

Tertiary Fossils from North Kankyô-dô, Korea.

By

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With Plates XII and XIII

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Relatively little is known regarding the Tertiary invertebrate fauna of Chôsen (Korea), aside from Prof. Yokoyama's paper¹⁾ on some fossil shells of the Pliocene age from the Island of Saishû (Quelpart). Recently Mr. I. Tateiwa, geologist of the Geological Survey of Chôsen sent me some fossil shells of an older age for examination, which he had obtained from the Tertiary rocks in the environs of Meisen, North Kankyô-dô. Some other materials had also been collected by Prof. T. Ogawa and Mr. T. Itô from the same places.

Mr. Tateiwa²⁾ divided the Tertiary rocks of this district on lithologic and paleobotanic evidences into two groups, the lower Ryûdô and the upper Meisen. The Ryûdô group is found to consist of shales, sandstones and coals, and contains a rich flora of the so-called "Arctic Miocene". The Meisen group is subdivided into three members, the lower Heirokudô, the middle Kanchindô and the upper Mankodô.

1) Jour. Coll. Sc. Imp. Univ. Tokyo, 1923, Vol. 44, Art. 7.

2) Geological Atlas of Chôsen, No. 4, 1925.

The Heirokudô formation comprises conglomerates, sandstones and sandy shales. The fossil Molluscs are not rich in this formation. The following species are determined by me.

Potamides (Cerithidea) kampokuensis n. sp.

Batillaria Tateiwai n. sp.

Batillaria Yamanarii n. sp.

Polinices (Euspira) meisensis n. sp.

Acila submirabilis n. sp.

Arca (Anadara) daitokudoensis n. sp.

Arca (Anadara) abdila n. sp.

Phacoides cf. *saxorum* Lamarck

Cyclina (Cyclinorbis) lamulata n. sp.

Owing to the bad state of preservation, the following forms are not determined specifically: *Potamides* sp., *Rimella* sp., *Leda* sp., *Ostrea* sp., *Pecten* sp., *Meretrix* sp., *Cardium* sp., and *Tellina* sp.

The Kanchindô formation is a thick bed of shale with occasional calcareous nodules, and contains leaves, casts of shells and fishes. But owing to the poor condition of the fossils and the frequent deformation of the casts by shearing, the greater half of the species are hardly to be determined. Only few of the well characterized bivalves are here listed

Pitaria Itoi n. sp.

Chione Tateiwai n. sp.

Macoma sp.

Mya crassa Grewingk?

Yoldia laudabilis Yokoyama

Cardium sp.

Thyasira aff. *bisecta* Conrad

The Mankodô formation comprises conglomerates, sandstones and coals, associated with flows of basalt. Prof. Ogawa obtained the following species from the lowest horizon of this formation:

Arca (Anadara) Ogawai n. sp.

Phacoides cf. *acutilineatus* Conrad

Pitaria Itoi n. sp.

Macoma inquinata Deshayes

Panope sp.

Mr. Tateiwa sent me the following Molluscs which he obtained in a ferruginous coarse sandstone of Kinshôdô, an upper horizon.

Genota cryptoconoides n. sp.

Polinices (Neverita) coticae n. sp.

Glycimeris cisshuensis n. sp.

Arca (Anadara) Ogatai n. sp.

Pecten (Chlamys) meisensis n. sp.

Diplodonta ferruginata n. sp.

Chione Tateiwai n. sp.

Mr. Tateiwa states the age of the Meisen group to be the Oligocene, and he correlates it to the Chôki group of South Chôsen. To my great regret, the total number of the shells is too small to admit of any valuable correlation being made. But my opinion does not much differ from his and I think the fauna of the Meisen group as a whole will not be younger than the Lower Miocene.

Exactly speaking, there exists an obvious difference in age between the Heirokudô formation and the other two formations,—the Kanchindô and the Mankodô. The study of the fauna of the Heirokudô is rather in favour of their Upper Eocene origin. Among the Gastropoda, *Batillaria Yamanarii*, a new species, shows certain resemblances to *B. calcitrapoides* (Lamarck) on the one hand, and *B. clandestina* (Deshayes) on the other hand, both from the Lutetian and the Bartonian, but it exhibits some features different from the typical species of the Recent. *B. Tateiwai*, a new species, also indicates a characteristic echinated ornament of a very old type of this genus. *Placoides* cf. *saxorum* represented in the collection differs little from the original form of Deshayes; it ranges in Europe from the Lutetian to the Bartonian. The concentric sculpture of the Korean form rather resembles that of *P. hosdenacensis* (Deshayes), a Lutetian species. *Arca daitokudoensis*, a new species, presents affinities with *Arca nigeriensis* Newton of the Upper Eocene of Nigeria. *Acila submirabilis* n. sp. and *Cyclina lamulata* n. sp. are apparently very close to some living species

of the genera, especially in sculpture and in outline, but as far as observed, can not be connected with them, since the formers have radical differences. *Polinices meisensis*, a new species, is more nearly related to some *Euspira* of the Oligocene in California than to the living species of the same subgenus in Japanese waters. It is remarkable that the Molluscs of the Heiokudô are quite different from those of the Eocene of India and Java.

