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The Meisen Miocene of North Korea

By

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With 2 Text-figures and Plates IV-V

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Distribution of the Tertiary beds deposited under the sea in Chosen (Tyôsen, Korea) is limited on the east side of that arm of land.[1] There are two chief stretches of these along the edge of Japan Sea, one in North Kankyô-dô,[2] and the other in North Keisyô-dô. The north stretch or the one in North Kankyô-dô is seen between Zyôsin and Ranan making a narrow band which has a run of NNE-SSW in a rough statement. The Tertiary of this part is made up by two chief groups, of which the lower one was not made under the sea, while the other the Meisen series forming a very thick group of beds is of chiefly sea origin.

The stratigraphy of the Meisen series was worked out by TATEIWA, YAMANARI, and SIRAKI.[3] These writers made good geological maps in addition. The molluscan fossils from the beds got by TATEIWA and other persons were given names and listed by myself.[4] I gave two weeks last year in that district and made some discoveries new to science which will be given in the lines coming after with general account of the Meisen Miocene series.

Before going forward, I have to say the credits of Mr. I. TATEIWA, Mr. T. SIRAKI and Professor NAKAMURA in giving me wide knowledges about the geology of the Meisen and Kissyû districts.

1) In Basic English, but the scientific words are not changed.

2) Place names are given the letters by Nippon system.

3) TATEIWA: Geological Atlas of Chosen, no. 4; YAMANARI: Geological Atlas of Chosen, no. 3; SIRAKI: Geological map of the coal field in south part of North Kankyô-dô going with the report "Tyôsen Tanden Tyôsa-hôkoku, vol. 6."

4) Tertiary Fossils from North Kankyô-dô, Korea (Mem. Coll. Sci. Kyoto Univ., B, vol. 2, no. 3, 1926).

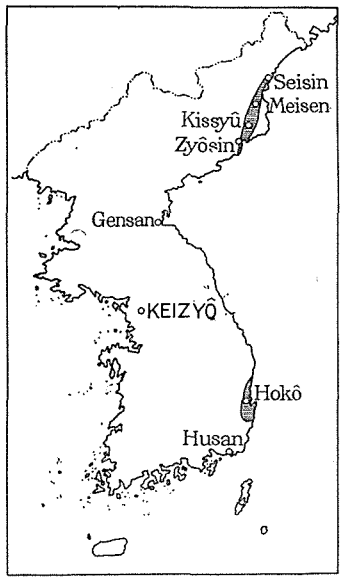

Fig. 1. Chief Distribution of the Tertiary System on the East Coast of Korea.

Mr. I. YOKOTI very kind of him made an offering of mastodon teeth to Imperial University of Kyôto. I have to say in addition that without helps given by Mr. T. KURODA the work would have been very hard to take over. The pictures were kindly made by Mr. N. TAKAHASI. Sense of debt to all the persons is here noted.

The base.—The Meisen series has well development in the Meisen and Kissyû districts of North Kankyô-dô. The greater part of the base of the Tertiary in these areas is made of granite which came into dolomite and crystalline schists of the pre-Cambrian Matenrei system. The granite makes high mountains to the west of the Tertiary field. The Ryûdô series or the lower group of the Tertiary resting upon the granite is made up of sedimentary and pyroclastic beds about 80 m. thick and a very thick covering of alkali basalt.

The Meisen series comes upon the basalt at west side of the area while it is touching the granite by a great fault which put east-side limit of the band-like Tertiary field. Volcanic activity was violent from time to time while the Tertiary beds were put down and it did not come to an end till the late Pleistocene. Volcanic rocks which came into the terrigenous beds or out over the faces are making wide distributions.

TATEIWA giving a list of plants of the Ryûdô series makes statement that that group of the Tertiary may not be younger than the Tyôki (Choki) beds of south Korea which is taken to be Oligocene. He takes forward being of opinion that the Meisen flora, though may be a part of the Lower Tertiary, is not older than that of the Tyôki.

Structure.—The Tertiary band of the Meisen-Kissyû districts comes into first look as if it is a graben, but truely it is a tilted block. The Ryûdô and Meisen beds are resting upon a great back slope facing east and are limited by a great fault running with the east edge of the band with a NNE-SSW direction. Giving a more

detailed account, the beds are put into narrow bands by a number of step faults which are parallel to the great fault of the east edge. The Tertiary beds are naturally monoclinal and sloping east in general but for slope to the opposite direction near along the east limiting fault. In this way, a great syncline with unequally sloping wings is made. Putting into other words, the Tertiary band of North Kankyô-dô is made wide at Meisen-Kissyû district forming a basin longer than wide. The general strike of the structure is NNE-SSW, not taking into account a small number of small dip and diagonal faults.

Divisions of the Meisen series.—Names of the beds are different by different writers. The name of divisions used by myself before in a paper on the fossils of this series were those put in order by TATEIWA the earliest writer. I was able to make clear that the opinions of YAMANARI and SIRAKI are true in the same way. The divisions are to be changed a little taking up the ideas of the three writers in addition to my observations. They are now to be given in going down order:

6. Upper Banko sandstone.....200—400 m.
5. Middle Banko sandstone..... 60—110 m.
4. Lower Banko sandstone..... 70—100 m.
3. Kantin shale..... 80—200 m.
2. Inan sandstone..... 50—300 m.
1. Heiroku conglomerate.....200—240 m.

Here the words sandstone or conglomerate do not have the sense of simple making up of the divisions but only give the general idea taking the sorts of beds which make greater parts of the divisions.

With the east fault, there is a very thick conglomerate which is probably equal to the lower 5 divisions though it is not quite like the normal beds of the west side in lithological qualities. To this special conglomerate, YAMANARI gave a name Yondoukdong conglomerate which may be said shortly "Entoku conglomerate."

Heiroku conglomerate.—This division is the lower part of the Heirokudô formation of TATEIWA and equal to the basalt conglomerate of YAMANARI. It is made of chiefly false-bedded conglomerate of dark basaltic material as its second name gives suggestion, separating the Inan sandstone over, which is made up of light granite material. Gravels in the conglomerate are well rounded and of different sizes ranging from coarse sands up to coarse gravels in degree. The matrix is made of massive medium sands which are

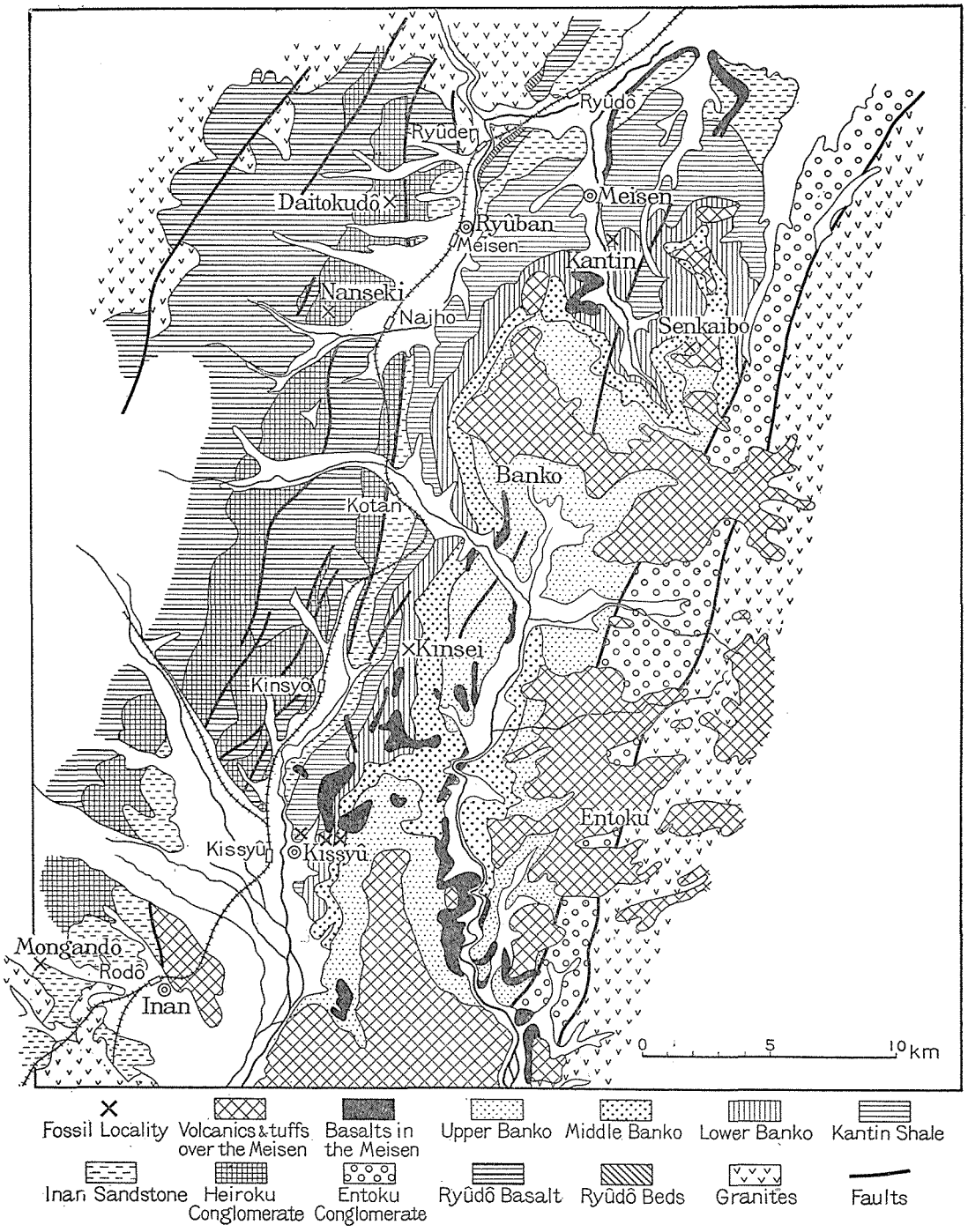

Fig. 2. Geological Map of the Kissyû and Meisen Districts.

not frequently pasted together, but are made somewhat hard by weight. The basalt material is clearly sent from the base which is made of the Ryûdô basalt and naturally the beds are made thin to the east being taken place by the granitic Entoku conglomerate which is very hard by silicification. The Heiroku conglomerate which is not a simple basal conglomerate is not able to put into groups because stretches of beds are not regular. There is, however, a separate brackish water part near the base being made of massive sands and dark mud of about 70 m. thick, full of molluscs.

