東京帝國大學理學部紀要

第二類　地質學 鑛物學 地理學 地震學

第三冊　第七篇

JOURNAL

OF THE

FACULTY OF SCIENCE

IMPERIAL UNIVERSITY OF TOKYO

SECTION II

GEOLOGY, MINERALOGY, GEOGRAPHY, SEISMOLOGY

Vol. III　Part 7

TOKYO

Published by the University

March 3, 1933

The "JOURNAL OF THE FACULTY OF SCIENCE" is the continuation of the "JOURNAL OF THE COLLEGE OF SCIENCE" published by the University in forty-five volumes (1887–1925), and is issued in five sections:

Section I.—Mathematics, Astronomy, Physics, Chemistry
Section II.—Geology, Mineralogy, Geography, Seismology
Section III.—Botany
Section IV.—Zoology
Section V.—Anthropology

All communications relating to this JOURNAL should be addressed to the DEAN OF THE FACULTY OF SCIENCE, IMPERIAL UNIVERSITY OF TOKYO.

Faunal Study of the Wanwanian (Basal Ordovician) Series with Special Notes on the Ribeiridae and the Ellesmereoceroids.

By

Teiichi KOBAYASHI.

With Plates I–X.

CONTENTS.

I. Acknowledgements.

This palaeontological work was prepared in the United States National Museum during the winter of 1931–1932. Here I take the opportunity to express my sincere thanks to Drs. E. O. Ulrich, R. S. Bassler, A. F. Foerste, C. E. Resser, J. Bridge and C. A. Cooper for their courtesies, suggestions and criticisms.

II. Wanwanian Stratigraphy.

i) *Introduction :—*

Above the Upper Cambrian Tsinania zone remarkable differences appear in the faunas occurring on two sides of the "Tsinling-Keijo Line"[1] which separates the southern palaeogeographical province, embracing southern and central China, and southern Korea from the northern region including nothern Korea, South Manchuria, and northern China. In the latter area there is a thick deposit of limestone and dolomite with intercalations of limestone conglomerate, banded marl and shale, grouped in the Tsinan series of Willis; the area in which these beds were deposited being called the "Tsinan Basin."[1].

Little is known of the Tsinan series of Shensi and Kansu on the western border of the Tsinan basin, except for fragmentary notes on the Pingliang shale and *Didymograptus enodus* shale in Kansu. Grabau[2] has made important contributions to the knowledge of this series in the provinces of Shansi, Shantung, and Chihli; and I have studied it in North Korea and South Manchuria.[3] Recently, R. Endo[4] completed an interesting paper on the Ordovician fossils of South Manchuria which will appear shortly.

The palaeontological evidence so far brought to light shows that the Ordovician faunas of the Tsinan Basin have close relationship to those of North America and the Arctic regions. In accordance with

1) T. Kobayashi (1930), Cambrian and Ordovician Fauns of South Korea and the Bearing of the Tsinling-Keijo Line on Ordovician Palaeogeography. (Proc. Imp. Acad. VI, 10.)

2) A. W. Grabau (1922), Ordovician Fossils from North China. (Palaeont. Sinica. B. I. Fasc. 1.)

3) T. Kobayashi (1927), Ordovician Fossils from Korea and South Manchuria. (Japan. Jour. Geol. and Geogr. V); (1931) Studies on the Stratigraphy and Palaeontology of the Cambro-Ordovician Formation of Huo-lien-chai and Niu-hsin-tai, South Manchuria. (Japan. Jour. Geol. Geogr. Vol. VIII.)

4) R. Endo (1932), The Canadian and Ordovician Formation and Fossils of South Manchuria. (U. S. Nat. Mus. Bull. 164.)

the stratigraphical sequence and palaeontological data the series is divisible into three parts namely, in ascending order, the Wanwanian, the Wolungian, and the Toufangian. Each of these is characterized by certain cephalopods as follows:

Wanwanian . . . . . by the Ellesmereoceroids.
Wolungian . . . . . by the Piloceroids.
Toufangian . . . . . by the Actinoceroids.