The rocks of the Kanchindô formation probably belong to the Oligocene. The fossils have something in common with those of the Asagai sandstone of the Jôban coal-field, North Japan. Prof. Yokoyama¹⁾ deems the geological age of the Asagai as well as the underlying Iwaki group which contains characteristic leaves of the so-called "Arctic Miocene" as Miocene. I think the Asagai is the equivalent of the Astoria and San-Lorenzo Oligocene on the west coast of North America. The materials of the Kanchindô comprise *Yoldia laudabilis* Yokoyama, one of the commonest forms of the Asagai.

The fossils of the Mankodô formation comprise some elements closely allied to those of the Miocene and Oligocene of the west coast of North America. On the other hand, it is quite different faunistically from the Miocene of Java and other southern islands. Most probably the age of the Mankodô is not younger than the Lower Miocene.

Description of the New Species

Genota cryptoconoides n. sp. Plate XII, fig. 1.

Holotype.—In Geol. Surv., Chôsen, no. LXXVIII.

Shell biconical, fairly strong, spirally lirate. Spire conical with a sharp apex, a little shorter than the aperture. Protoconch minute, conical, of 2 smooth convex whorls, the nucleus obtuse, slightly lateral. Whorls 7, broad, short, regularly increasing, with a sloping concave shoulder, lightly convex below the blunt angle; the last large, somewhat tumid, scarcely contracted toward the base, gradually produced into a large conical snout. Sculpture consisting of many subequal spiral cords; there is a

¹⁾ Molluscan remains from the lower part of the Jô-Ban Coal-field, Jour. Coll. Sc. Imp. Univ. Tokyo, 1924, Vol. 45, Art. 3, p. 9.

smaller thread or two in each interspace of the cords on the later whorls. The round angle of the shoulder which is a little lower than the middle of the whorl is obscurely tubercled, the tubercles are about 25 on the penultimate whorl and are nearly obsolete on the last. The spirals are stronger and spaced wider on the base. Incremental lines fine, hair-like, flexuous. Suture deep. Aperture long and narrow, angled above, narrowed below to a broad, open, slightly recurved canal. Outer lip broken, but evidently roundly sinuated above. Inner lip thin, hollowed into the substance of the shell, narrowed anteriorly, spreading a short distance beyond the arcuate parietal wall; columella vertical, slightly excavated, twisted, with a round edge opposite the fasciole. Height, 43mm.; diameter, 19mm.

Occurrence.—Kinshôdô (Mankodô formation).

This splendid shell, of which there is only one partly broken specimen, forms an intermediate type of *Cryptoconus* and *Genota*. It rather resembles *Cryptoconus calophorus* (Deshayes) of the Lutetian in its general outline and sculptures. The typical *Cryptoconus*, however, is a smaller shell without shoulder. The tuberculation on the angle exhibits a character of *Genota*.

Batillaria Tateiwai n. sp. Plate XII, figs. 5, 6.

Colype.—In Geol. Surv., Chôsen and in Geol. Inst., Kyôto Imp. Univ.

Shell moderately small, turreted, spirally spinosely threaded. Spire elevated and narrowly conical, about three times the height of the aperture; apical angle about 28° . Whorls about 12, regularly increasing, biangulate; base flatly concave. Protoconch missing in all specimens at hand. Two to three apical whorls are smooth and moderately convex; the succeeding whorls are ornamented with 3 equally spaced threads of equal strength and 10 to 13 discontinuous axial ribs making a series of tubercles in crossing the spirals; the uppermost thread on the upper angle grows subsequently into a keel with prominent round tubercles on later whorls; the median thread does not develop at all; the threads on the lower angle is of intermediate strength between the others, it has a slightly granulated

appearance on the penultimate whorl. At first, the axials are stronger than the spirals, then catagenesis of the former and anagenesis of the latter taking place, a reticulated sculpture is attained on the fifth to the sixth whorls. Finally, the axials become almost obsolete on the later whorls except for the tubercles which often develop into short spines. The whole surface is covered by very fine regular spiral striations and irregular, flexuous incremental lines. Aperture rhombic; outer lip broken in all specimens at hand; columella straight, concave above, narrowed below; inner lip markedly limited, spreading a short distance above the columella. Canal short, straight, truncated anteriorly. Suture deeply impressed, margined above by a thread. Periphery round, bicarinate; the upper keel continuing to the marginal thread of the suture. Base marked by flexuous incremental lines. Height, 19.8mm.; diameter, 7.8mm.