The thick top part of the conglomerate which keeps little sign of life but for some bad thin coals, seems to have been made on the land by running river waters, but not under the sea, though certain facts in support to this opinion are very poor. There is no true marine bed, which is in the same level as the lower brackish water part, put on view.

The lower part is seen only along the Ryûdô basalt which face was not flat, so the sea-side at the starting time of the Heiroku was unregular. As the brackish water beds were made in some separate inlets and river mouths, they are not in one unbroken part of beds and every one of the beds does not go very far along the strike. TATEIWA gave attention to animal fossils in three chief levels at Nanseki west of Naiho station. The order of changes may be caused by changes of ecological conditions of a small basin. The example of Nanseki seems to be very interesting for working out in details. The molluscan communities at different places, however, are little different. *Batillaria yamanarii, B. tateiwai, Cerithidea kanpokuensis, Anadara daitokudoensis* and *Cyclina lunulata* are the common forms seen almost in every level at every place. *Ostrea gravitesta* with its test of great weight and size is one of the most special fossils of the lower Heiroku. Uncomplete specimens of *Vicarya callosa*, though not very frequent, were made discovery at Nanseki near Naiho in the Meisen district and Mongandô in the Kissyû district. List of molluscan forms at Nanseki will be given under:

Acila submirabilis MAK.
Anadara abdita MAK.
Anadara daitokudoensis MAK.
Batillaria tateiwai MAK.
Batillaria yamanarii MAK.
Cancellaria kobayashii (YOK.)
Cerithidea kanpokuensis MAK.
Cerithium meisense MAK.
Clementia sp.
Corbula sp.
Cyclina lunulata MAK.
Euspira meisensis MAK.
Joannisiella tateiwai MAK.
Laternula sp.

Lucina meisensis MAK.
Nassarius cf. *kometubus* OTUKA.
Pterorhytis sp.
Searlesia kurodai MAK.
Solen sp.
Venerupis (*Amygdala*) sp.
Vicarya callosa JENKINS

This community is the representative example of all lower Heiroku. There are quite a number of places where full of molluscan forms are taken, specially at Daitokudô near Meisen station, at Ryûdô and at Mongandô, coarse sandstones and massive siltstones are full of broken bits of molluscs, of which some are nearly complete. I had not time enough to have looks for probable new places outside the Meisen-Kissyû district.

After I gave account on the fossils of the Heirokudô beds, two or three discoveries of faunules like it have been made in Japan. One of these is that of the Uetuki Miocene[5] of the west and another is the Lower Kadonosawa of the north.[6] The two species of *Batillaria* and the oyster are common in the three beds at far separate places. The Uetuki faunules are in much nearer relation to that of the Heiroku, because in addition to the three forms, there are *Vicarya callosa*, *Euspira meisensis*, *Anadara daitokudoensis*, *Anadara abdita* and *Cyclina lunulata* in common.

Vicarya callosa and the two forms of *Batillaria* in the same way have been overvalued as fingerpoints to the Lower Miocene, though they are limited in brackish water beds which are only side branches of the chief body of the Japonic Miocene made under the open sea, and such side branches are not uncommon near the unregular base, but not so frequent in the middle part. In this way, the same community would not come again between the thick beds of the Miocene but for some very limited examples. As starts of the series are different at different places, the brackish water beds near the bases are not possible to be the same time. We have but rough knowledge about the geological distribution of the said forms that they seem to be not ranging up to the Upper Miocene.

The Kadonosawa beds have a number of molluscan forms common in the younger levels such as the Lower Banko which is a very unfrequent brackish water deposit in the middle Miocene. On the other hand, the Uetuki series may be a part of south expansion of the Heiroku, with which the Tyôki beds of south Korea is taken

5) TAKEYAMA, T. 1933: Notes on the Genus Vicarya. Jap. Jour. Geol. Geogr., vol. 10.
6) OTUKA, Y. 1934: Tertiary Structures of the N. W. End of the Kitakami Mountainland. Bull. Earthq. Res. Inst., Vol. 12.

into relation in addition. Another part of the Uetuki made under the open sea keeps *Miogypsina* cf. *kotoi* and *Operculina* cf. *complanata* on an account by YABE. I have given a stage name "*Uetukian*" in an earlier time with the Uetuki as the representative which might be about equal to the Burdigalian in geological age. The marine *Uetukian* is covering a wide space in the east part of the chief island of Japan probably ranging to the north. The waters of that time was warm at least all the way through the chief island and Korea.

Inan sandstone.—Coming after the land condition of the higher Heiroku, the base of the Inan, which was put under the sea, is frequently marked by unregular erosion face while the bedding planes of the two divisions are in harmony. It was the time of the Miocene transgression took a step forward. The beds were made in the littoral and sublittoral zones where the different sorts of terrigenous sediments were got together, so that, though the greater parts are made of sands, there are a number of lens-form masses of conglomerates, silts and muds. Generally saying, the medium sands of the lower part is changing into the finer silt of the top, conglomerates and shales being frequently put in without any order.

This division is almost completely made of granite material and its relations but for that of basalt got from the conglomerate under. When weathered the sandstone become bright light-coloured making such a comparison with the grey Heiroku, while the new part under the water table is dark green. Animal and plant forms are not so frequent as in the other divisions. I have seen some uncomplete produces which are not of different sorts from those of the Lower Banko.

The Inan sea was wider than that of the lower level at least to the south as the beds make a narrow expansion which goes south to Zyôsin resting upon the granite and dolomites group without the lower Tertiary beds coming between.

Kantin shale.—This division is made up almost completely of shale which is white when weathered but grey at first. The shale keeps a number of animal and plant prints. TATEIWA made a list of the plant leaves. Keeping of the molluscan forms are not very good having been changed into poor print marks, but for a number in calcareous septaria which are not very common. The print marks are kept almost in every part of the shale, though number of sorts is small. The list of named forms in all comes under:

Yoldia thraciaeformis STRORER

Nuculana sp.
Cardium nuttallii CONRAD
Thyasira bisecta CONRAD
Lucina acutilineata CONRAD
Protothaca tateiwai MAKIYAMA
Pitar itoi MAKIYAMA
Tellina optiva YOKOYAMA
Macoma secta (CONRAD)
Macoma tokyoensis MAKIYAMA
Mya cuneiformis BÖHM
Periploma yokoyamai MAKIYAMA

In addition to the molluscs, there are fish and whale bones of which nothing in detail has come to my knowledge at present.

The Kantin shale is the representative of the mud-belt of the higher Meisen sea while it was chiefly formed when the transgression was at its greatest amount. Forms lived in the Miocene sublittoral zone are the most general, making a comparison with the brackish water forms of the Heiroku, Inan and the lower Banko. *Mya cuneiformis* as has been made a statement by myself[7] is a special form of north Japan ranging from the Middle Miocene to the Pliocene. Very wide geological and geographical distribution of *Thyasira bisecta* and *Lucina acutilineata* is not neccessary to say over again in detail. Other sorts such as *Protothaca tateiwai, Periploma yokoyamai* and *Tellina optiva* like *Mya cuneiformis* are specially common, though not fixed, in the Miocene of the north part of Japan. The faunule in all is pointing cold water condition of the Kantin sea, making again an important comparison with the warmer water forms of the Heiroku.

Lower Banko sandstone.—This is the lower part of the Mankodô beds as named by TATEIWA and equal to the Kissyû sandstone of YAMANARI. Beds of medium-grained sands and sandstone make the greater part of the division. There are silt and mud beds put between the sands as the group of beds was made in the belt of variables. The base is well marked: the Kantin shale is sharply put limit to the Banko sandstone, frequently by a sign of small erosion on top. In comparison with the transgressive Inan and Kantin beds, the Lower Banko is the first produce of the regression coming after. The Kantin shale is thicker to the middle of the Tertiary basin

7) MAKIYAMA, J. 1934. This Mem. Vol. 10, p. 157.

getting to 200 m. or more thick at Kantin near Meisen, while it is not much thicker than 80 m. at Kissyû in west side and comes short of, though it was put away by a strike fault in part, the east side where the Banko is resting straightly upon the conglomerate of the base.

Transgressive and regressive overlaps in this way put out on view that the Meisen series was made in an inland sea or a narrow water-way between the chief land to the west and east islands. Salinity of such a limited water would be very low when it was not very deep. The molluscs of the Lower Banko were those lived in brackish water taking in such genera as *Ostrea*, *Anadara*, *Trapezium*, *Corbicula*, *Protothaca* and *Batillaria*.

List of molluscs from the Lower Banko sandstone at Kinsei.

Anadara ogawai MAK.
Cerithidea sirakii MAK.
Cardium shiobarense YOK.
Chlamys meisensis MAK.
Diplodonta ferruginata MAK.
Diplodonta usta GOULD
Dosinia kaneharai YOK.
Dosinia sirakii MAK.
Glycymeris cisshuensis MAK.
Meisenia tateiwai MAK.
Phos meisensis MAK.
Neverita coticazae MAK.
Ostrea cf. *gigas* THUNBERG
Pitar itoi MAK.
Protothaca tateiwai (MAK.)
Searlesia kurodai kinseiensis MAK.
Surculites cryptoconoides MAK.

