

²G. P. DESHAYES: *Op. cit.*, p. 472, Pl. XXXI, fig. 31.

crowded and some of them swollen so as to become broad, round varices; the interspaces much narrower than the ribs. Last whorl convex, with transverse ribs, which are indistinct except for the varices; base concave, smooth, but ornamented with very fine, crowded, spiral striae and wavy lines of growth; aperture unseen, but apparently small; inner lip concave, callous, with a short straight columella.

The present specimens are similar to *C. alternata* GABB¹ from the Martinez of California, but the latter has higher whorls, and is ornamented with alternated spiral riblets.

Cerithium cliffensis HANNA² from the Middle Eocene of California is one of the forms allied to ours, but in the former the transverse ribs are less in number, and one spiral riblet is alternated with three finer ones. *Cerithiopsis dumblei* GABB³ from the Upper Eocene of California is easily distinguished from the present specimens by its larger apical angle and less numerous spiral lines.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura, province of Higo.

Strombidae

Orthaulax, GABB.

Orthaulax japonicus NAGAO

Pl. XIX (II), Figs. 1, 2; Pl. XXII (V), Figs. 9-11, 15

1924. *Orthaulax japonicus* NAGAO: "Occurrence of *Orthaulax* in the Palaeogene of Japan," p. 13, Pl. I, figs. 1-4.

This species has been reported for the first time as existing in various localities in NW Kyûshû. Subsequently I have obtained other material from the same localities as well as in some new places. Some of these are here figured. All the localities of this species hitherto known to me are as follows:

1. Akase, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone.
2. Ipponmatsu, Ginsui-mura, Miike-gun, province of Chikugo; *ibid.*
3. A point direct south of Miike-machi, Miike-gun; *ibid.*
4. Takesaki, Kôyagi-jima, province of Hizen; *ibid.*
5. The Kakize Mine, Takashima, province of Hizen; the Upper *Orthaulax japonicus* Zone.
6. The Kôyagi Mine, Kôyagi-jima, province of Hizen; *ibid.*
7. The Hashima Mine, Hashima, province of Hizen; *ibid.*
8. Ôura, Ômuta city, province of Chikugo; *ibid.*

Besides the above places, a few more localities are now known to me as will be stated in Pt. II.

¹ W. M. GABB: "Pal. Calif.," Vol. I, p. 116, Pl. XXI, figs. 114, 114a.

² M. A. HANNA: "Eoc. Invert. Fauna La Jolla Quadr.," *Op. cit.*, p. 310, Pl. L, figs. 1-4.

³ R. E. DICKERSON: "Tejon Eocene of California." *Univ. Calif. Publ. Bull. Geol.*, Vol. IX, p. 489, Pl. XXXVIII, fig. 12.

Buccinidae

Hemifusus, SWAINSON

Hemifusus [?] sp. indet.

Pl. XVIII (I), Fig. 4

An imperfect external cast lacking the extremities has been obtained from the Miike coal-field.

Shell ovately fusiform, consisting of a few whorls (about 5 [?]); spire relatively low and conical; each whorl rapidly increasing in diameter downward, angulated at about the mid-point of its depth; the surface above the angle flat and inclined outward, and that below the angle also flat and nearly vertical.

Ornamentation consisting of two sharp carinae, many interstitial ribs, and numerous fine striae. Upper carina lying on the angle of the whorl itself and the lower one near the lower suture. Of the finer spiral ribs, there is one lying between the two carinae, another narrower one on the lower part of the upper surface and several still narrower ones on its upper part; all the interspaces between the carinae and ribs are covered with crowded fine striae.

Body whorl large, inflated and bicarinated; base convex, contracted into an anterior canal of unknown length; columella apparently smooth; aperture elongate.

Locality and geological horizon: The Kachidachi Sandstone; Tôka, Ômuta city, province of Chikugo.

Siphonaliidae

Siphonalia, ADAMS.

Siphonalia sp. indet. *a*

Pl. XXII (V), Fig. 8

I have only a small specimen of *Siphonalia* (9 mm. high).