Occurrence.—Nanseki (Heiokudô formation).

This species being not like the modern forms of *Batillaria* has flattish base and spinose sculptures. In general features and in the detailed ornamentation, it is rather allied to some Eocene species of Europe. Apparently, *B. Sowerbyi* Deshayes, a Bartonian species, differs little from the present species.

Batillaria Yamanarii n. sp. Plate XII, fig. 4.

Holotype.—An example from Nanseki, in Geol. Surv., Chôsen.

Shell turreted, prominently tubercled. Spire high, narrowly conical, about three times the height of the aperture; apical angle less than 20° . Whorls more than 9 (embryonal whorls missing), regularly increasing, subcentrally angulate and projecting. Sculpture consisting of 8 to 9 obscure axial plicae which rise to prominent tubercles on the angle, and many subequal fine spiral threads, the interspaces microscopically striated. Suture deeply impressed, marginate above. Periphery rounded, with two spiral ridges. Base convex, arched around the neck. Incremental lines strongly flexuous, sinuated backward. Aperture roundly pyriform; columella straight, slightly recurved, obliquely truncated below. Height of 8 whorls, 26.7mm.; true height, about 28mm.; diameter, 11 mm.

Occurrence.—Nanseki and Daitokudô (Heiokudô formation).

There are only few specimens to illustrate this species and these unfortunately have imperfect terminations with consequently fractured apertures. Some tubercled varieties of *Batillaria multiformis* (Lischke), a recent species of Japan, is easily distinguished from the present species in having flattened whorls with less prominently tubercled axial plicae and a shorter columella. *B. Yamanarii* is not related to any other living form, while it is more closely allied to some Eocene species of Europe. *B. clandestina* (Deshayes) possesses prominent tubercles or short spines on the angle at the upper third of the whorl and many spiral threads. *B. Yamanarii* is a less elevated shell with obscure spirals. *B. calci-trapoides* (Lamarck) is also one of the closely allied forms of the Korean species, but it differs from the latter in having more prominent tubercles, granuled peripheral carinae and obsolete spirals.

Potamides (Cerithidea) kanpokuensis n. sp. Plate XII, figs. 2, 3.

Cotype.—In Geol. Surv., Chôsen and in Geol. Inst., Kyôto Imp. Univ.

Shell moderately large, turreted, rather solid, costate and spirally grooved. Spire elevated, conical, about three times the height of the aperture; outline straight. Protoconch missing in all specimens at hand. Whorls about 14, regularly increasing, flattened; base flatly concave, excavated around the neck; periphery round. Suture canaliculate, deep, margined. Sculpture consisting of distant, round, broad, low but distinct axial ribs, 12 to 14 on the penultimate whorl, suboblique and slightly arcuate, stopped at the periphery of the body-whorl by a spiral groove taking its origin at the suture; crossed by 3 spiral grooves, of which the uppermost one is the deepest; base with 6 equidistant distinct spiral cords and well-marked growth-lines. Aperture oblique, ovate; outer lip fractured, but was apparently sharp and convex. Columella vertical, nearly straight. Inner lip spreading over a short distance of the columella, extending over the parietal wall, sharply marked off. Height, 35mm.; diameter, 15mm.; apical angle, 25°.

Occurrence.—Nanseki (Heiokudô formation)

Polinices (Neverita) coticaeae n. sp. Plate XII, fig. 8.

Holotype.—A specimen from Kinshôdô, in Geol. Surv., Chôsen, no. LXXV.

Shell depressedly globose, of moderate size, fairly solid, smooth except for oblique incremental lines. Spire slightly elevated, outline convex, a little higher than the half of the aperture. Whorls $6\frac{1}{2}$, flatly convex, the last large in proportion, base tumid. Suture appressed and inconspicuous. Aperture oblique, semilunulate, rounded below; outer lip simple; inner lip nearly straight, heavily callous; callus filling the posterior angle of the aperture and spread out a short way on the body-whorl, umbilical callus transversely grooved in the middle. Umbilicus wide, pervious, channeled anteriorly, scarcely spirally striated, half encroached on by the callus. Height, 27mm.; diameter, 26mm.; major diameter of aperture, 23mm.

Occurrence.—Kinshôdô (Mankodô formation).