As put on the list, the community of Kinsei which is kept in a lower part of the Lower Banko sandstone is made up of forms in water more salted than that of the Heiroku. While the sea was narrowed by being made full of the terrigenous material, salinity became low by degree. The top parts have very simple communities made up of *Ostrea*, *Trapezium* and two or three uncommon forms which are only good for very little salted waters.

Middle Banko sandstone.—The middle group of the Banko sandstones is not clearly put limit to the lower division, but it is specially marked by keeping fresh water molluscan forms and thin beds of lignite. Chief part is made of sandstones and mudstones resting on every another by turns, frequently the lignites and other sorts of beds coming between them. For example, orders of beds seen along small rivers to the east of Kissyû are put out on a table together with the lower group.

Plants and molluscan forms are specially full in the mudstones. *Unio*, *Planorbis*, *Viviparus* and *Lymnaea* take places in a number of levels. Unhappily keeping of the forms are very bad having

been crushed by weight or completely taken away by an acid water. For that reason, nothing was able to make clear in detail about names of sorts and order of development.

The sandstones of this division are made so specially harder than the rest as that they are possible to be taken as a key to the lignites which are not very good material to be worked though.

Upper Banko sandstone.—The higher part of the Banko sandstones is made up almost completely of false-bedded thick coarse sands with some small-grained conglomerates in part. The beds are little different all through the field. They are all brown with a little green effect not only on the weathered faces but even on a new cutting giving a suggestion that they were made under a special condition good for forming ferruginous sand grains. The false-bedding and round gravels in it as well give an idea that the higher Banko sandstone was made on land by running waters. Such a condition would come after the wet-places which were general while the Middle Banko times. It is a representative of the last stage of a cycle of sedimentation.

The Upper Banko is seemingly almost unfertile keeping little sign of life, but for a mastodon which was got from the lower part at Senkaibô in the Meisen district. The mastodon is clearly a near relation to *Trilophodon angustidens* and may be a possible special form of the same in this part of the world in any opinion. The teeth do not put out any mark of the higher development seen in the later sorts of mastodons.

The last stage of the Meisen series would not be younger than the Middle Miocene taking the mastodon into account. The Banko fauna in all is in agreement with this opinion and the statement is not at all opposite to the view that the Heiroku is the Lower Miocene.

Entoku conglomerate.—Along the east edge of the Tertiary field a thick simple group of conglomerates was made while the normal divisions were in development in the basin. The conglomerates which have gravels of great sizes were pasted together by silica to very hard masses. As has been given statement before, the conglomerate is equal to the all Meisen series, but for the Upper Banko which is resting upon the top in part. Up to this time, no life record to be a sign of geological time has been made discovery.

General account.—The Meisen series may be put in two groups that are stages: the old Heiroku and the young Kantin, the second taking in all the divisions from the Inan sandstone up to the top of

the series. The Heiroku stage is markedly different from the other in that the beds are made of basaltic material and keep the special group of the past lives taken to be of the Lower Miocene. Though its lowest part is a brackish water deposit, the thick top parts were made by rivers.

The Kantin stage put out a complete cycle of sedimentation, starting from the littoral condition of the Inan sandstone which changes up into the salt water sublittoral mud of the Kantin shale covered again by the littoral beds of the Lower Banko and ending in the river made beds of the Upper Banko after got through the wet-place condition of the Middle Banko. At the time of the greatest transgression when the Kantin shale was made, sea water was free to come in the inland sea of Meisen, but, while the sea was not very deep before and after the Kantin times, salt in the water was not great by enough addition of river waters. The Meisen series was made in a narrow low place between the old chief land of Korea to the west and an island or an arm of land to the east. The fossils of the Kantin stage are pointing the Middle Miocene age of that group of beds as in comparison with the examples taking places in Japan, while that of the Heiroku stage would be the same as the Uetuki fauna in certain ways and possibly be of the Lower Miocene.

Lower and Middle Banko sendstones in the valley between Kitunandô and Ditoku near Kissyû:

Upper Banko	Greenish yellow, false-bedded, medium grained sands	seen 100 m.
Middle Banko	Shale with dark coal substance	1
	Ochre sands	2–4
	Sandstone with fine conglomerates	2.3
	Dark muddy sandstone with coals	2
	Ochre false-bedded sandstone	50?
Lower Banko	Dark shale with *Trapezium*	9
	Oyster sandstone (*Ostrea gigas*)	0.3
	Coarse massive sands with laminae of silts	20?
	Buff medium and coarse sands	15?
	Thin-bedded muddy sandstone	seen 4

Lower and Middle Banko sandstone beds in the east valley of Kissyû Town:

Upper Banko	Greenish yellow false-bedded coarse and medium sands	seen 20 m.

Middle Banko	Grey sandy shale with fossil plants, *Unio, Viviparus* and *Planorbis*.....8
	Grey muddy sandstone with shales having coal substance.....20
	Grey shale, lower part with *Trapezium, Corbicula* etc.....3
	Ochre false-bedded medium sandstone with *Unio* etc.....80?
Lower Banko	False-bedded sandy shale.....8
	Buff false bedded sands.....4
	Grey shale with *Trapezium*, lower part with *Ostrea gigas*.....5?
	Buff massive coarse sands.....10?
	Grey sandstone with thin shales with *Ostrea gigas* and *Macoma tokyoensis*.....20?
	Buff coarse and medium sands.....15?
	Buff false-bedded sands with *Pitar itoi*.....4
Kantin Shale	Grey siltstone with *Thyasira bisecta, Mya cuneiformis, Nonion* sp. etc.

Account on the fossil Molluscs

Genus *Anadara* GRAY, 1847

Type: *Arca antiquata* LINNÉ, 1578 (original designation)

The group *Anadara* may be a subgenus under the genus *Arca* by an opinion, but not a synonym of the second. We are not able to take *A. antiquata* as the type of *Arca* LINNÉ, 1758, for SCHUMACHER did not put forward types for the most genera in his book (Essai Nouv. Syst. Test., 1817) and his word "type" is not pointing a genotype rightly. I took CHILDREN's type species *A. tortuosa* for the genus *Arca* when I gave accounts on *Trisidos kiyonoi*[8] (MAKIYAMA, 1931), but now we have to take *A. noae* LINNÉ, 1758 (subsequent designation by SCHMIDT, 1818) as the first fixed type of[9] *Arca.*

Anadara abdita MAKIYAMA,[4] 1926 (p. 152, pl. 12, fig. 11)

Distribution: Heiroku stage at Nanseki, Daitokudô and Mongandô: Uetuki series.

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8) The Venus, vol. 2, p. 269.

9) REINHART, P. W., 1935, Bull. Mus. Hist. Nat. Belg., II, no. 13, p. 16.

4) This Memoirs, vol. 2.

Anadara daitokudoensis MAKIYAMA,[9] 1926 (p. 153, pl. 12, figs. 10, 14, 15)

Distribution: Heiroku stage at Daitokudô and Nanseki; Uetuki series.

YOKOYAMA[10](1929) made reference of this species from the Uetuki series to *A. camuloensis* OSMONT, 1905

Species Group of *Anadara trilineata* (CONRAD, 1856)

In this group the radial cords are two-parted by a middle line. The radials of later development are in four divisions. In addition to the American forms, the group is made up of the Japonic species *Arca amicula* YOKOYAMA, 1925 and *A. ogawai* MAKIYAMA.

Anadara ogawai MAKIYAMA,[9] 1926 (p. 154, pl. 12, fig. 16)

Distribution: Lower Banko sandstone at Kinsei and Kissyû; Kantin shale at Kantin.

Genus *Acila* H. & A. ADAMS, 1858

Type: *Nucula divaricata* HINDS, 1843 (subsequent designation by STOLICZKA, 1871).

Acila submirabilis MAKIYAMA,[9] 1926 (p. 151, pl. 12, fig. 9.)

Distribution: The present species does not very frequently come out from the Heiroku stage. Nanseki and Daitokudô.

Acila is one of the commonest pelecypods in the Tertiary deposits of Japan. SCHENK puts *Acila ashiyaensis* NAGAO, 1928 into a synonym of *A. submirabilis* which is covering more forms from other places of Japan with the name *A. mirabilis* than the first outline made in 1926.

Genus *Yoldia* MÖLLER, 1842

Type: *Nucula arctica* GRAY, 1824 (subsequent designation by WOODRING, 1925)

Species Group of *Yoldia thraciaeformis* STORER, 1838

This group is equal to *Megayoldia* VERRIL & BUSH, 1897. As I have given statement (1934, p. 130), *Y. thraciaeformis* was got from the species group of *Y. laudabilis* and it is different from the second only in having a well marked but not very sharp ridge on the back part of the shell face. *Y. scapha* YOKOYAMA.[11] 1926 and

10) Jour. Fac. Sci. Univ. Tokyo, sec. 2, vol. 2, pt. 8 p. 368.

11) A number of Prof. YOKOYAMA's works on Tertiary Molluscs of Japan are printed in Jour. Fac. Sci. Univ. Tokyo, Sec. 2. between 1925 and 1931.

Y. gratiosa YOKOYAMA. 1923 are the species of this group, but probably they are synonyms of *Y. thraciaeformis.*

Yoldia thraciaeformis (STORER, 1838)

Distribution: Kantin shale at Kantin, Kissyû etc; a common form. Upper Kadonosawa series (OTUKA, 1934, p. 609); Miocene and Pliocene of Toyohara, Odomari, Nairo, Sannosawa etc. in Sakhalin (Karahuto); Miocene of Rumoe and Embets in Hokkaidô; Pliocene of Sawane, Sado Island. Onma Pliocene (ONOYAMA, 1934). The Tertiary and Recent distribution of this species is limited in the colder waters of North Pacific. The geological range is from the Middle Miocene to the present day.