In my opinion, the Wanwanian corresponds approximately to Ulrich's Ozarkian or its upper half; the Wolungian to the Canadian; and the Toufangian to the lower half of his Ordovician.

Endo in his recent study of the Canadian and Ordovician fossils from South Manchuria came to nearly identical conclusions concerning these formations and divided the Toufangian series into three formations, the Ssuyen, Wuting and Kangyao which he considers to be contemporaneous with the Black River, Blount (Athens) and Stone River Groups in North America respectively.

The Wanwanian series is an excellent key bed for stratigraphic purposes, being well defined at its base by a certain limestone called variously, "Ohuzumaki limestone," algal limestone, or "limestone with *Cryptozoon*-like structure," which I have denominated the Wanwankou limestone. This limestone contains, on the one hand, abundant remains of gastropods, cephalopods, and ribeirioids, while, on the other, it contains trilobites and brachiopods which still show close affinity to the Upper Cambrian groups, and thus contains a record that is transitional between the Cambrian and the Ordovician. The study of its fossils is therefore of great importance and interest, revealing as it does aspects of the vast faunaltr ansformation, the rise of the Ordovician forms, and the decadence of the Cambrian life.

ii) ***Stratingraphical relation :—***

The Toufangian, Wolungian, and Wanwanian series are most readily studied in the region around Huo-lien-chai and Niu-hsin-tai, South Manchuria, where the complete sequence can be observed at Huo-lien-chai, and Chiu-shu-kou and other valleys in the Niuhsintai Basin; The Wanwankou limestone conformably overlies the Yingtzu series of late Upper Cambrian age, and as stated above, forms the lowest division of Wanwanian series showing a peculiar *Cryptozoon*-like structure. Beside *Cryptozoon* there have been found cephalopods gastropods, and other fossils, among which *Ellesmereoceras elongatum*, and *Ellesmereoceras* (?) *multicameratum* are the most common forms. At Huo-lien-chai and other places the Wanwankou limestone is overlain by

the Chiushukou shale followed by the main dolomite above. The latter was called the Hsiapingchou dolomite by K. Ozaki[1] which name will be applied hereafter.

At certain localities the Wanwankou limestone gradually changes from limestone to dolomite, as one proceeds from its base towards the top. In such cases, it is feasible to differentiate the upper Wanwankou dolomite from the lower Wanwankou limestone proper. The term "*proper*" will hereafter be attached when referring to the lower non-dolomitic limestone portion of Wanwankou formation. In my previous paper I did not separate the two into members, but merely treated them together under the name of Wanwankou limestone, since their faunas are closely allied to each other; but now I believe that such a separation is desirable.

In the Sosan area[2], in the northern portion of the Korean Peninsula, the Wanwanian series has the following succession:—

Hsiapingchou dolomite.	Dark gray dolomite.
Wanwankou dolomite.	Dark gray dolomite with *Cryptozoon*-like structure.
Wanwankou limestone proper.	White or light gray limestone with *Cryptozoon*-like structure.

In the Wanwankou valley in the Niuhsintai basin numerous fossils were collected from the Wanwankou dolomite lying directly over the Wanwankou limestone proper.

The Chiushukou shale usually occurs as a thin bed varying in thickness from five to fifteen meters, and is composed of many alternate layers of shale and marl. If traced for any distance, this shale has a tendency to thin out. It appears to be certain that the Wanwankou limestone proper is older than the Chiushukou shale, but the upper dolomite member is possibly not always older, for in some places, as in the Sosan area, it is not intercalated by the shale. The dolomite and the shale thus occurring in the same horizon may be explained as representing different sedimentation facies. Another evidence which substantiates this view is the marked dissimilarity between the faunas contained in the two strata.

---

1) H. Yabe and T. Sugiyama (1930), On some Ordovician Stromatoporoids from South Manchuria, North China and Chosen (Korea) with Notes on two new European Forms. (Scince Rep. Tohoku Imp. Univ. Second Series (Geol.) Vol. XVI, No. 1.)