At first sight, this species appears to be *P. didyma* Bolten which ranges from the Miocene to the Recent, but that species has a more depressed shell sculptured by faint spiral striae and a very wide, barely spirally striated umbilicus sometimes with two or three ridges within. The moderately raised spire and the narrower and channeled umbilicus characterizing the present species.

The holotype is a fully grown individual and is far smaller than the adult of *P. didyma*. The shell exhibits affinities with *P. reclusiana* Deshayes and its ancestral mutations from the Oligocene, the Neogene and the Recent of California.

Polinices (Euspira) meisensis n. sp. Plate XII, fig. 7.

Holotype.—In Geol. Surv., Chôsen, no. XLV.

Shell medium in size, thick, globose, umbilicated; surface sculptured by fine close-set subequal oblique incremental lines. Spire somewhat elevated, but less than half the height of the aperture, bluntly scalar. Protoconch depressed, of 2 smooth flatly convex whorls; nucleus comparatively large with round tip. Whorls $5\frac{1}{2}$, convex, somewhat depressed just

below the suture, the last very large, flattened; base rounded. Suture deeply impressed, slightly channeled on early whorls. Aperture oblique, semilunular, rounded anteriorly, the posterior corner pointed, filled with thick callus. Outer lip simple, sharp but strong; inner lip nearly straight, but slightly concave in its whole length, moderately callous, forming a very thick callus on the parietal wall. Umbilicus opening, moderate and elongate; callus pad rudimental. Height, 24mm.; diameter, 21mm.; major diameter of aperture, 17mm.

Occurrence.—Daitokudô (Heiropudô formation)

Unfortunately this species is represented by only one specimen which has a callus quite similar to *Polinices* (*Euspira*) *pila* Pilsbry, a living species in the waters of Hokkaidô (Yezo). But it differs from the latter species in having a less elevated but scalar spire, obtusely shouldered whorls and a flattened body-whorl. *P. pallida* Broderip et Sowerby has a smaller umbilicus and round whorls. Among fossil forms, the new species exhibits the closest affinity with *P. victoriana* Clark et Arnold from the Oligocene deposits of Vancouver Island, especially in size, contour, and in the umbilical characters. The Canadian shell, however, has strongly appressed suture and less scalar spire.

***Acila submirabilis* n. sp.** Plate XII, fig.9.

Holotype.—In Geol. Inst., Kyôto Imp. Univ., collected by Mr. Tateiwa.

Shell subovate, inequilateral, moderately convex, posterior side very short and obliquely subtruncated. Beaks small adjacent, directed backwards, situated at about the posterior fifth. Anterior dorsal margin gently sloping, lightly convex; posterior dorsal margin a little longer than the half of the anterior, steeply sloping, nearly straight; apical angle about 110° or more; anterior end narrowly rounded; posterior end angulate; ventral margin regularly arched, slightly sinuated near the posterior end. Lunule obsolete, escutcheon very small, semicircular, circumscribed by a groove, broader than long, situated on the impressed cordate surface which is bounded by rounded ridges running from the beaks to the posterior end. Sculpture like that of *Acila mirabilis*, consisting of divaricating oblique threads; the

line of main divarication is a little posterior to the middle, and one more runs near the posterior ridge. The interspaces of the threads are finely imbricated by incremental lines. Anterior teeth 16 to 18, highest at the middle, the series occupying the half of the length of the anterior dorsal margin; posterior teeth 9 to 10, much smaller than the anterior. Length, 23mm.; height, 11.5mm.

Occurrence.—Nanseki (Heiokudô formation).

This species resembles *Acila mirabilis* Adams et Reeve, a species very common in the Neogene and the Recent of Japan. Apparently, it is distinguished from the latter in having a well-defined line of divarication of threads near the posterior ridge which runs from the beaks to the posterior end. The most important differences between them, however, are confined chiefly to their lunules and escutcheons. The lunule of *Acila mirabilis* is a very narrowly lanceolated, impressed area circumscribed by a distinct ridge extending from the beak to the anterior end. *Acila submirabilis* has no such well-defined lunule, and the oblique threads extend to the very margin of the dorsal slope. The posterior area bounded by the ridges is usually assigned to the escutcheon, but the true escutcheon is a very small cordate or semicircular area circumscribed by more or less impressed grooves. In *A. mirabilis*, there is one more ridge inside the posterior area and outside the escutcheon, appearing as a pouting, and circumscribing the second area into which the threads never extend. In *A. submirabilis*, the posterior area is concave without pouting in the middle and the threads extend to the margin.

Acila gettysburgensis Reagan, an Oligocene species of California, is closely allied to the present species in having a distinct sinus which extends from the beak to the ventral edge and a little anterior to the posterior end. But the American species differs from the present species, being much more akin to *A. mirabilis*.