Genus *Glycymeris* DA COSTA, 1778

Type: *Arca glycymeris* LINNÉ, 1758 (tautonymy)

Glycymeris cisshuensis MAKIYAMA, 1926 (p. 155, pl. 13, figs. 2, 3.)

Distribution: Lower Banko sandstone at Kinsei. Ashiya Oligocene (Nagao, 1928)

There is no form in near relation with this species, though it seems somewhat like *G. vestita* (DUNKER, 1882).

Genus *Chlamys* BOLTEN & RÖDING, 1798

Type: *Chlamys cinnabarina* BOLTEN & RÖDING, 1798=*Ostrea islandica* GMELIN, 1791 (subsequent designation by HERRMANNSEN, 1846)

Chlamys meisensis MAKIYAMA, 1926 (p. 156, pl. 13, fig. 4)

Distribution: Lower Banko sandstone at Kinsei.

This form is far greater than the holotype in size when in full growth. A broken bit of an old example which was probably higher than 10 cm. is at hand. The 23 to 27 chief radials on the shells of the type size are two-parted, every space between them with a smaller radial of the second order, while the two parts of the every radial of the first order on the very older part of the greater example are again two-parted, like this forming four-parted flat and wide radials separated by wide spaces, every one of which has a middle two-parted radial of the second order and two smaller side radials of the third order.

Genus *Ostrea* LINNÉ, 1758

Type: *Ostrea edulis* LINNÉ, 1758 (subsequent designation by CHILDREN, 1823)

Ostrea gigas THUNBERG, 1793

Distribution: A very common form of the Tertiary and Recent brackish waters of Japan. It is coming out from the Lower Banko sandstone at different places in the area. Specially good examples are to be got at Kinsei. A great number of this oyster is frequently forming reefs about a metre thick in the higher levels of the Lower Banko.

This species by itself made a wide distribution in Japan while the Tertiary times, and strangely enough it was true that no other species of oyster did a comparison with it in existence, when in other part of the world some special oysters made so special developments in turn as they are possible to be used as zonal fossils. *Ostrea gigas* has kept on for long times and still it is living.

Ostrea gravitesta YOKOYAMA,[12] 1926

Distribution: Heiroku stage at Nanseki, and Daitokudô; Uetuki series; Lower Kadonosawa series (OTUKA); Green Tuff of Akita-ken (OTUKA); Tukiyosi Miocene of Mino.

This very thick oyster is common in the lower levels of the Heiroku. When young it is not much different from *O. gigas*, but individuals in full growth are not like the second. Naturally the valves of great weight were resting flat on the base of sea, the other vale being only an operculum. The great number of examples at Nanseki are seen in the bed of fine material in their natural position.

O. gravitesta comes out from the lower level as the Heiroku, while *O. gigas* is in the higher level as the Banko in all examples ever came to our knowledges. But this may not be a general law, as this specialy thick oyster is doubted by some to be a good species. Very old *O. gigas* is very narrow and long in general, but sometimes they have a look like *O. gravitesta* in having very thick shell with a round outline. I have got a fossil examples of the second type from the Pleistocene estuary beds of Sayama west of Tôkyô.

Genus *Cardium* LINNÉ, 1758

Type: *Cardium costatum* LINNÉ, 1758 (subsequent designation by CHILDREN, 1823)

Subgenus *Cerastoderma* POLI, 1795

Type: *Cardium edule* LINNÉ, 1758 (subsequent designation by VON MARTENS,[13] 1870)

12) Jour. Fac. Sci. Univ. Tokyo, sect. 2, vol. 1, p. 388, pl. 45, figs. 1, 2.
13) Zool. Rec. 1869, p. 586.

Species Group of *Cardium* (*Cerastoderma*) *decoratum* Grewingk

Cardium (Cerastoderma) nuttallii CONRAD, 1838

Distribution: Kantin shale near Kissyû; Miocene, Pliocene and Pleistocene of California and Oregon. Living: Hokkaidô; Karahuto and Bering Sea; South of California.

The Kantin material is poorly kept. There are some print marks of this form in the shale, but only one nearly complete example got in a concretion is at hand. Though comparison in detail with the other materials is not made, its outline and ornaments are without doubt of that species.

Subgenus not certain:

Cardium shiobarense YOKOYAMA,[14] 1926

Distribution: Miocene of Siobara (type); Lower Banko sandstone at Kinsei; Tanagura beds of Iwaki (YOKOYAMA, 1931).

Cardium shiobarense was not a form made certain as the first material from Siobara was very poor. The materials from the three different places, however, are not much different in their general outlines, ornaments, and in other details. Moreover there is no named species like this in this part of the world.

Genus *Diplodonta* BRONN, 1831

Type: *Venus lupinus* BROCCHI, 1814 (subsequent designation by HERRMANNSEN, 1846)=*Diplodonta rotundata* (MONTAGU, 1803)

Taras antiquatus RISSO, 1826 the monotype of *Taras* is in doubt. That species has not been made clear to be truely *D. rotundata.*

Diplodonta ferruginata MAKIYAMA, 1926 (p. 157, pl. 12, figs. 12, 13)

Distribution: Lower Banko sandstone at Kinsei; Lower Kadosawa series (OTUKA).

An uncommon Lower Banko form. I was not able to get another material from the type locality.

Species Group of *Diplodonta usta* (GOULD, 1862)

This group is equal to the section *Felaniella* DALL, 1899 which is probably of smaller value.

Diplodonta usta (GOULD, 1862)

This is *Mysia* (*Felania*) *usta* of GOULD.

14) Jour. Fac. Sci. Univ. Tokyo, sec. 2, vol. 1, p. 134, pl. 20, figs. 2-5.

Distribution: Lower Banko sandstone at Kinsei; Miocene of Togari in Mino, Okuyamada near Kyôto, Sinano (KURODA, 1931), Iwaki, Okada beds in Hokkaidô; Pliocene of Kaga; Pliocene and Pleistocene of Kwantô. Living: north-east part of Japan.

This species is one of the most frequent forms in the younger Tertiary beds in Japan, specially of the north part. It makes sometimes great groups. The Kinsei form is smaller than the living one of Hokkaidô.

Genus *Joannisiella* DALL, 1895

Type: *Cyrenella oblonga* SOWERBY, MS. HANLEY, 1856 (original designation)

Synonym: *Joannisia* DALL, 1895, not *Joanisia* MONTEROSATO, 1888.

Joannisiella meisensis n. sp. Pl. V Figs. 8, 9.

Outline roundly egg-form, almost equal-sided; curve of outer face regularly round, without any flat part; ventral edge regularly curved, dorsal edge short, its two ends not well marked off from the ventral edge; no cut on the back end; umbones at the middle or very little back. Shell more regularly curved with a wider front end and round back edge than in the type species of the genus. Right valve cotype 24 mm. long and 22 mm. high; left valve cotype 22 mm. long and 19 mm. high; shell seems to be 15–18 mm. wide.

Distribution: Heirokudô stage at Mongandô (type) and Nanseki.

The cotypes are made of two separate valves of different individuals got from the fine conglomerate at Mongandô by TATEIWA. This form is not like the type species living in the Japonic waters in being more regularly outlined. It has no straight part with the edges. The living form is marked with cut back end and nearly straight ventral edge. Another living form *Cyrenoida coreensis* ADAMS & REEVE, 1850 which is a *Joannisiella* in addition is in the nearest connection with the present new species, but that species is different in being much smaller when in full growth and the umbones being in front of the middle. The slopings of the two dorsal edges of *J. meisensis* seem to be sharper than in any other form. A Pliocene shell pictured by YOKOYAMA in 1920 under a name *Diplodonta semiaspera* seems to be not that species of PHILLIPI but to be a *Joannisiella* in a near relation with *J. oblonga*.

Genus *Thyasira* LEACH, 1818

Type: *Tellina flexuosa* MONTAGU, 1803 (monotype)

Thyasira bisecta (CONRAD, 1849)

Distribution: Common in the Kantin shale, specially good materials were got at Kantin and Kissyû, Oligocene to Recent.

Details of the wide distribution in Japan were given by YABE and NOMURA (1925), new additions were made by YOKOYAMA in a number of his papers (1925–1931). See GRANT and GALE (1931) about the distribution in America. R. HÄGG[15] gave a note on this shell in the Tertiary of Spitsbergen (1925).

I have given some discussions on this species in a paper[16] (1934, pp. 146–151).

Genus *Lucina* BRUGUIÈRE, 1797

Type: *Venus pensylvanica* LINNÉ, 1758 (subsequent designation by SCHMIDT, 1818) It was not clear in what division of the genus the under example is placed.

Lucina meisensis n. sp. Pl. IV Fig. 5.

A small, thin, round *Lucina* (*Phacoides* or *Dentilucina* of some writers) with fine regularly spaced concentric threads on the outer face; outline equal-sided, a feeble top of umbone being at the middle; dorsal slopes not sharp, forming an angle about 50°, the back slope nearly straight, while the front one curving out; back end straightly cut, vertical, as long as the back slope; ventral edge regularly round making a part of a circle with the centre on the top of umbone; front end narrowly round. Outer face with two bent lines, starting from the umbones, one in the back and the other in the front part; the back one goes to the lower angle of the back cut, limiting a back flat face; the front bent line curving, short and not so well-marked, limiting a narrow moon-form place. Teeth and inside not seen. Holotype (a left valve) 16 mm. long and 14 mm. high, face curve feeble. Another example 13.6 mm. long, 12.4 mm. high and 6.8 mm. wide.