2) T. Kobayashi (1931), Studies on the Ordovician Stratigraphy and Palaeontology of North Korea, etc. (Bull. Geol. Surv. Chosen. Vol. XI, No. 1,) pp. 11–14.

In summary, I shall generalize the stratigraphical relation of all of these beds in the following manner:

Hsiapingchou dolomite

Chiushukou shale.

Wanwankou limestone. { Wanwankou dolomite / Wanwankou limestone proper.

iii) ***Faunal characters :—***

In my previous papers I described eight species from the Wanwankou limestone (in its broad sense) and seven from the Chiushukou shale. These, listed in accordance with the new stratigraphical divisions defined above, are :—

1) From the Wanwankou limestone proper in the Huolienchai area and the Niuhsintai basin,

Ellesmereoceras elongatum Kobayashi.
Ellesmereoceras subcirculare Kobayashi.
Ellesmereoceras (?) *multicameratum* Kobayashi.
Clarkoceras poulseni Kobayashi.

2) From the Wanwankou dolomite in the Niuhsintai Basin.

Ellesmereoceras elongatum Kobayashi.
Ellesmereoceras subcirculare Kobayashi.
Ellesmereoceras curvatum Kobayashi.
Ellesmereoceras (?) *flexuostriatum* Kobayashi.
Ellesmereoceras (?) *multicameratum* Kobayashi.
Eremoceras wanwanense Kobayashi.
Ptychaspis walcotti Mansuy.

3) From Chiushukou shale in the Huolienchai area and Niuhsintai basin.

Agnostus chiushuensis Kobayashi.
Ptychaspis angulata Mansuy.
Ptychaspis chinhsiensis Sun.
Ptychaspis bella Walcott.
Ptychaspis suni Kobayashi.
Koldinioidia typicalis Kobayashi.
Lingulella liui Sun.

While at the U. S. National Museum, I continued my investigation of the Wanwanian fauna. As suggested in my cited paper, it has been my belief that the generic reference of the Wanwanian *Ptychaspis* is open to grave doubt, since the group certainly appears to be more closely allied to *Saukia* and *Calvinella* than to *Ptychaspis* s. str. Recently Ulrich and Resser thoroughly worked out the American specimens of

the Saukinae, and established this new subfamily distinct from the Ptychaspinae. Availing myself the opportunity to compare my specimens with those studied by Ulrich and Resser and also with the Ozarkian cephalopod materials which Ulrich and Foerste are now investigating, I have been able to determine more accurately the identity of the dubious species from the Wanwanian.

Previous generic reference.	Present generic reference.
Ptychaspis angulata Mansuy.	*Prosaukia angulata* (Mansuy).
Ptychaspis walcotti Mansuy.	*Calvinella walcotti* (Mansury).
Ptychaspis bella Walcott.	*Calvinella bella* (Walcott).
Ptychaspis chinhsiensis Sun.	*Tellerina chihsiensis* (Sun).
Ptychaspis suni Kobayashi.	*Tellerina suni* (Kobayashi).
Ellesmereoceras (?) *curvatum* Kobayashi.	*Ectenoceras curvatum* (Kobayashi).
Ellesmereoceras (?) *multicameratum* Kobayashi.	*Multicameroceras multicameratum* (Kobayashi).
Eremoceras wanwanense Kobayashi.	*Sinoeremoceras wanwanense* (Kobayashi).

As a result of the present study of the Wanwanian material I can add about fifty new species which are arranged below according to localities and horizons :—

1) From boulders of the Wanwankou limestone proper collected at San-chia-tzu in the Niuhsintai basin.

Cyrtendoceras holmi new species.

2) From the Wanwankou limestone proper at Chiushukou valley in the Niuhsintai basin.

Ectenoceras curvatum (Kobayashi).
Wolungoceras chiushuense new species.

3) From the Wanwankou dolomite at Wanwankou valley in the Niuhsintai basin.