Arca (Anadara) abdita n. sp. Plate XII, fig. 11.

Holotype.—In Geol. Surv., Chôsen, no. XXXIII.

Shell medium in size, oblong, thick, inflated, inequilateral, right valve

missing in all specimens at hand. Beaks at the anterior third of the hinge margin, prominent, much inrolled. Anterior end rounded, shortly and obliquely truncate above, regularly arcuate below passing gradually into the broadly rounded ventral margin which is straightened behind; posterior end produced, twice as long as the anterior, narrowly rounded; posterior slope nearly straight, about twice as long as the anterior. Antero-dorsal angle about 120° ; postero-dorsal 140° . Sculpture consisting of 29 to 32 squarish granulate subequal radial ribs, each with a shallow median groove; interspaces even, squarish, a little narrower than the ribs; concentric sculpture of regularly spaced lines, which on the ribs appear as prominent oblong granules. Cardinal area narrow; hinge straight with numerous fine teeth. Inner margin strongly crenate; surface striated along the inner side of the pallial line. Length, 39mm.; height, 30.5mm.; thickness of the left valve, 14mm.; hinge margin, 27mm.

Occurrence.—Nanseki (Heiropudô formation).

This species somewhat resembles *A. subrenata* Lischke, a Recent species of Japan. It differs, however, from the latter in having the gently arcuating antero-ventral margin and the less produced and less oblique posterior end which is narrowly rounded. The ribs of *A. subrenata* are round-topped while those of the present species are often obscurely dichotomous.

Arca (Anadara) daitokudoensis n. sp. Plate XII, figs. 10, 14, 15.

Cotype.—In Geol. Surv., Chôsen, and in Geol. Inst., Kyôto Imp. Univ.

Shell rather small, somewhat squarely oval, elevated and ventricose. Beaks prominent, distant, curved a little forward, at the anterior third of the shell, keeled posteriorly. Anterior end short, regularly rounded; posterior end sharply rounded; posterior margin oblique, straight; ventral margin arcuate; postero-dorsal angle about 125° , that of antero-dorsal a little smaller. Sculpture consisting of 28 narrow, granulated, equal, radial ribs; the interspaces much wider than the ribs, excavate, wrinkled with incremental lines. Area lanceolate, distantly chevroned, rectilinear, with

numerous small teeth. Margin sharp, crenate. Length, 29mm.; height, 23mm.; diameter, 21mm.

Occurrence.—Daitokudô (Heiropudô formation).

The few left valves representing this species are somewhat related to *Arca nigériensis* Newton, an African Eocene species, in its squarish contour, and the general details of the sculptures. The Korean species has, however, a few chevrons on its rather broader area. The subgenus *Anadara* is distinguished from *Scapharca* chiefly on account of the possession of equi-sized valves. But there is an evident tendency to become inequivalved in the adults of *Anadara*, and many of the young shells of *Scapharca* are really equivalves. Therefore the distinction seems to me to be not important.

Arca oclusa Reeve of existing seas differs in having more approximate beaks and in lacking the posterior keel. *Arca elegans* Philippi has broader ribs with shallower interspaces. *Arca staminea* Say, a Miocene species of Maryland, is related to the present species, although the latter has not the deeply excavated interspaces of ribs.

Arca (Anadara) Ogawai n. sp. Plate XII, fig. 16.

Holotype.—An example from Kanchindô, preserved in Geol. Inst., Kyôto Imp. Univ.

Shell somewhat variable, longer than high, trigonal to subovate. Beaks small, rather high, incurved, and anterior to the middle. Dorsal margins lightly convex, sloping, the posterior twice as long as the anterior. Anterior end broadly and regularly rounded, obtusely angled with the dorsal margin, and passing gradually into the long, gently arcuating ventral margin; posterior end produced, narrowly rounded. Sculpture consisting of 30 to 31 equal flat radial ribs, each medially sulcated, supplemented usually near the ventral margin by a finer groove on either side of the median one; interspaces subequal to the ribs; the whole surface crossed by fine concentric threads which are less inconspicuous in the interspaces. Area rather wide, lozenge-shaped, with many deeply incised chevrons and transverse striae. Hinge-line straight, with numerous vertical teeth. Margin crenate.