Shell fusiform, composed of five whorls; spire elevated, but shorter than the body whorl; each whorl convex, separated by a deep suture, and ornamented with about nine, elevated, round, transverse ribs and numerous fine, crowded spiral striae; interspaces between the transverse ribs concave and as broad as the ribs themselves. Body whorl long, convex; aperture narrow, elongated, and deeply emarginate, with short, oblique anterior canal; columella recurved; outer lip smooth inside; inner lip also smooth and concave.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura, Uto-gun, province of Higo.

Sycum, BAYLE

(Bulbifusus, CONRAD)

Sycum (Bulbifusus [?]) miikense nov. sp.

Pl. XIX (II), Figs. 3, 3a

Shell large, pyriform, inflated, smooth, consisting of 4 whorls; spire depressed conical; each of the spire-whorls very small in height, with a convex shoulder, flattened or slightly concave posteriorly; sutures very deep and canaliculated. Body whorl considerably large, excavated posteriorly, convex at the sides, and rapidly contracted at the origin of the anterior canal; anterior canal moderately long, oblique, and somewhat twisted; outer lip thin, and smooth inside; inner lip excavated; columella relatively broad, long, oblique, lacking any well developed plaits; callosity unknown. Surface ornamented with fine, sometimes very distinct, lines of growth. Test thin.

Dimension: ca 14.5 cm. high.

This species is represented by a large, distorted external cast with a small part of test attached. The existence of the infrasutural crenulated beads, one of the characteristics of *Bulbifusus* CONRAD, is not determined, but there is a probability of their presence, judging from the canaliculated suture formed with the elevated outer margin. The callosity may be present, but is probably thin. Moreover, no columellar plait appears, but there is a trace of an indistinct oblique fold at the middle part of the columella.

In general, the present one has many features in common with *Bulbifusus inauratus* CONRAD,¹ the type of *Bulbifusus*, from the Claiborne Eocene of Alabama (Lutetian). I am not well acquainted with CONRAD's species, but compared with the figures of this species given by M. COSSMANN and G. W. TRYON,² our form is considerably larger and has a shorter spire.

Locality and geological horizon: The Manda Group; The Yotsuyama Mine, Ômuta city, province of Chikugo. One specimen was obtained during the sinking of the shaft.

Pleurotomidae**Turris**, BOLTON**Turris higoensis** nov. sp.

Pl. XXI (IV), Figs. 14, 14a

Shell small, with an elevated and acuminate spire; apical angle about 25°; sutures distinct. Whorls about 7 or 8 in number, each sharply angulated at about one third the depth from the upper margin; the surface above the angle flattened or somewhat concave and slightly sloping

¹ M. COSSMANN: "Essais de Paléont.," Vol. IV, p. 81, Pl. III, figs. 6, 7.

² TRYON: Man. Conch., Vol. III, p. 102, Pl. XXIX, fig. 55.

downward; that below the angle a little convex, almost parallel to the axis of the shell; each of the spire-whorls sculptured by spiral striae and a spiral row of tubercles; spiral striae about 8 in number in the penultimate whorl, narrow, confined to the lower surface, and subequal in breadth to the interspaces; of the striae the uppermost one lying on the angle and being most prominent; tubercles number about 12 on the penultimate whorl, prominent, situated on the angle, and obliquely elongated for a short distance; upper surface of whorl above the angle apparently smooth, except for crowded lines of growth, and for a somewhat granulose spiral band along the upper suture. Body whorl high and large, about as high as the spire, sharply carinated at the shoulder; ornamented with numerous spiral striae and slightly broader interspaces in alternation; sides convex, gradually tapering anteriorly. Aperture elongate with a straight, moderately long anterior canal; outer lip notched above; inner lip smooth and sinuated. Lines of growth bisinuated, giving rise to a granulose appearance where they cross the spiral striae.

Dimension: ca. 19 mm. in height.

This species is represented by a single specimen with a deformed body whorl and imperfect extremities. Its generic position is not certain at present, but it is similar in many features to *T. (Eopleurotoma) torquata* (DESH.)¹ from the Ypresian of France. The former, however, has a more tapering spire and more tabulated whorls.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura, Uto-gun, province of Higo.

Scaphandridae

Cylichna, LOVEN

Cylichna paupereula nov. sp.