Distribution: Heiroku stage at Nanseki (the measured example) and Mongandô (type).

This form seems to be not uncommon in the lower levels of the Heiroku stage, though a good complete example is hardly seen. The type is not complete, but has a beautiful outer face and is in full growth. This species is probably in very near relation with *L. khataii* OTUKA, 1934 from the Lower Kadonosawa series, but the

15) Bull. Geol. Inst. Upsala, vol. 20, p. 46.

16) This Memoirs, vol. 10.

second is not so equal-sided. In the ealier time (1926), I made a comparison between an example of this form from Nanseki and *L. saxorum* DESHAYES; it is true that their looks are so like to every other. The statement would be an error, for the two forms are separated by long times and spaces, one in the Miocene of the east and the other in the Eocene of the west.

Lucina acutilineata CONRAD, 1849

Distribution: Kantin shale at Kissyû (the east valley) and Kantin; Miocene and Pliocene of Japan at a number of Places; Oligocene to Recent on the west coast of North America.

Genus *Venerupis* LAMARCK, 1818

Type: *Venus perforans* MONTAGU, 1823 (subsequent designation by CHILDREN, 1823) The groups coming after are put in this greater group by STEWERT[17] (1930, p. 222).

Subgenus *Protothaca* DALL, 1902

Type: *Chama thaca* MOLINA, 1782 (original designation)

Venerupis (Protothaca) tateiwai (MAKIYAMA, 1926) (p. 150, pl. 13, figs. 5, 6;) Pl. IV, Fig. 1.

This is *Chione tateiwai* MAKIYAMA, 1926. *Protothaca sakaensis* MAKIYAMA, 1927 is a synonym.

Distribution: Lower Banko sandstone at Kinsei (type); Kantin shale at Kantin; Miocene of Sinano (as *P. sakaensis*).

This species may be a very common form in the Lower Banko levels, though we have no knowledge of its wide distribution in that bed in addition to the type locality. It is greater in size when in full growth than the holotype which is 37 mm.[18] long. A beautiful material at hand is 49 mm. long and 43 mm. high, while another example is a bit of far greater one than this, probably being longer than 52 mm.

Subgenus *Amygdala* RÖMER, 1857

Type: *Tapes decussatus* LINNÉ, 1758 (subsequent designation[19] by SACCO, 1899).

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17) GABB's California Cretaceous and Tertiary Type Lamellibranchs.

18) I made an error in 1926 (p. 160): "length 37mm" should have been the height; the holotype is truely 37mm. long and 31mm. high.

19) JUKES-BROWN, 1914, Synopsis of the Veneridae. Proc. Mal. Soc., vol. II, p. 91.

Synonym: *Ruditapes* CHIAMENTI, 1900; not *Amygdalum* MEGERLE, 1811 or *Amygdala* VAN PHELSUM, 1774 (not put into as a genus).

Venerupis (Amygdala) sp. aff. **variegata** SOWERBY, 1855.

There is only one complete left valve from the fine conglomerate of the Heiroku stage at Nanseki under observation. A number of smaller bits and uncomplete print marks of the same form in addition are seen in the same material. It is a form longer but lower than *A. variegata*, though it is much like in the design of the outer face.

The examples at hand are all smaller than the living species, the complete one being 17.2 mm. long and 9.7 mm. high. This form is in connection with *A. variegata* and may be grouped under the same species group.

Genus *Cyclina* DESHAYES, 1850

Type: *Cyclina chinensis* DESHAYES, 1850 (monotype) = *Venus sinensis* GMELIN, 1791.

A section *Cyclinorbis* was given in 1926 based upon the Heiroku species coming under. The only special quality of that group separating from the genus was a lunule-like place marked by lines. But it is true that these lines though not so clear have existence on some examples of *C. sinensis* as well. For that reason *Cyclinorbis* may be a synonym of *Cyclina* s.s. and will not be used hereafter.

Cyclina lunulata MAKIYAMA, 1926 (p. 158, pl. 13, fig. 1.)

Distribution: Heiroku stage at Nanseki and Mongandô.

This species is different from the type *C. sinensis* in that the shell is longer; the umbones are smaller, lower and at a short way back the middle and that the outer faces have finer concentric lines.

Genus *Dosinia* SCOPOLI, 1777

Type: *Chama dosin* ADANSON, 1757 (subsequent designation by HERRMANNSEN, 1847) = *Artemis africana* REEVE, 1850.

Dosinia sirakii n. sp. Pl. IV, Fig. 3, 4.

A species like *Dosinia japonica* REEVE, 1850 in its outline. Shell heavy, round, a little more tumid than *D. japonica;* umbones nearer to front end than in the living form under comparison; antero-dorsal edges short and nearly straight, unlike the curving in edges of *D. japonica* and *D. troscheli*, LISCHKE, 1874. Concentric lamellae rough and high all over the face; lunule deeply marked; escutcheon without sharp edges. Hinge thick and strong, right middle chief tooth wide

and strong, sloping back; left front chief tooth very small and thin; pallial sinus up sloping. Holotype measured 52 mm. long, 50 mm. high and 26 mm. thick.

Distribution: Lower Banko sandstone at Kinsei.

Some five examples of which none is complete are at hand. The shells are weathered and broken; but still, it is clear that they are different from the common species of Japonic *Dosinia* such as *D. japonica* and *D. troscheli* in its rough lamellate growth lines, very short and little curved front dorsal edges and in its strong and sloping back right middle tooth. It is not necessary to make comparison with other living and Tertiary forms, but for *D. chikuzensis* NAGAO, 1928 a species from the Ashiya series which is said to be Oligocene. The last form, however, is not so unequal-sided as in the present new species, for the front side is longer. The thick chief teeth of which the second one of the right is sloping back and the front one of the left is small are the most special mark of *D. sirakii.*

Subgenus *Kaneharaia* new

Type: *Dosinia kaneharai* YOKOYAMA, 1926, Miocene of Siobara, Japan.

Shell higher than long, with sloping dorsal edges, no escutcheon; outer face strongly curved out, with flat concentric cords separated by narrow grooves, not ever lamellate; middle chief teeth strong, high, simple, sloping forward and being not in two parts or triangular, the lower end standing straightly up from the inner edge of the hinge stage; front teeth very small and thin; pallial sinus up sloping.

This group is very much like *Dosinidia* DALL, 1902 (type: *Venus concentrica* BORN, 1780) in its detail of the outer face and in having no clearly marked escutcheon. The middle chief teeth of that group in the warmer waters of America are two-topped and stopping at a little up from the inner edge of the stage. In other groups of *Dosinia*, long and narrow chief teeth are put on a flat face of the teeth stage, while in *Kaneharaia*, the spaces between the teeth are very deeply hollowed.

DALL put *D. ponderosa* (GRAY, 1852) of California in his *Dosinidia*. *Kaneharaia* is a group special to the Miocene seas of Japan, but probably it is not a straight relation to *Dosinidia*. The outer face of a *Dosinidia* is not lamellate, because it is covered by a thick periostracum. This will be true in addition in *Kaneharaia*, though such parallel qualities are not dependent on phyletic connection.

Dosinia (Kaneharaia) kaneharai YOKOYAMA,[19] 1926 Pl. IV, Fig. 2.

Distribution: Lower Banko sandstone at Kinsei; Miocene of Siobara (type).

The material from the Meisen series is in better keeping than that of the type which is a print mark of an outer face. The shell substance which is thick is well kept, but the outline is not very complete having been broken to bits before fossilization. Judging from the general form and face qualities, the Banko sort is put in the same species as *D. kanenharai* from Siobara.

Observation of the teeth was made by destruction of some examples, but as the mass of sandstone is much harder than the shell substance which is loose and cracked, the teeth stages have gone to bits while operation. A nearly complete right stage, however, put out the special teeth of the group. Uniting the other small bits, a general look of the stages was able to be judged. The right front tooth is thin, small and parallel to the middle tooth which is strong and simple, separated by a deep space which is in the same level with the smooth hollow in front for joining the left front side tooth. The two edges of the front hollow are not made high. The right back tooth is very long, being almost parallel to the dorsal edge of the valve. The top is in two parts with a sharp edge, of which the inside one is ending at a short way up from the edge of the stage. The left middle tooth is strong and wide at the base; its back side is an upright flat face forming a sharp edge in joining the front sloping face. It is not two-parted, but a very feeble angle on the front slope is a sign pointing the past existence of the two parts. The chief teeth go a different way, and the two front right teeth are sloping forward.

Genus *Pitar* RÖMER, 1857

Type: *Venus tumens* GMELIN, 1791 (monotype)

Species Group of *Pitar itoi* MAKIYAMA, 1926

Pitar itoi MAKIYAMA, 1926 (p. 159, pl. 13, fig. 7.) Pl. V, Figs. 11, 12.

Distribution: Kantin shale at Kantin; Lower Banko sandstone at Kinsei and Kantin (type).

This is a common form of the Lower Banko sandstone, specially it is full in the fossil masses at Kinsei. This species is not a species of *Pitar* in narrow sense, in that the shell is far greater in size; the outer face is rough with growth lines and the teeth are not of the

normal *Pitar*. As it was given account on, the front right chief tooth is very short while the left back chief tooth is long and thin. In this point, *P. itoi* is a sort in near relation to *Amiantis* CARPENTER, 1864 in some measure. Here I put a special species group of *P. itoi* for the time being (=*Calpitaria ?*)

Genus *Meisenia* new

Type: *Meisenia tateiwai* n. sp.