Length, 47mm.; height, 34mm.; diameter 29mm. (holotype)

Length, 41mm.; height, 34mm.; (a paratype, right valve)

Length, 48mm.; height, 37mm. (another paratype, left valve)

Occurrence.—Kanchindô and Kinshôdô (Mankodô formation)

The ribs are variable in this species. Some specimens have ribs a little broader than their interspaces, while some other examples show much narrower ribs with inconspicuous median grooves. Such an *Arca* which has medially grooved ribs is not known to exist in Japanese waters. Some Pliocene species of *Arca* which came from Gôroku near Sendai and Omma near Kanazawa have distinctly dichotomous ribs. Recently Prof. Yokoyama described *Arca amricula*,¹⁾ a new species from the Pliocene of Shinano, whose ribs are almost invariably split into two parts by a median longitudinal groove and each of these parts often made again bipartite by a smaller groove. These Pliocene forms are easily distinguished from the present species in their ovate, more inflated shells with larger beaks. *A. Ogasawai* exhibits an affinity with Conrad's *Arca trilineata*, a Miocene species of the west coast of North America. It differs from that species in that the shell is more transversely trigonal and the ribs are narrower. The figures of *Arca subrostrata* Conrad of the Miocene of Maryland have some resemblance to the present species.

Glycimeris cisshuensis n. sp. Plate XIII, figs. 2, 3.

Holotype.—In Geol. Surv., Chôsen, no. LXX, a left valve of an adult.

Shell attaining a large size, thick and solid, suborbicular to transversely ovate, somewhat longer than high, convex, slightly oblique, inequilateral. Beaks prominent, located a trifle in advance of the middle, turned inwards, approximate, but not contiguous, rounded. Anterior end broadly rounded, posterior end narrowly rounded, slightly produced with the dorsal margin descending nearly straight; the basal margin regularly arcuate. Surface with many radiating impressed lines crossed by concentric incremental

1) Tertiary Mollusca from Shinano and Echigo, Jour. Fac. Sc. Imp. Univ. Tokyo, 1925 Sect. II, Vol. 1, Pt. 1, p. 19.

lines. The ligamental area long, about four-sevenths of the length of the shell, rather broadly triangular, equilateral, flattened, without chevroned groove but transversely finely striated. Interior faintly radially striate; posterior adductor-scar slightly smaller than the anterior, distinctly impressed, thickened, anteriorly bounded by a sharp ridge which becomes weaker toward the beaks; pallial line well-marked, simple, but with minute pointed sinus adjacent to the posterior adductor-scar. Basal margin very prominently crenate. Hinge-plate thick and large, the lower margin obtusely angulate at the middle; young shell with about 12 oblique teeth on each side; teeth hooked, decreasing in size distally, finely but distinctly pectinated. Length, 67mm.; height, 62mm.; thickness of left valve, 22mm.

Occurrence.—Kinshôdô (Mankodô formation)

In the type specimen, the ligamental area getting very large contracts the hinge-plate and obliterates the teeth in the middle. The young shell of *G. cissluensis* is more equilateral and more transverse.

In general contour and appearances this species somewhat resembles *G. vestita* (Dunker) (= *Pectunculus vestitus* Dunker) which lives in Japanese waters. There are, however, some important differences. The hinge-plate of the fossil species is much larger, longer and thicker, and the teeth are hooked and pectinate; the shell is more convex; and the surface is not so finely striated radially.

Pecten (Chlamys) meisensis n. sp. Plate XIII, fig.4.

Holotype.—In Geol. Surv., Chôsen.

Shell about 70mm. in height, higher than long, subequivalve and equilateral except for ears, rather thin, compressed, radially costate. Beaks small, sharply pointed, approximate. Ears very unequal, the anterior large, triangular, that of the right valve with a deep byssal notch; the posterior about two-thirds the length of the anterior, narrowly triangular, obliquely truncated behind. Discs right-angled above with the dorsal margins descending nearly straight toward the regularly rounded ventral margin, the anterior side very slightly longer than the posterior. Left valve more inflated than the right which has a long ctenolium consisting of high sharp

denticles. Sculpture: anterior ear of left valve with about 9 unequal, scaly radial riblets, that of the right valve divided into the upper area with 4 irregular round radial riblets, and the lower byssal area with flexuous, lamellated, horizontal, incremental lines; posterior ears with 4 to 6 low scabrous riblets, which interspaces with a feeble riblet; these riblets are obsolete near the upper margin; discs with 23 to 27 equal, equidistant, flat-topped, roundly edged, dichotomous ribs; interspaces as wide as or a little wider than the ribs, usually with a scaly intercalating riblet. Development: prodissoconch small, oval, smooth; smooth ribs appear first, then the intercalating riblets; the ribs become dichotomous after reaching a height of about 30mm.; in the adult, the ribs are scaly. Incremental lines very fine, not much imbricated. Interior obscurely radially grooved, ventral margin strongly crenate. Hinge with distinct cardinal crura; resilifer pit highly triangular, deep, with rather sharply raised margins. Height, 68mm.; length, about 65mm.; diameter, 24mm. (holotype). Height, 47mm.; length, 44mm.; thickness of the right valve, 8mm. (paratype preserved in Geol. Inst. Kyôto Imp. Univ.)