Pl. XXII (V), Figs. 12-14

Shell small, thin, and rather short, the height being a little less than twice the width; subcylindrical, with arcuated sides; slightly tapering behind and more prominently in front; sharply truncated at the posterior end and rounded at the anterior. Apex sunken, shallow, funnel-shaped, circumscribed by a sharp ridge, the diameter of the sunken portion being more than a third the breadth of shell. Aperture narrow, elongated, and moderately dilated in front; columella broad and reflected outward. Surface apparently smooth except for the lines of growth.

Dimensions:	HEIGHT	BREADTH
	7 mm.	4 mm.
	6	3
	4	2.5

I have seven specimens, in most of which the anterior extremity is broken and the surface more or less eroded.

¹G. P. DESHAYES: *Op. cit.*, Vol. III, p. 367, Pl. XCVIII, figs. 22-24.

The present species resembles "*Bulla*" *desertorum* OPPENHEIM¹ from the Upper Mokattum Beds of Egypt, knowledge of which is based on the inner casts. Our form is also allied to *C. goniophora* (Desh.)² from the Lutetian of France, but is shorter and has its sunken upper portion narrower.

Among the previously reported Japanese species, this is similar to *C. musashiensis* TOKUNAGA³ from the Lower and Upper Musashino formations, and is more closely allied to *C. affabilis* YOK.⁴ from the Neogene deposits of Mino. *C. musashiensis* is, however, higher with its anterior portion less tapering and its sides less convex, and *C. affabilis* is more convex at the sides, with the anterior portion of the aperture more dilated than in ours.

Locality and geological horizon: The Lower *Orthaulax japonicus* Zone; Akase, Ôda-mura, Uto-gun, province of Higo.

¹P. OPPENHEIM: "Zur Kennt. alttert. Faunen in Agypten," p. 339, Pl. XXVI, figs. 12, 13.

²G. P. DESHAYES: "Descrip. Anim. s. Vert. Bas. Paris," Vol. II, p. 632, Pl. XXXVIII, figs. 26-29.

³S. TOKUNAGA: "Foss. Env. Tokyo," p. 32, Pl. II, fig. 12; M. YOKOYAMA: "Foss. Miura pen.," p. 27, Pl. I, fig. 4; M. YOKOYAMA: "Foss. Upper Musashino," p. 27, Pl. I, fig. 10.

⁴M. YOKOYAMA: "Moll. Foss. Tert. Mino," p. 216, Pl. XXVIII, figs. 1, 2.

PLATE XVIII (I)

(The figures are natural size.)

- Fig. 1. *Lima* sp. Loc.: Kunai, Arao-mura, Tamana-gun, province of Higo; the Yotsuyama Sandstone. An internal mould of a right valve, lateral view.
- Figs. 2, 2a, 2b, 3. *Polinices (Neverita) eocenica* NAGAO. Loc.: Kôyagi-jima off Nagasaki, province of Hizen; the Lower *Orthaulax japonicus* Zone. 2, dorsal view; 2a, apertural view; 2b, apical view; 3, apertural view.
- Figs. 4, 4a. *Hemifusus* [?] sp. Loc.: Tôka, Ômuta city, province of Chikugo; the Kachidachi Sandstone. An internal mould; 4, dorsal view; 4a, apertural view.
- Figs. 5, 5a, 5b, 6, 6a. *Cardium miikense* NAGAO. Locs.: 5, 5a, 5b, Ôura, Ômuta city; the Upper *Orthaulax japonicus* Zone; 6, 6a, Miike-machi, Miike-gun, province of Chikugo; the Lower *Orthaulax japonicus* Zone. 5, sinistral view; 5a, posterior view; 5b, dorsal view; 6, dextral view; 6a, anterior view.
- Figs. 7, 7a. *Crassatellites fuscus* (YOK.) Loc.: the Miike coal-field, the precise locality being unknown; the Manda Group. 7, sinistral view; 7a, dorsal view.
- Figs. 8, 14, 15. *Turritella okadai* NAGAO. Loc.: Miike-machi, Miike-gun, province of Chikugo; the Lower *Orthaulax japonicus* Zone. 8, dorsal view; 14, 15, apertural views.
- Fig. 9. *Tellina* sp. a. Loc.: Hakamadake, Tamana-gun, province of Higo; the Yotsuyama Sandstone. An external mould of a left valve; lateral view.
- Fig. 10. *Turcricula* sp. Loc.: The northern foot of Hakamadake, Tamana-gun, province of Higo; the Manda Group. An external cast of a deformed specimen; apertural view.
- Figs. 11-13. *Melania* [?] *miikensis* NAGAO. Locs.: 11, Ôura, Ômuta city, province of Chikugo; the Upper *Orthaulax japonicus* Zone; 12, 13, Kôyagi-jima off Nagasaki, province of Hizen; the Lower *Orthaulax japonicus* Zone. 11, apertural view; 12, 13, dorsal views.
- Fig. 16. *Macrocallista ariakensis* NAGAO. Loc.: Miike-machi, Miike-gun, province of Chikugo; the Lower *Orthaulax japonicus* Zone. An internal mould of a left valve; lateral view.
- Figs. 17, 17a. *Pentacrinus ariakensis* YOK. Loc.: The northern foot of Hakamadake, Tamana-gun, province of Higo; the Yotsuyama Sandstone. A fragment of a column.