Shell thick, like *Pitar*, but without lunule and escutcheon; teeth like *Pitar*, but the right back chief tooth has a run with the edge of the stage and is separated from the umbone. Pallial line seems to be like that of *Pitar*.

We keep two right valves which are the only representatives of *Meisenia tateiwai* n. sp. One example is complete, but the sandstone substance inside was hardly taken away to make clear the pallial line without damage of this material of great value. In this way, the knowledge of this special form is not complete to put up a new genus fixed in position. The joining apparatus, however, is very special not seen in other groups of pelecypods. A genus like this, though in doubt, may be named.

The right back tooth is stretching on the lower stage edge. Its direction of run makes right angles with the middle tooth which is sloping back a little separated from the first by a wide space. There is no mark of a start of the back tooth straight under the umbone, though the front part in the type is broken to come short of the tooth. The tooth is long and simple without any sign of two-parted top. If we do not take this special tooth into account, the other qualities of the teeth stage is quite like that of *Pitar*. The very back tooth may have started from the type of *Pitar*, which is two-parted and makes a thick stage edge. The highest part of the tooth is not parallel to the lower edge of the stage in *Pitar*. It is certain that the tooth of *Meisenia* would not take such a look by rubbing away of the equal tooth of a *Pitar*. This group will be grouped under the *Veneridae*.

Meisenia tateiwai n. sp. Pl. IV, Figs. 6, 7.

Right valve thick, outline quadrately subovate, unequal-sided, inflated in some measure, no lunule and no escutcheon marked on. Outer face marked with growth lines, but not ornamented; front end narrowly round; back end wider; ventral edge long, more widely rounded forming a narrow curve in joining the back end; back

dorsal edge with a ligament groove inside making a very feeble angle with the back end, running for a short way parallel to the ventral edge and to the longest diameter across the middle of the valve. Umbone in front part, at about the front 1/3. Tooth stage not very thick in comparison with the thick shell; a shallow but wide hollow in the front part being in receipt of a left front side tooth; front chief tooth very short but high; middle chief tooth parallel to and about two-times as long as the first, sloping back a little, its back side rough, sloping, putting out a two-parted sign on view; back chief tooth sloping forward, on the very edge of the stage, long and high, not going forward, its back part parallel to the ligament edge. Holotype 64mm. long, 56mm. high; longest distance from the umbone to the back ventral curve, 61 mm.; distance between the ventral edge and the back dorsal edge, 57 mm.; length of ligament, 32 mm.; distance from the front end of the tooth stage to the back end of the back chief tooth, 25 mm.

Distribution: Lower Banko sandstone at Kinsei (not frequent).

This form is very uncommon. It is somewhat like *Pitar itoi* in outline, but it has no line marking a lunule and its face is smooth. The right valve at hand (holotype) is in full growth having a little turned in ventral edge which is made thicker. The pallial line and sinus was not able to make clear. The teeth are like that of *Pitar* in part as has been given statement.

Genus *Mya* LINNÉ, 1758

Type: *Mya truncata* LINNÉ, 1758 (subsequent designation by CHILDREN, 1822)

Species Group of *Mya arenaria* LINNÉ, 1758[20]

Synonym: *Arenomya* WINCKWORTH, 1930.

M. arenaria, *M. japonica* JAY, 1857, *M. grewingki* MAKIYAMA, 1934 and *M. profundior* GRANT & GALE, 1931 are grouped here.

Mya cuneiformis (BÖHM, 1916)[21]

Synonym: *M. donaciformis* KURODA, 1931 (Miocene of Sinano).

Distribution: Kantin shale at Kantin and Kissyû. Miocene and Pliocene of Japan and Sakhalin.

It was given account how *M. cuneiformis* is different from *M.*

20) This memoirs, vol. 10, p. 156.

21) Jahrb. Preuss. Geol. Land., p, 557.

grewingki, *M. arenaria* and *M. japonica* by the writer[20]. The first example of this species was said in error to have been got in the Gretaceous beds of Sakhalin. This form is one of the common fossils in the Kantin shale and it was seen at a number of places at the side of the two place names on the top.

Genus *Periploma* SCHUMACHER, 1817

Type: *Periploma inaequivalvis* SCHUMACHER, 1817 (monotype)

Periploma yokoyamai MAKIYAMA, 1934 (p. 153)[20]

Distribution: Kantin shale at Kantin and Kissyû. Miocene of Sakhalin (YOKOYAMA,[22] type); Miocene of Sinano (KURODA).

P. yokoyamai was separated from *P. besshoensis* (YOKOYAMA, 1924) as a different species based upon the picture given by YOKOYAMA. The type is got from the Miocene sandy shale (Beds 2) of the River Pohlé, Russian Sakhalin.

Genus *Tellina* LINNÉ, 1758

Type: *Tellina radiata* LINNÉ, 1758 (subsequent designation by CHILDREN, 1823).

Tellina optiva YOKOYAMA,[23] 1925

Distribution: Kantin shale at Kantin and Kissyû; Miocenes of Izumo; Miocene and Pliocene in Hokkaidô and Karahuto (S. Sakhalin); Upper Kadonosawa series (OTUKA).

This is a very special form not going well with the common divisions under the genus *Tellina*. It was put in the group of *Macoma* by OTUKA by a reason on which he did not give any account. The teeth and other inside qualities have not been worked out with care. The material at hand from the Kantin shale does nothing in this purpose, being print marks or in poor keeping. They are, however, little different from the type in general form. This species seems to be limited in the beds with the Oyasio fauna which is pointing a relation with the north.

Genus *Macoma* LEACH, 1819

Type: *Macoma tenera* LEACH, 1819 (monotype) = *Tellina calcarea* GMELIN, 1791.

Macoma tokyoensis MAKIYAMA, 1927[24].

22) Jour Fac. Sci. Univ. Tokyo., Sect. 2, vol. 2, pl. 74, fig. 1.
23) Jap. Jour Geol., vol. 2, p. 6, pl. 2, figs. 3, 4.
24) This Memoirs, vol. 3, p. 50.

Distribution: Kantin shale at Kantin and Kissyû. Miocene to Recent in Japan.

The name has been put forward to take place the homonym *Tellina dissimilis* MARTENS, 1865 (not *T. dissimilis* DESHAYES, 1854). It has a very wide distribution and range in Japan, though it is necessary to go over with care all the examples from different places. Probably it was living in the waters of the Banko levels in addition: some poor materials from a bed of silt in the Lower Banko sandstone near Kissyû seem to be the same form.

Subgenus *Rexithaerus* CONRAD, 1869

Type: *Tellina secta* CONRAD, 1837 (subsequent designation by DALL, 1900).

Macoma (Rexithaerus) secta (CONRAD, 1837)

Distribution: Kantin shale at Kantin and Kissyû. Miocene to Recent of West America; Pleistocene of Simosa (YOKOYAMA); living in Japan (Seto Inland Sea, north part of Japan, Takao in Taiwan etc.).

The Kantin material of this form is poor for observation in detail. It is, however, well putting out the general outline on view equal to that of the living form of Japan. What is the true species position of the so-named *M. secta* of this country is not a question at present.

Genus *Batillaria* BENSON, 1842

Type: *Batillaria zonalis* (LAMARCK) = *Cerithium zonale* BRUGUIÈRE, 1792 (monotype).

The most special mark of the shell is the form of the mouth; the columella straight or turned a little; the canal is very short, widely opened and cut off in front; the outer lip is making a forward expansion under a wide inlet of the back part and there is a very narrow posterior canal. The callus on the parietal wall is frequently made very thick near the back canal. There are spiral threads on the inside face of the outer wall. The base is round and not made hollow. Adult shell has a valix, which is not well marked off from the face of the base, opposite the outer lip. The whorls are almost flat and the suture does not give a strong tight feeling. The axials are catagenetic, making waves on the upper parts of the later whorls, with one or two lines of tubercles in going across the chief spiral cords. The spirals are anagenetic: two cords on the nepionic whorls, of which the one over and one more cord of second order starting

on the neanic whorls near the top suture are inceasing in size while development to the chief spirals of the later whorls. The suture is wave like, but it has a run parallel to the spirals in general. When the shell gets to old, the suture goes a short way up as expansion of the mouth takes place.

I have given an account on the Meisen species that they are very much like some European Eocene forms grouped under *Batillaria* by COSSMANN in keeping marked spines or sharp tubercles in place of the feeble ones of the type and other living species. The whorls of the Meisen forms are angled at middle giving a tight feeling of the suture. Their bases are a little hollowed and have no valix. The spirals are smaller in number than in the living forms. The development of the ornaments, however, is in the same way as in the true *Batillaria*. Unhappily the mouths of the fossil shells are not kept very well, but they seem not very different from the type *Batillaria*. Under these conditions, the Meisen forms may be grouped under another subgenus which does not take the Eocene forms of Europe as joiners.

Subgenus *Tateiwaia* new

Type: *Batillaria tateiwai* MAKIYAMA, 1926. Heiroku stage at Nanseki.

Shell like *Batillaria* s.s., but the spire is scalariform with shouldered whorls which are given a little tight feeling at the suture. Ornaments: catagenetic axials forming high sharp-pointed tubercles on the angle of the later whorls and a small number of anagenetic spirals which are running over the axials. Base curved in, without a valix. Columella upright. Distribution: Lower Miocene of Japan, seemingly up to the Middle Miocene.

Batillaria (Tateiwaia) tateiwai MAKIYAMA, 1926 (p. 147, pl. 12, figs. 5, 6.)

Synonym: *Cerithium sakamotoi* YOKOYAMA,[10] 1929.

Distribution: Heiroku stage at Daitokudô, Nanseki etc; Uetuki series and Lower Kadonosawa series of the chief land.