Huenella wanwanensis, new species.
Helicotoma wanwanensis, new species.
Matherella walcotti, new species.
Clisospira niuhsintaiensis, new species.
Archinacella wanwanensis, new species.
Proplina bridgei, new species.
Proplina ampla, new species.
Proplina (?) sp.
Scenella sp. undt.

Stenotheca (?) *manchurica*, new species.
Scaevogyra ulrichi, new species.
Scaevogyra naticaformis, new species.
Ellesmereoceras foerstei, new species.
Ellesmereoceras abruptum, new species.
Ectenoceras subcurvatum, new species.
Ectenoceras ruedemanni, new species.
Wanwanoceras peculiare, new species.
Burenoceras (?) *reticulatum*, new species.
Multicameroceras cylindricum, new species.
Wanwanella wanwanensis, new species.
Wanwanella striata, new species.
Wanwanella striata auriculata, new variety.
Wanwanella tumida, new species.
Wanwania ambonychiformis, new species.
Wanwania compressa, new species.
Wanwanoidea trigonalis, new species.
Wanwanoidea trigonalis delicata, new variety.
Ribeiria manchurica, new species.
Ribeiria manchurica pennata, new variety.
Ribeiria bassleri, new species.
Euchasma eopteriformis, new species.
Euchasmella delicatostriata, new species.
Eopteria asiatica, new species.
Eopteria alta, new species.
Eopteria obsolata, new species.
Eopteria flora, new species.
Eoschyrina billingsi, new species.
Pseudotechnophorus typicalis, new species.
Pseudoeuchasma typica, new species.
Kingstonia semicircularis, new species.
Kingstonia convexa, new species.
Kingstonia humilis, new species.
Stenopilus convexus, new species.
Plethopeltis orientalis, new species.
Plethopeltis resseri, new species.
Platycolpus (?) *granulatus*, new species.

4) Hsiapingchou dolomite at Wan-wan-kou.

Proterocameroceras mathieui Grabau.

iv) *Chronological discussion.*

As shown in the annexed list on page 321, the Wanwanian fauna contains sixty species and three varieties. The faunal character of the Wanwankou limestone proper is not as different from that of the overlying Wanwankou dolomite, as the list indicates. The absence of gastropods and ribeirioids are due chiefly to the difficulty of extracting specimens of these groups from the limestone. Some cephalopods common to the Wanwankou limestone and dolomite, are specifically identifiable only by the examination of polished sections. A more remarkable difference is recognizable between the Wanwankou dolomite and Chiushukou shale. The former contains abundant gastropods, cephalopods and ribeirioids, none of which can be procured from the Chiushukou shale. As to brachiopods, a protremate species is known from the former bed, while an atremate from the latter. Trilobites occur rather abundantly in both, but there is still a strong difference that cannot be overlooked. Six species of trilobites are described from the Chiushukou shale and eight from the Wanwankou dolomite, with none common to the two beds. *Calvinella walcotti* (Mansuy) ranges from the Lingulella-Obolus zone of the Yingtsu series which in turn lies below the Wanwankou limestone proper, up into the latter limestone bed. To consider the bearing of this faunal difference between these strata we must be cautious, because the Chiushukou shale is an argillaceous bed and the Wanwankou limestone and dolomite are calcareous beds; hence, there is a possibility that the faunal difference may be due to difference of rock facies to some extent. As stated above, such an interpretation is also supported by the stratigraphical relation between the two beds; namely, the Chiushukou shale and the upper part of the Wanwankou dolomite merge. Under these circumstances it is reasonable to assume that the faunal difference may be attributable to sedimentation on the one hand, but of course there is always the possibility that actually we are dealing with an faunal change due to the usual causes.

So far as present knowledge goes, the Hsiapingchou dolomite is practically barren of fossils except for *Proterocameroceras mathieui* Grabau. This species is the most common species in the Wolungian fauna and the genus is characteristic of the Wolungian of Eastern Asia, as well as of the Canadian in North America and Arctic regions. Thus, this bed is considered to be probably contemporaneous with the lowest Canadian rather than with the uppermost Ozarkian. This, however, cannot be definitely determined without further material.