Ebina photo.

PLATE XIX (II)

(The figures are natural size.)

- Figs. 1, 1a, 2, 2a, 2b. *Orthaulax japonicus* NAGAO. Loc.: Miike-machi, Miike-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 1, 2, dorsal views; 1a, 2a, apertural views; 2b, apical view.
- Figs. 3, 3a. *Sycum (Bulbifusus [?]) miikense* NAGAO. Loc.: The Yotsuyama Mine, Ômuta city; the Kachidachi Sandstone. An internal mould; 3, dorsal view; 3a, apertural view.
- Figs. 4, 7, 8, 15. *Turritella miikensis* NAGAO. Loc.: Miike-machi, Miike-gun, province of Chikugo; the Lower *Orthaulax japonicus* Zone. 4, 15, apertural views; 8, dorsal view; 7, dorsal view of the specimen figured in 4.
- Fig. 9. *Turritella* [?] sp. Loc.: Ipponmatsu, Ginsui-mura, Miike-gun; The Lower *Orthaulax japonicus* Zone. Dorsal view.
- Figs. 5, 6, 10, 11, 11a, 12, 13, 13a, 16. *Turritella okadai* NAGAO. Locs.: 5, 12, Kôyagi-jima off Nagasaki, province of Hizen; the Lower *Orthaulax japonicus* Zone; 6, 11, 11a, 13, 13a, 16, Miike-machi, Miike-gun, province of Chikugo; the same zone; 10, Ipponmatsu, Ginsui-mura, Miike-gun; the same zone, 5, 11, 13a, 16, apertural views; 6, 10, 11a, 12, 13, dorsal views.
- Figs. 14, 14a. *Nerita subgranulosa* NAGAO. Loc.: Ipponmatsu, Ginsui-mura, Miike-gun, province of Chikugo; the Lower *Orthaulax japonicus* Zone. 14, basal view; 14a, dorsal view.