Batillaria (Tateiwaia) yamanarii MAKIYAMA, 1926 (p. 148, pl. 12, fig. 4.)

Synonym: *Cerithium proavitum* YOKOYAMA,[10] 1929.

Distribution: Heiroku stage at Daitokudô, Nanseki etc; Uetuki series and Lower Kadonosawa series of the chief land.

10) p. 367 and p. 366; see the foot note under the *Anadara*.

This form is nearer to *Batillaria* s.s. in the qualities of its body whorl and the base is not so strongly curved in as the type species. The tubercles are frequently very high, specially on the later whorls. Two spiral lines are marked on the inside wall of the outer lip.

Genus *Vicarya* D'ARCHIAC & HAIME, 1854

Type: *Nerinea? vernuili* D'ARCHIAC, 1850 (monotype).

TAKEYAMA[5] (1933) gave an account of this genus in detail and made certain that two forms *V. callosa* JENKINS, 1864 and *V. vernuili yokoyamai* TAKEYAMA, 1933 are of the Japonic Miocene.

Vicarya callosa JENKINS, 1864

Distribution: Heiroku stage at Nanseki and Mongandô. Lower Miocene of Japan, for example the Uetuki series. Miocene of Java, Sumatra, Philippines and Burma (Oligocene?).

No complete example is under test. But the special marks of his species are well pointed with the poor material from the Heiroku beds.

Genus *Cerithium* BRUGUIÈRE, 1792

Type: *Murex vertagus* LINNÉ (subsequent designation by MONTFORT, 1810).

The name *Cerithium* takes place of *Rhinoclavis* SWAINSON, 1840 which is *Clava* of MARTYN and *Vertagus* of SCHUMACHER.

Subgenus *Proclava* THIELE, 1929

Type: *Vertagus pfefferi* DUNKER, 1882 (monotype, as *Cerithium*)

Cerithium (Proclava) meisense n. sp. Pl. V, fig. 20.

A small, narrow and very high cone with a sharp top angle is the outline of this new species. 8 whorls in 13 mm., without protoconch and nepionic whorls in all examples at hand; the last whorl 5.7 mm. wide; whorls flat, separated by a deep suture. Ornament is made up of 3 spiral cords of about equal size and 28 axial threads which is running over the spirals to make marked roundly square grains; two more spirals thinner than the rest upon the round periphery, the higher one seen near the lower suture on the spire whorls. Base curving in, with low, not well marked spirals, produced forward into a short neck of columella. Columella with a sloping fold inside. Outer lip, canal and other qualities of mouth not very different from the type species.

Distribution: Heiroku stage at Nanseki.

A small example which is not in full growth is taken as the

holotype. Another example from the same place keeps a greater body-whorl of the later development, ornamented by a wide spiral row of highly produced tubercles at the top part near the suture. The row is nothing but the first spiral cord in special development, and its face is marked by a number of spiral lines. This design of ornament is much like that of *Batillaria atukoae* OTUKA, 1934 from the Lower Kadonosawa of North Japan, which is, however, far much greater than the present form in size.

In having a narrower shell ornamented by stronger axials and thinner spirals, the type of the genus is different from this new species. It has one or two valices on the body whorl while the examples *C. meisense* at hand do not have such an increased axial structure, probably because they are not in full growth.

Genus *Cerithidea* SWAINSON, 1840

Type: *Melania lineolata* GRIFFITH & PIDGEON, 1834 (offered herewith).

GRIFFITH and PIDGEON gave a picture and note of this species based upon an example kept in British Museum with the said name given by GRAY. It seems not very different from *Cerithidea decollatus* (LINNÉ, 1767) which is a representative form of the genus.

Cerithidea kanpokuensis MAKIYAMA, 1926 (p. 149, pl. 12, figs. 2, 3.)

Distribution: Heiroku stage at Nanseki, Daitokudô and Mongandô.

Subgenus *Cerithideopsilla* THIELE, 1929

Type: *Cerithidea* (*Cerithideopsilla*) *fluviatilis* (POTIEZ & MICHAUD, 1838) (monotype) = *Murex cingulatus* GMELIN, 1791, not *Murex fluviatilis* GMELIN, 1791 the type species of *Tympanotonos*.

Cerithidea (Cerithideopsilla) sirakii n. sp. Pl. V, Figs. 10, 15.

Shell smaller and narrower than the type species, with 14 whorls in 23.7 mm. (holotype). Spire high and narrow, side straight, making a sharp angle about 20°–25° at the top (top angle of the type species is about 30° or more); spiral ornament: 3 cords with grains, of which the topmost one is touching the suture and far wider and stronger than the rest, the middle cord is the thinnest, while the lowest one is about a third as wide as the top cord; spaces between the cords some measure wide, normally with a very feeble thread; round periphery with two spirals which are like the middle cord of the whorl

face in size and form. Suture deeply lined, partly covering the upper peripheral cord. Axials only marked by grains upon the spirals; number of grains of the lower two cords are two-times of that of the topmost cord. Body whorl measuring 7.5 mm. in diameter; base with a number of spiral lines.

Distribution: Lower Banko sandstone at Kinsei: print marks in the same sandstone near Kissyû, and in the Inan sandstone at the river side about a kilometer south of Inbyô station.

The holotype seems to be one in full growth though it has no sign of valix on the body whorl. None of other examples are complete: the protoconch and the mouth are not pictured. It is, however, clear that the qualities about the mouth are not very different from the type species judging from the general curve of the growth lines. The development of ornaments is in the same design as the type species, but it is more complex.

Genus *Natica* SCOPOLI, 1777

Type: *Nerita vitellus* LINNÉ, 1758 (subsequent designation by HARRIS, 1897).

As has been pointed out by WINCKWORTH,[25] it is not natural to put a sharp line between *Natica* and *Polinices* simply basing upon the calcareous or corneous operculum. The common round and smooth shells of the different groups are made by adaptation to their special ways of living and behaviours. Only the details about the mouths are before palaeontologist for use in classification. Under this condition, it is better to put all the groups in a simple genus *Natica*. Such groups as *Polinices, Euspira, Neverita* and *Tectonatica* are subgenera under the genus.

Subgenus *Tectonatica* SACCO, 1890

Type: *Natica tectula* BONELLI, 1826 (monotype).

Natica (Tectonatica) janthostoma DESHAYES, 1839

Distribution: Lower Banko sandstone at Kinsei. It is one of the commonest species in the Miocene, Pliocene, Pleistocene and Recent seas of Japan.

There is only one complete example among the material from Kinsei which is made up of broken parts of this species.

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25) Jour. Conch., vol. 20, p. 13, 1934.

Subgenus *Neverita* RISSO, 1826

Type: *Neverita josephina* RISSO, 1826 (monotype).

Natica (Neverita) coticazae (MAKIYAMA, 1926) (p. 150, pl. 12, fig. 8)

Distribution: Lower Banko sandstone at Kinsei.

A species in relation to *Neverita recluziana* DESHAYES, 1839 of California, but the funicle and parietal callus of the Meisen species are in less development not covering completely the umbilicus.

Subgenus *Euspira* AGASSIZ, 1838

Type: *Natica glaucinoides* SOWERBY, 1838 (subsequent designation[26] by DALL, 1908)

Synonym: *Lunatia* GRAY, 1847.

Natica (Euspira) meisensis (MAKIYAMA, 1926) (p. 150, pl. 12, fig. 7)

Distribution: Heiroku stage at Daitokudô (type), and Nanseki; Lower Kadonosawa series (OTUKA); Uetuki series (TAKEYAMA).

Genus *Pterorhytis* CONRAD, 1868

Type: *Murex* (*Cerostoma*) *nuttalli* CONRAD, 1837 (*ipso facto* type)

As '*Purpura* MARTYN, 1784' is given no attention by the law, the second old name *Cerostoma* CONRAD, 1837 which was put right to *Ceratostoma* by HERRMANNSEN in 1846, has been used by some writers. But the new name *Pterorhytis* was given by CONRAD to take place *Cerostoma* the homonym of an insect. *Ceratostoma* by rectification is not able to take into account. *Pterorhytis* was used by DALL, COSSMANN and ARNOLD.

Pterorhytis sp.

Broken bits and inside forms of a *Pterorhytis* from Nanseki and Mongandô are at hand. The material is so poor that no detailed observation is possible. It is probably like *P. burnetti* (ADAMS & REEVE, 1850). The whorls have two to three spiral cords on the lower face. The valices are not so strong as in the living species. The most special mark of this form is some number of teeth within the outer lip.

Genus *Searlesia* HARMER, 1914

Type: *Trophon costifer* S. V. WOOD. 1848 (original designation)

Searlesia kurodai n. sp. Pl. V. Figs. 13, 14.

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26) The type given by HARRIS, 1897 is not good in law, because that species has not been listed in 1838 by AGASSIZ (see: STEWART, 1926, p. 324 foot note 69 & 1930 p. 42. FINLAY, H. J., 1928. Trans. N. Z. Inst., vol. 59, p. 348.)

Shell thick, like *S. costifer* in outline and in size, but has a little shorter spire in comparison with the body whorl, and more number of axial folds. Whorls 6, faces feebly convex; suture deeply marked, going down; the last whorl much the greatest, about two-thirds of all whorls in height, ornamented by 10 high and strong round-topped axial folds, with deep round-based spaces, as well as by 8 to 10 unregular flat spiral cords and a number of delicate spiral threads all over, the cords running over the axials; aperture narrow, angled at the back end; canal open, long and a little curved, the top not well marked off from the mouth; outer lip not thick, toothed within. Holotype 32.3 mm. high and 12.5 mm. wide.

Distribution: Type from the Heiroku stage at Nanseki.