Among the eleven species of gastropods, *Proplina* (?) sp., *Scenella* sp.,

Stenotheca (?) *manchurica* and also *Archinacella niuhsintaiensis* are represented by poor specimens. Thus these are omitted in drawing stratigraphic conclusions and there then remain the following seven species :—

Helicotoma wanwanensis, new species.
Matherella walcotti, new species.
Clisospira wanwanensis, new species.
Proplina ampla, new species.
Scaevogyra ulrichi, new species.
Scaevogyra naticaformis, new species.

Both *Proplina* and *Scaevogyra* are important genera in the from Ozarkian of North America. *Verispira*, represented by three species bed d4 and one from bed d1 of Bohemia is considered by Perner[1] to be a subgenus of *Scaevogyra*. However, *Scaevogyra* s. str. so far as I am aware, is restricted to the Ozarkian in North America. *Proplina* has a wider range rising up to the Canadian and higher. Also many species of *Helicotoma* and *Clisospira* are reported from the Canadian of Europe and America, but *Helicotoma uniangulata* (Hall) is the only species from the Ozarkian of New York, together with a similar species in the upper Ozarkian of Greenland.[2] On the other hand the genus *Matherella* is Ozarkian and Upper Cambrian. If the *Clisospira lirata* belongs to this genus, its upper limit rises to the Canadian. Judging from these genera the gastropoda fauna supports the Ozarkian age of Wanwankou dolomite rather than Upper Cambrian or Canadian.

As discussed elsewhere[3] the Wanwanian ellesmereoceroids show an intimate relationship to those from the Ozarkian of North America and the Arctic regions. As the result of this reexamination, the numbers of their species and genera are increased and also the generic references of a few species are changed. At present twelve species are recognized from the Wanwankou dolomite and seven from the Wanwankou limestone, among which four species are common to the two formations. As *Wanwanoceras*, *Sinoeremoceras* and *Multicameroceras* are new genera, they should be left out of the chronological discussion. Then *Ellesmereoceras*, *Ectenoceras* and *Burenoceras* come into consideration, which are

1) Perner (1911), in Barrande's Systême silurien du Center de la Bohême, Vol. IV, Gastropodes Tome III, p. 216.

2) Poulsen (1927), The Cambrian, Ozarkian and Canadian faunas of Northwest Greenland. (Jubilaemsekspeditionen Nord om Grønland (1920–1923), Nr. 2.) pp. 285 & 289

3) T. Kobayashi (1931), Op. cit. (Japan. Jour. Geol. Geogr. Vol. VIII), pp. 150–152; Op. cit. (Bull. Geol. Surv. Chosen, Vol. XI, No. 1), pp. 27–29.

according to Ulrich and Foerste's monographic work, now in progress, are all characteristic of the upper Ozarkian in North America. *Ellesmereoceras* occurs also in the Ozarkian of Greenland.

In the underlying Wanwankou limestone there occur *Wolungoceras*, *Clarkoceras* and *Cyrtendoceras*. *Wolungoceras* and *Cyrtendoceras* have hitherto not been described from formations older than the Wolungian or Canadian, but *Clarkoceras* is a genus characteristic of the upper Ozarkian. Therefore, judging from the general aspects of the contained cephalopods, the Wanwankou limestone and dolomite correspond to the upper Ozarkian in North America.

It is an important fact that in North America the number of cephalopod genera and species sporadically increases in passing from the lower Ozarkian to upper Ozarkian. Our knowledge of cephalopods before the upper Ozarkian is so meager as only a few, very simple forms occur in the Cambrian and lower Ozarkian anywhere in the world.