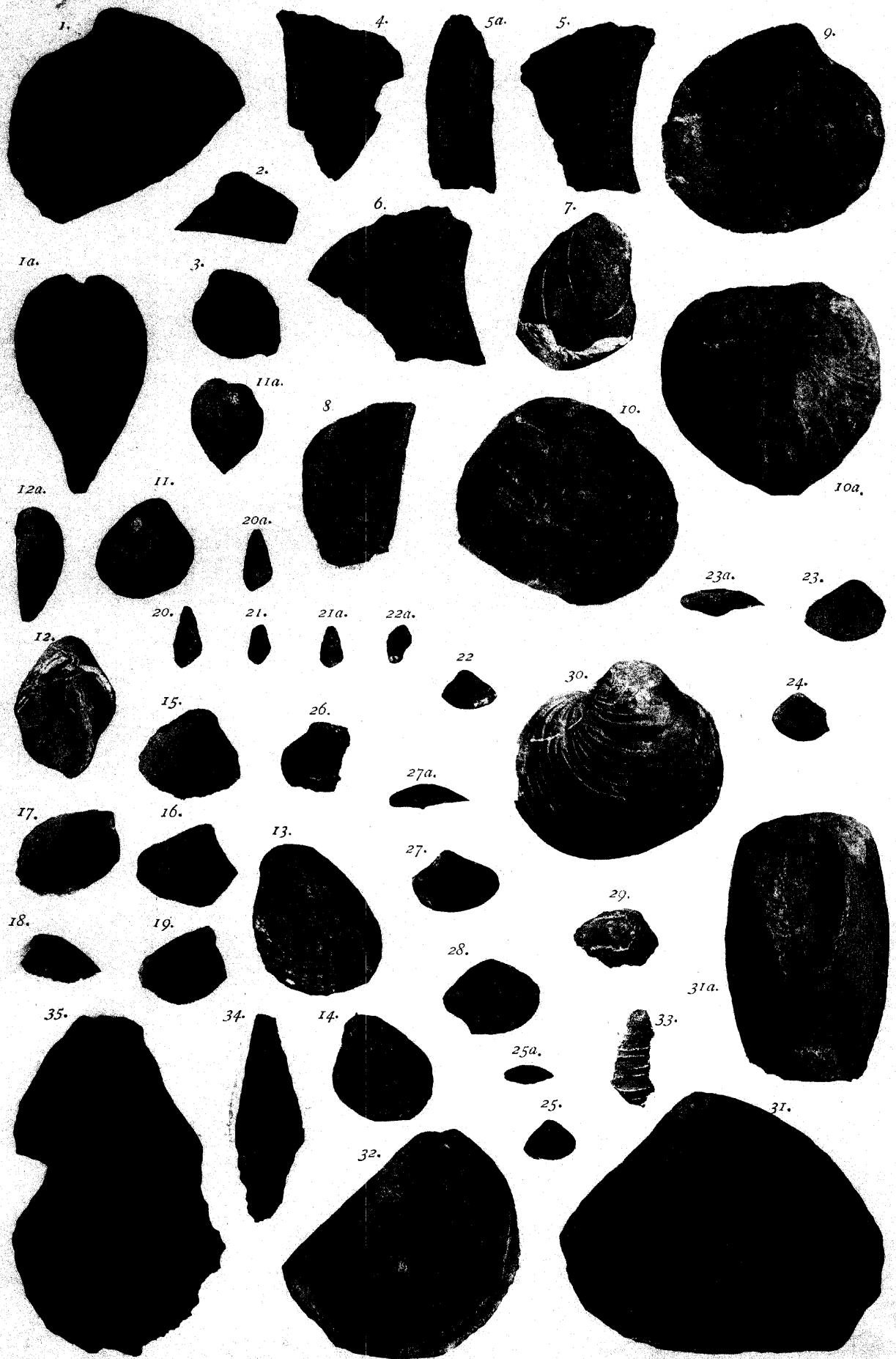


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PLATE XX (III)

(The figures are natural size.)