Only the type is complete but for the protoconch; other materials are all broken. A round look of the whorls is given by the round folds which are made higher at the middle, though in fact the sides are almost flat. The folds are about as wide as the hollowed spaces. They come to the end on the wide periphery and do not go down to the base. The spiral cords are 22 in number on the last whorl, the suture is covering the 9th cord from the top. The finer spirals are running all over the faces, even on the tops of the cords, making a net-work with the growth-lines. The teeth of the outer lip are made longer giving such a look as transverse lines inside. The inner lip is deeply marked in upon the outer face over the columella.

No form like the present species has been given account from the Miocene of this part of the world. It is somewhat like the type species and other European forms, but none of which is to be made reference here.

Searlesia kurodai kinseiensis n. subsp. Pl. V, Fig. 16.

Different in the details of spirals from *S. kurodai.* The spiral cords are wider than in the species. Every narrow space between the cords has finer spiral threads. The spiral cords on the base are low and narrow.

Distribution: Lower Banko sandstone at Kinsei.

There are only two examples, one of which gets to a great size with a wide body whorl 18 mm. in diameter.

Genus *Phos* MONTFORT, 1810

Type: *Murex senticosus* LINNÉ, 1758 (original designation)

Subgenus *Coraeophos* new

Type: *Phos* (*Coraeophos*) *meisensis* n. sp.

Coraeophos is like *Phos* s.s. in general form but has no valix. Axials and spirals are nearly equally strong, making a cancellate face of the whorls. The three young whorls coming after the protoconch are ornamented by feeble axial threads only. The stromboid cut at the base of the outer lip is very shallow and unclearly marked.

Phos (Coraeophos) meisensis n. sp. Pl. V, Figs. 18, 19.

Shell smaller than the type *Phos*, the holotype measuring 16.2 mm. high and 8 mm. wide, another example in full growth being about 20 mm. high. The early three whorls (nepionic) ornamented by feeble axial threads, the last of the three with small signs of spirals. 22 axials and 10 spirals on the body whorl; suture on the 5th spiral from the top at first, but later going down on the 6th; axials not going on from whorl to whorl, almost regularly spaced, making high grains across the spirals. Mouth like the type *Phos;* columella with a sloping fold at the base and two spiral threads on the middle part; there is a somewhat hollowed place between the base of the whorl and the columella; outer lip with 8 short spiral cords inside and a very shallow stromboid in-curve near the base.

Distribution: Lower Banko sandstone at Kinsei.

A general look of this form is like *Nassarius* in some measure, specially in its *Cancellaria*-like ornament. But the qualities about the mouth are of *Phos* having no thick callus. The columella end is pointed sharply with a sharp fold upon the edge. *Antillophos* WOODRING, 1928 having a design of ornament like *Phos* is different from the present new group. *Fax* IREDALE, 1925 *Phos tabidus* HEDLEY, 1904 as the type is a narrow and high gastropods unlike *Coraeophos* and it seems to have no stromboid curve and no sloping fold upon the columella edge.

Nassa iwakiana YOKOYAMA, 1931 would be a *Phos* and may be taken in the same group as the present new form. That species is ornamented by a smaller number of spirals and axials than in *Nassarius nakamurai* KURODA, 1931 a Miocene fossil form from Sinano which is in addition in the nearest relation to the Meisen species.

Genus *Nassarius* FRORIEP, 1806?

Type: *Buccinum arcularia* LINNÉ, 1758 (monotype)

Nassa LAMARCK, 1799 may be put out simply as a homonym of *Nassa* BOLTEN and RÖDING, 1798. The change of LAMARCK's *Nassa* into *Nassarius* by DUMÉRIL was not right looking from the present day law, because his attempt was to put out all the old names at that times.

Nassarius cf. **kometubus** OTUKA, 1934 Pl. V, Fig. 17.

Distribution: Heiroku stage at Nanseki.

Only one crushed example is at hand. It is not very different from *Nassarius* (*Zeuxis*) *kometubus* OTUKA, 1934 (p. 631), but its outer lip is toothed. There are 8 spirals on the spire whorls and 17 on the last, while the axials are 28 in number.

Genus *Cancellaria* LAMARCK, 1799

Type: *Voluta reticulata* LINNÉ, 1767 (monotype).

Subgenus *Narona* H. & A. ADAMS, 1854

Type: *Cancellaria clavatula* SOWERBY, 1832 (subsequent designation by COSSMANN, 1899)

Cancellaria (**? Narona**) cf. **kobayashii** (YOKOYAMA, 1927)

Distribution: Two examples came from the Heiroku stage at Nanseki.

An egg-formed *Cancellaria* with plicate columella about 19 mm. high. In its general outline and ornament, the present form is clearly a very near relation with *Cancellaria kobayashii* (YOKOYAMA, 1927) and *C. pristina* (YOKOYAMA, 1922) which are the only examples of *Narona* like species in Japan.

In comparison with these, the Heiroku form is different in its detail of ornament, but unhappily the two examples at hand having been crushed by pressure are changed their forms. The distribution of *C. kobayashii* in Japan seems to be limited in the Pliocene so far as we have had knowledge of it. The Heiroku form may probably be a new species.

Genus *Surculites* CONRAD, 1865

Type: *Surcula* (*Surculites*) *annosa* CONRAD, 1865 (monotype).

This group was based upon a doubted species in DALL's opinion (1918) and it was put in synonym of *Surcula* by COSSMANN (1896). But GRANT and GALE giving an account in detail made it clear as a good genus which is covering a number of groups such as *Clinura*, *Megasurcula*, *Pseudotoma* and *Cryptoconus*, because the name is older than the others in near relation.

Subgenus *Megasurcula* CASEY, 1904

Type: *Surcula carpenteriana* GABB, 1865 (subsequent designation by STEWART, 1926).

DALL had a view (1918) that this special group of California is equal to *Cryptoconus* VON KÖNEN, 1867. COSSMANN (1906) had the same view as DALL and he put it under *Bathytoma*. STEWART (1926) made a note of *Cryptoconus* be different from *Pseudotoma* BELLARDI, 1875 in which the Californian form *Surcula carpenteriana* was taken. This species and other Californian forms down from the Miocene may be grouped under a separate subgenus *Megasurcula* from *Pseudotoma* and *Cryptoconus* of Europe as has been done by GRANT and GALE (1933). Distribution of *Megasurcula* would have been wider at one time in the Miocene than now. OTUKA (1934) gave accounts of two new species of *Surculites* from the Kadonosawa Miocene of north Japan: *S. kurodai* and *S. yokoyamai*, of which the second is a *Megasurcula* being a relation with the type species of California.

Surcula (Megasurcula) cryptoconoides (MAKIYAMA, 1926) (p. 146, pl. 12, fig. 1.)

Distribution: Lower Banko sandstone at Kinsei.

This species is without doubt a *Megasurcula* with a *Surcula*-like anal sinus, but not a *Genota* which is marked by a *Turris*-like anal sinus. It is possibly a near relation to *Megasurcula remondii* (GABB, 1866) of California. The general look of this form is like *Bathytoma* HARRIS and BURROWS, 1891, which is living in the warmer waters of Japan.

Addition

At the side of the species given accounts on the top lines, there are some very uncomplete samples of such forms as *Corbula, Corbicula, Tellina, Laternula, Solen, Trapezium, Unio, Turbonilla, Viviparus, Planorbis, Lymnaea* etc. of which some are important as they are pointing the sorts of their living places. But these were not fixed to any species, for their keepings are in bad conditions, though the names of genera are little doubted.

Account of Plates

Plate IV

Plate V

All the types of new forms are kept in the Geological Institute of this University.

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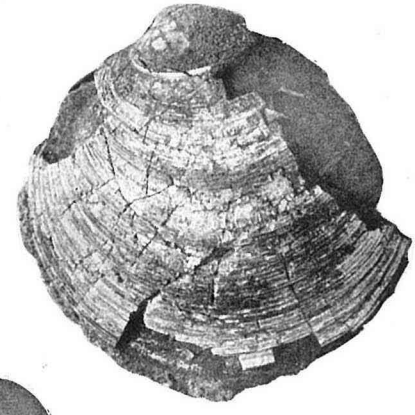

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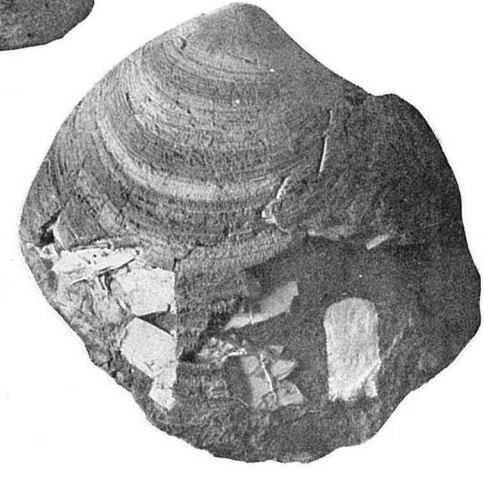

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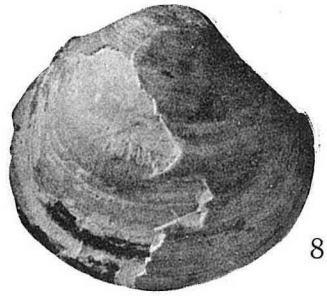

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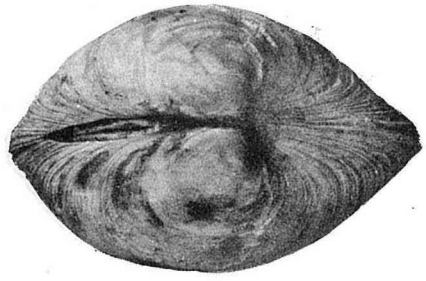

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