As to the trilobites, *Kingstonia* is a genus very common in the Upper Cambrian in North America, only one species being assigned to the Ozarkian in North Vermont. The genus *Calvinella* ranges from the Upper Cambrian to the lower Ozarkian. *Stenopilus convexus* and *Plethopeltis orientalis* have close resemblances with *S. latus* and *P. buehleri* from the Eminence dolomite, therefore the Wanwankou dolomite should be of the lower Ozarkian age, and if not, it has more possibility for Upper Cambrian than for Ozarkian. The Chiushukou shale should also still be lower Ozarkian, judging from the trilobite genera, because *Prosaukia*, *Calvinella*, and *Tellerina* are all limited to the Upper Cambrian and lower Ozarkian in North America.

Except for a species of *Ribeiria* from the Mons formation in the Cordillian trough, nothing has hitherto been known of the ribeirioids from the Ozarkian, so chronological deductions from them are not of much value at present. But this group of Crustacea should be an important Ozarkian faunal element, because ten genera, seventeen species and three varieties of the ribeirioids are contained in the Wanwankou dolomite.

In summarizing the chronological discussion, it must be pointed out that the gastropods support an Ozarkian age of the Wanwankou dolomite and judging from the cephalopods, this limestone and dolomite should be of the upper Ozarkian, but if we merely consider the trilobite genera, this and also the Chiushukou shale should be lower Ozarkian. Under these circumstances, it is question whether the Wanwanian series corresponds to the whole Ozarkian or to a middle portion, but if the coming of new forms is more valuable for chronological purposes

than the decay of the old fauna, then there exists a greater possibility that the Wanwanian is upper Ozarkian; however it may be premature to decide to correlate in detail the Wanwanian in Eastern Asia with contemporaneous Ozarkian strata in North America.

If a tentative correlation is required, it follows in a descending order:—

International time scale.	Subdivision of Wanwanian strata.		Ulrich's time division.
Ordovician.	Wanwanian	Hsiapingchou dolomite	Lower Canadian
		Chiushukou shale.	
		Wanwankou dolomite	Upper Ozarkian.
		Wanwankou limestone proper.	
Cambrian	Yingtzu series.	Obolus-Lingulella zone.	Lower Ozarkian
		Tsinania zone.	Upper Cambrian

At any rate a statement from my previous paper[1] may be repeated, "a remarkable transformation between the Cambrian and Ordovician fauna took place in passing from the Obolus-Lingulella zone of the Yingtzu series to the Wanwankou limestone in a broad sense." This is particularly emphasized by the remarkable development of the cephalopods and ribeirioids. Such a transformation is certainly of much higher order than those occurring from the Wanwanian to Wolungian and from Wolungian to Toufangian, because these transformations are demarcated by the evolutional stages of cephalopod groups and not by the appearance of cephalopod faunas. Therefore, as far as South Manchuria and North Korea are concerned, there remains no question as to the correctness of drawing the Cambro-Ordovician boundary at the base of the Wanwanian series.

III. Description of Fossils.

Brachiopoda.

Genus HUENELLA Walcott, 1908

Huenella (?) *wanwanensis*, new species.

Plate VI, figures 11 & 12.

Two specimens of ventral valves are in hand.

Description:—Shell strongly convex, subquadrate in outline, with a long hinge which is a little less than the length of the shell; beak

1) T. Kobayashi (1931), Op. cit. (Japan. Jour. Geol. Geogr. Vol. VIII, pp. 149-150).

small ; cardinal angle round ; mesial sinus broad but not deep ; the sinus abruptly curving and sloping down in the lower portion and projecting beyond the plane of junction. Surface marked by a number of fine radial ribs ; between every two of them, two or three finer lines are observed which again bifurcate near the margin of the shell.

The figured specimen (Plate VI figure 11) is 11 mm. high, and may be 16 mm. long, if it be complete.

Comparisons:—There are two species somewhat allied to this species, *Huenella orientalis* Walcott[1] from the Upper Cambrian of North China and *Huenella simon* Walcott[2] from the Upper Cambrian of Canada, but both of them have more prominent mesial sinus on less convex valves. *Huenella vermontana* Walcott[3] from the Middle Cambrian of Vermont is another allied species which is different from this species by its uniform and coarser radial ribs.