- Figs. 1, 1a, 2, 3, 9. *Venericardia nipponica* YOK. Locs.: 1, 1a, 2, 3, Sakasegawa-mura, Amakusa-Shimo-shima, province of Higo; the lowest part of the Sakasegawa Shale; 9, the Yotsuyama Mine, Ômuta city, province of Chikugo; the Kachidachi Sandstone. 1, 3, sinistral views; 2, the hinge of a right valve; 9, dextral view of an external cast.
- Figs. 4-8. *Pedalion tomiyasui* NAGAO. Loc.: Kôyagi-jima, off Nagasaki, province of Hizen; the Lower *Orthaulax japonicus* Zone. 4, sinistral view; 5, 7, 8, dextral views; 5a, anterior view; 6, the hinge.
- Figs. 10, 10a, 30. *Cyrena (Batissa) ponderosa* NAGAO. Locs.: 10, 10a, Urakoshi, Oniki-mura, Amakusa-Shimo-shima; the Toishi Beds; 30, the Kakize Mine, Takashima, province of Hizen; the Hashima Beds. 10, dextral view; 10a, anterior view; 30, sinistral view.
- Figs. 11-14. *Venericardia mandaica* (YOK.). Loc.: Ushibuka-machi, Amakusa-Shimo-shima; the Sakasegawa Group [?]. 11, dextral view; 12, the hinge; 11a, 12a, anterior views; 13, 14, sinistral views.
- Figs. 15-19. *Venericardia* cfr. *mandaica* (YOK.). Loc.: Sanshûnoô, Sakasegawa-mura, Amakusa-Shimo-shima; the Itchôda Sandstone. Five external casts. 15, 16, 17, 19, dextral views; 18, sinistral view.
- Figs. 20, 20a, 21, 21a. *Rissoina* [?] *gemma* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 20, 21, apertural views; 20a, 21a, dorsal views.
- Figs. 22-25a. *Corbula (Cunaeorbula) kyushuensis* NAGAO. Locs.: 22, 22a, 25, 25a, Mirokudake, Amakusa-Kami-shima; the Lower *Orthaulax japonicus* Zone; 23, 23a, 24, Akase, Ôda-mura, Uto-gun, province of Higo; the same zone. 22, 24, sinistral views; 23, 25, dextral views; 22a, posterior view; 23a, 25a, dorsal views.
- Figs. 26-29. *Macrocallista ariakensis* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 26, 27, sinistral views; 28, 29, dextral views; 27a, dorsal view.
- Figs. 31, 31a, 32. *Lima amaxensis* YOK. var. *kumasoana* NAGAO. Locs.: 31, 31a, Amakusa-Shimo-shima, the precise locality being unknown; the Sakasegawa Group [?]; 32, Yamaguchi, Hondo-machi, Amakusa-Shimo-shima; the Itchôda Sandstone. Two internal moulds; 31, 32, sinistral views; 31a, anterior view.
- Fig. 33. *Turritella* sp. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone.
- Fig. 34. *Turritella* sp. Loc.: Mirokudake, Amakusa-Kami-shima; the Lower *Orthaulax japonicus* Zone.
- Fig. 35. *Lima amaxensis* YOK. Loc.: Yamaguchi, Hondo-machi, Amakusa-Shimo-shima; the Itchôda Sandstone. An external cast, dextral view.