Occurrence.—Kinshôdô (Mankodô formation).

***Diplodonta ferruginata* n. sp.** Plate XII, figs 12, 13.

Holotype.—In Geol. Surv., Chôsen, no. LXXXII.

Shell thick, lenticular, very oblique and equilateral, roughly quadrangular in outline, valves moderately convex with marked incremental lines. Beaks slightly raised, oblique, small, sharply pointed, approximate. Anterior end rounded, narrower and shorter than the posterior, the front dorsal margin sloping, short, nearly straight. Posterior end broadly rounded, subtruncate below, twice as long as the anterior end; posterior dorsal margin horizontal, straight. Ventral margin long, running a short way parallel to the posterior dorsal margin, passing gradually into the anterior end and forming a rounded obtuse angle with the posterior end at the point of highest distance from the beak. Hinge-line arcuate, right valve with a high pointed triangular suboblique anterior and a rather strong, longer, oblique, bifid posterior cardinal; left valve with a small

bifid anterior and a lamellar posterior cardinal. Ligament long, external; nymphs well developed. Adductor-scars well impressed, subequal, oblong, close to the margin, continuous with the simple pallial line. Margin thin, smooth. Height, 15.5mm.; length, 18mm.; thickness of the right valve, 5.4mm.

Occurrence.—Kinshôdô (Mankodô formation).

This species bears some resemblance to the figures of *D. irradiata* Cossmann from the Lutetian of Paris. But the antero-dorsal margin of the present species is much shorter than that of that species. *D. Gouldi* Yokoyama, a living species of Japan, differs in having a thin orbicular shell with long sloping antero-dorsal margin. *D. ferruginata* is a more transverse shell with a long horizontal postero-dorsal margin.

Cyclina (Cyclinorbis) lunulata n. section, n. sp. Plate XIII, fig. 1.

Holotype.—In Geol. Surv., Chôsen, no. xxxii.

Shell suborbicular, a little longer than high, inequilateral, moderately convex, thick, concentrically finely ribbed. Beaks not much raised, a little convex, acute, approximate, inclined forward, located at about the posterior third. Anterior end produced, broadly rounded, the dorsal margin long, arcuate, slowly declivate; posterior end broader, more elevated; regularly round; the dorsal margin high, short, arcuate; ventral margin semicircular. Lunule very small, concealed below the beaks, superficial; there is defined a large oval lunule-like area bordered by a distinct line. Sculpture consisting of fine dense, regular concentric riblets, which are sharpened and elevated at the extremities. Hinge-plate moderately broad, arcuate, with 3 divergent, subvertical cardinals, the right posterior bifid. Posterior dorsal margin crenate within, the other part of the interior margin smooth. Pallial sinus long, subvertical. Height, 47mm.; length, 49mm.; diameter, 27mm.

Occurrence.—Nanseki (Heiropudô formation).

This species exhibits the characteristic outline and dentition of *Cyclina*. But it differs from the genotype (*C. sinensis* Gmelin) in having a large lunule-like area bordered by a well-defined line which extends from the beak to a little above the anterior end. Moreover, the beaks are very

posterior, the sculptures are finer and without radials. A new section *Cyclinorbis* is established here based on the above characteristics.

Pitaria Itoi n. sp. Plate XIII, fig. 7.

Cotype.—In Geol. Inst., Kyôto Imp. Univ.

Shell large, solid, elongate, cordately ovate, ventricose. Beaks high, approximate, swollen, turned inwards and forwards, sharply pointed, a little in front of the anterior quarter of the entire length. Antero-dorsal margin descending, regularly convex. Anterior and posterior ends equally evenly rounded; postero-dorsal margin about twice as long as the anterior, slightly convex, slowly descending; ventral margin broadly round, passing gradually into the two ends. Lunule ovate-cordate, not deeply impressed, circumscribed by a superficial line, equally divided between the two valves; escutcheon ill-defined. Sculpture consisting of close, rough, irregularly spaced, fairly sharp incremental lines and unequal concentric waves. Hinge-plate heavy, rather short, arcuate behind the beaks; right valve with 3 stout cardinals, the anterior very short, tubercular; the middle large, subvertical; the posterior still longer and stouter, oblique, arcuate; a deep pit on a heavy plate in front of the cardinals; the left valve with 3 similar cardinals and one tubercular prominent anterior lateral; the posterior cardinal close to the nymph, long and thin. Adductor-scars not easily accessible. Pallial line distant from the margin; sinus ample, scarcely reaching the middle of the shell, a little ascending, rounded in front. Margin thick, smooth, rather blunt. Height, 44mm.; length, 54mm.; thickness of left valve about 28mm. Height, 41mm.; length, about 48mm.; diameter of closed valves, 39mm.