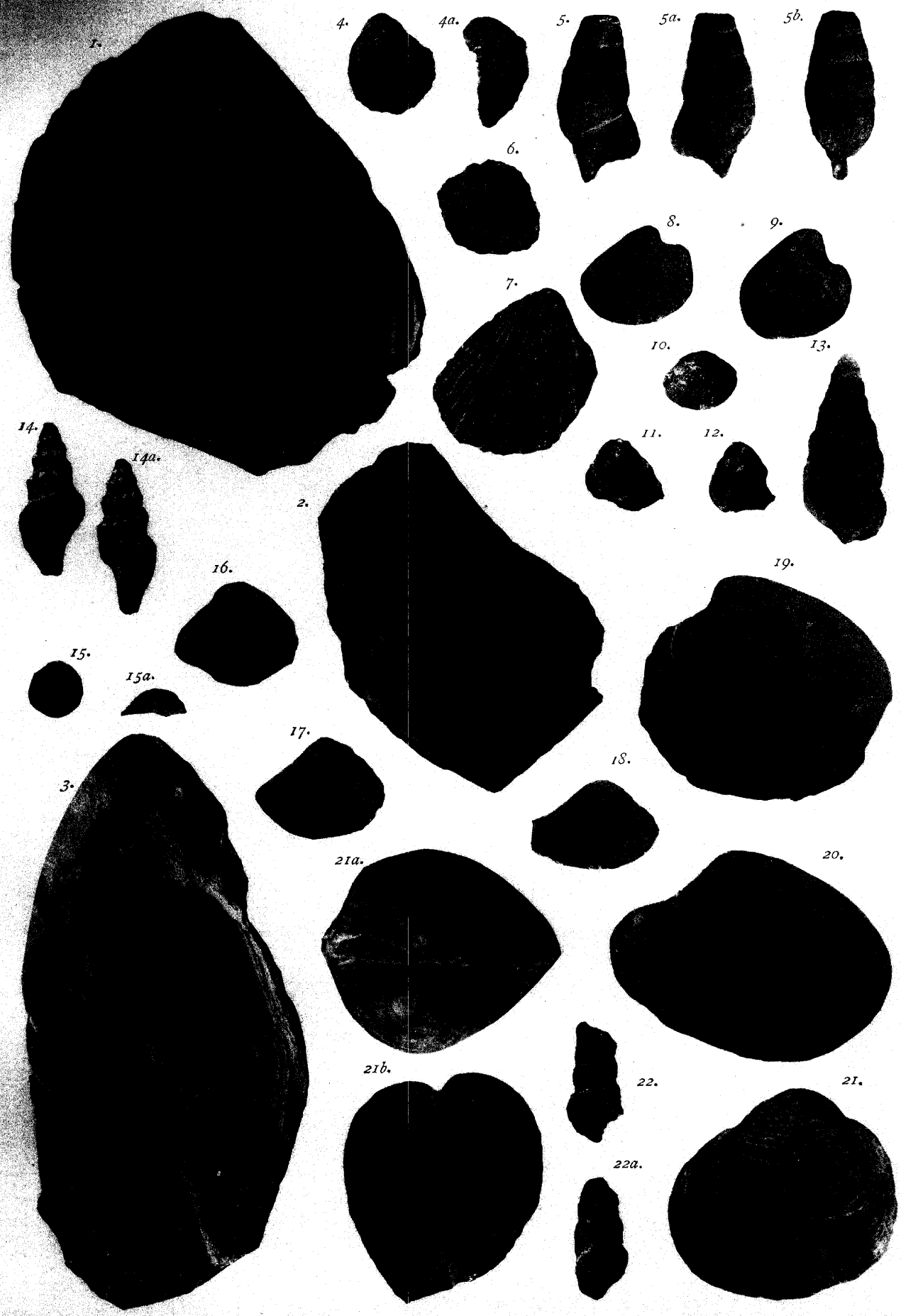


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PLATE XXI (IV)

(The figures are natural size, unless otherwise stated.)

- Figs. 1, 2, 3. *Lima eocenica* NAGAO. Loc.: Imada, Itchôda-mura, Amakusa-Shimo-shima; the lowest part of the Sakasegawa Shale. 1, 2, dextral views of two internal casts; 3, sinistral view of an external mould.
- Figs. 4, 4a. *Nerita subgranulosa* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun; the Lower *Orthaulax japonicus* Zone. An internal mould; 4, dorsal view, $\times 2$; 4a, apical view, $\times 2$.
- Figs. 5, 5a, 5b. *Faunus nipponicus* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 5, apertural view; 5a, dorsal view; 5b, dorso-apertural view.
- Fig. 6. *Venericardia mandaica* (YOK.) [?] Loc.: The Yotsuyama Mine, Ômuta city; the Kachidachi Sandstone. Sinistral view.
- Fig. 7. *Venericardia nipponica* YOK. Loc.: Ibid., dextral view.
- Figs. 8, 9. *Venericardia mandaica* (YOK.) Loc.: Ibid., dextral view.
- Figs. 10, 11, 12, 15, 15a. *Anomia* sp. Locs.: 10, 15, 15a, Mirokudake, Amakasa-Kami-shima; the Lower *Orthaulax japonicus* Zone; 11, 12, Iwasaki, Aizu-mura, in the same island; the same zone. 10, 11, 12, 15, lateral views of the convex valves; 15a, posterior view.
- Fig. 13. *Melania* [?] *miikensis* NAGAO. Loc.: Kôyagi-jima off Nagasaki, province of Hizen; the Lower *Orthaulax japonicus* Zone. Apertural view.
- Figs. 14, 14a. *Turris higoensis* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 14, dorsal view; 14a, dorso-apertural view. $\times 2$.
- Figs. 16-18. *Corbula* (*Cunaecorbula*) *kyushuensis* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. Dextral views. $\times 2$.
- Figs. 19, 20. *Pitaria* sp. Loc.: A sea coast south of Shimotsu-fukae, Amakusa-Shimo-shima; the Fukami Sandstone or the Sakasegawa Group. Sinistral views of two internal moulds.
- Figs. 21, 21a, 21b. *Cyrena* (*Batissa*) *ponderosa* NAGAO. Loc.: The Kakize Mine, Takashima off Nagasaki; the Hashima Beds. 21, sinistral view; 21a, dorsal view; 21b, anterior view.
- Figs. 22, 22a. *Cerithiopsis* [?] sp. Loc.: Akase, Ôda-mura, Uto-gun; province of Higo; the Lower *Orthaulax japonicus* Zone. 22, apertural view; 22a, dorsal view. $\times 2$.



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PLATE XXII (V)

(The figures are natural size, unless otherwise stated.)

- Fig. 1. *Cultellus* [?] *brevis* NAGAO. Loc.: The Kôyagi Mine, Kôyagi-jima off Nagasaki, province of Hizen; the Upper *Orthaulax japonicus* Zone. Lateral view.
- Figs. 2, 2a, 2b. *Venericardia nipponica* YOK. Loc.: Hirado-jima [?], province of Hizen; the horizon is unknown. These figures are here introduced for comparison.
- Figs. 3, 4, 4a. *Diplodonta* [?] *problematica* NAGAO. Loc.: Mirokudake, Amakusa-Kami-shima; the Lower *Orthaulax japonicus* Zone. 3, 4, dextral views; 4a, dorsal view.
- Figs. 5, 5a. *Unio* sp. Loc.: The Futagoshima Mine [?], Futago-jima off Nagasaki, province of Hizen; the Hashima Beds [?]. An internal mould; 5, dextral view; 5a, dorsal view.
- Figs. 6, 7. *Corbula subtumida* NAGAO. Locs.: 6, Kôyagi-jima off Nagasaki; the Lower *Orthaulax japonicus* Zone; 7, Akase, Ôda-mura, Uto-gun, province of Higo; the same zone. Sinistral views.
- Fig. 8. *Siphonalia* sp. Loc.: Akase, Ôda-mura, Uto-gun; the Lower *Orthaulax japonicus* Zone. An internal mould, dorsal view.
- Figs. 9-11. *Orthaulax japonicus* NAGAO. Locs.: 10, 10a, Kôyagi-jima off Nagasaki; the Lower *Orthaulax japonicus* Zone; 9, 9a, probably from the same locality; 11, 11a, the Kakize Mine, Takashima in the same province; the Upper *Orthaulax japonicus* Zone. 9, 10a, dorsal views; 9a, 10, 11a, apertural views; 11, ventro-apertural view.
- Figs. 12-14. *Cylichna paupercula* NAGAO. Loc.: Mirokudake, Amakusa-Kami-shima; the Lower *Orthaulax japonicus* Zone. 12, 13a, dorsal views; 12a, 13, apertural views; 13b, apical view; 12b, dorso-apertural view; 14, ventro-apertural view. $\times 3$.
- Figs. 15, 15a, 15b. *Orthaulax japonicus* NAGAO. Loc.: Kôyagi Mine, Kôyagi-jima off Nagasaki, province of Hizen; the Upper *Orthaulax japonicus* Zone. An internal mould. 15, apertural view; 15a, dorsal view; 15b, apical view.
- Figs. 16-19. *Cyrena (Batissa) ponderosa* NAGAO. Locs.: 16, 16a, Kôyagi-jima off Nagasaki; the Lower *Orthaulax japonicus* Zone; 17-19, the Kakize Mine, Takashima; the Hashima Beds. 16, 17, sinistral views; 18, dextral view; 19, lateral view; 16a, internal view showing the hinge.
- Figs. 20, 20a. *Venericardia nipponica* YOK. Loc.: Sakasegawa-mura, Amakusa-Shimo-shima; the lowest part of the Sakasegawa Shale. 20, sinistral view; 20a, anterior view.
- Figs. 21, 21a, 22, 22a. *Polinices (Lunatia)* [?] *utoensis* NAGAO. Loc.: Akase, Ôda-mura, Uto-gun, province of Higo; the Lower *Orthaulax japonicus* Zone. 22, dorsal view; 21, 22a, apertural views; 21a, apical view.