Occurrence.—Kanchindô (Mankodô and Kanchindô formations).

This species has the same general outline as *P. clarcki* Dickerson from the Oligocene of California, but it is a little more elongate, and a larger and heavier shell with somewhat different incremental lines.

Chione Tateiwai n. sp. Plate XIII, figs. 5, 6.

Holotype.—In Geol. Surv., Chôsen, no. LXXXV.

Shell transversely ovate, thick and solid, moderately convex, cancellated. Beaks approximate, small, not much raised, incurved and prosogyrate, about one-third the length of the shell from the anterior end. Posterior dorsal margin long, gently arcuate, anterior dorsal margin short, about half the length of the posterior, descending, straight; ventral margin regularly arcuate; anterior end regularly and narrowly rounded; posterior end subtruncate. Lunule large, ovate, defined by a sulcus, not depressed, without radial sculpture. Escutcheon narrow lanceolate, strongly depressed, the left-half larger and bounded by a sharp ridge extending from the beak to the posterior end, finely striated. Sculpture of concentric, sublamine ridges, interspaces of which are striated by incremental lines and latticed by numerous small, rounded, subequal, close-set, dichotomous radial threads; threads inconspicuous on the tops of the concentric ridges. Hinge strong but short, arcuate; right valve with 3 divergent cardinals; the anterior lamellar, oblique; the median subvertical, the posterior oblique, both moderately strong and lightly grooved; left valve also with 3 cardinals, the posterior tooth long and thin; there are indications of lateral teeth; nymph high, long. Inner margin smooth. Adductor-scars subequal, oval, the posterior roundish; the anterior rather deep. Pallial line deeply impressed; sinus V-shaped, pointed in front, scarcely reaching the middle of the shell. Margin smooth. Height, 37mm.; length, 31mm.; diameter, 22mm.

Occurrence.—Kinshôdô (Mankodô formation, holotype); Kanchildô (Kanchildô formation).

This form of *Chione* is quite unique in this country. It is rather related to some American forms of the Miocene age.

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PLATE XII

PLATE XII.

Fig.		Page.
1.	<i>Genota cryptoconoides</i> n. sp. Holotype.	146
2.	<i>Polamides (Cerithiidea) kampekuenensis</i> n. sp.	149
3.	" " "	149
4.	<i>Batillaria Yamanarii</i> n. sp. Holotype.	148
5.	<i>Batillaria Talcivai</i> n. sp.	147
6.	" "	147
7.	<i>Polinices (Euspira) meisensis</i> n. sp. Holotype.	150
8.	<i>Polinices (Noverila) coticazac</i> n. sp. Holotype.	150
9.	<i>Acila submirabilis</i> n. sp. Holotype.	151
10.	<i>Arca (Anadara) daitokudocensis</i> n. sp.	153
11.	<i>Arca (Anadara) abdita</i> n. sp. Holotype.	152
12.	<i>Diplodonta ferruginata</i> n. sp. Holotype.	157
13.	" " "	157
14.	<i>Arca (Anadara) daitokudocensis</i> n. sp.	153
15.	" " "	153
16.	<i>Arca (Anadara) Ogawai</i> n. sp. Holotype.	154

All figures in natural sizes.

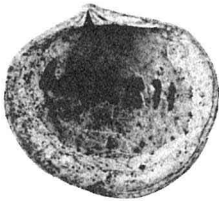
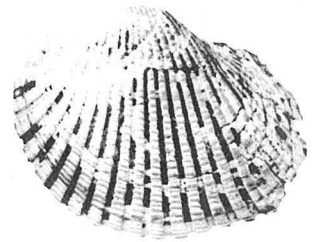


PLATE XIII

PLATE XIII.

Fig.		Page
1.	<i>Cyclina (Cyclinorbis) lamulata</i> n. sp. Holotype.	158
2.	<i>Glycymeris cisshuensis</i> n. sp. Holotype.	155
3.	" " "	155
4.	<i>Pecten (Chlamys) meisensis</i> n. sp. Holotype.	156
5.	<i>Chione Tateiwai</i> n. sp. Holotype, left valve.	159
6.	" " " , right valve.	159
7.	<i>Pitaria Itoi</i> n. sp.	159

All figures in natural sizes.