The present species as well as those three are quite distinct from typical forms of *Huenella*, such as *Huenella taxana* (Walcott) through the absence of strong ribs. As it is represented by meager specimens, its generic position is only provisional.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Gastropoda.

Genus HELICOTOMA Salter, 1859.

Helicotoma wanwanensis, new species.

PM 239 C 201 (1-b

Plate V, figure 3.

Description:—Shell of medium size, its spire consisting of about five volutions, horizontally coiled except the last whorl which is descending and uncoiling ; upper side of the body-whorl flat and horizontal, the outer wall sloping down and outward, forming an obtuse angle of about 110 degrees with the upper surface ; the lower side semi-circular which continues to the rather flat inner side of the whorl. Surface ornamented by numerous lines which are directed obliquely outward and forward from the suture to the periphery and sweeping backwardly and downwardly on the lateral side ; the peripheral carina

1) Walcott (1913), Cambrian Faunas of China, p. 85, pl. 4, figs. 14, 14 a-b.
2) Walcott (1924), Cambrian and Ozarkian Brachiopoda, p. 521, pl. 118, figs. 8, 9.
3) Walcott (1912), Cambrian Brachiopoda, p. 809, text-fig. 76.

well marked by two lines, one just on the margin and the other a little within the margin.

Comparisons:—*Helicotoma yabei* Kobayashi and *Halicotoma tamurai* Kobayashi[1] have been described from the Unkaku bed of North Korea and *Helicotoma kanekoi* Kobayashi[2] from the Shorin Bed of North Korea. All of these species are quite different from this species in the mode of coiling, cross section of the whorl and the surface ornamentation.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

a-b

Genus MATHERELLA Walcott, 1912.

9 PM240-4-7
9 PM241-5-9

Matherella walcotti, new species.

C 202 C 203

Plate IV, figure 7; Plate V, figure 9.

Description:—Shell sinistrally coiled, trochiform, consisting of about four gradually enlarging volutions, conical, much higher than broad, apical angle 60 degrees; cross-section of the body-whorl overturned oval-shaped, scarcely embracing the preceding whorl; suture moderately deep; umbilical edge not so sharp and umbilicus not so wide and deep as *Matherella saratogensis* (Walcott). Surface marked by oblique ridge which are directed backward from the sutures and turn a little forward at the periphery where the ridges take on more strength and prominence.

The holotype (Pl. IV, fig. 7), measures 11.2 mm. high and 7.6 mm. broad.

Comparisons:—*Matherella circe* Walcott[3] from the Chaumitien limestone of Shantung, the only species known from Eastern Asia is, however, quite distinct from the present species, differing especially in its depressed spire. *Clisospira lirata* Whitfield[4] from the Canadian of Vermont which may, so far as its figures and description are concerned,

---

1) T. Kobayashi (1930), Ordovician Fossils from Korea and South Manchuria, Pt. II, On the Bantatsu Beds of the Ordovician Age, (Japan. Jour. Geol. and Geogr. Vol. VII), p. 95, pl. XI, figs. 5a-c; pl. XI, figs. 4a-b.

2) T. Kobayashi (1931), Studies on the Ordovician Stratigraphy of North Korea with Notes on the Ordovician Fossils of Shantung and Liautung, (Bull. Geol. Surv. Chosen (Korea), Vol. XI, No. I), p. 35, Pl. I, figs. 8a-c; Pl. II, figs. 3a-c.

3) Walcott (1913), Cambrian Fauna of China, p. 88, Pl. 5, figs. 5.

4) Whitfield (1886), Bull. Am. Mus. Nat. Hist., I, p 308, pl. 24, figs. 16-16

not be real *Clisospira*, but *Matherella*, and is very closely allied to this species except in its more depressed and more rapid enlarging spire.

Matherella saratogensis,[1] the genotype of *Matherella*, is distinct from these three species in the following respects:

1) The body whorl is angulate on the lower side; the umbilical slope is much more steep in *M. saratogensis* than in these three species.

2) Surface of the shell is practically smooth except a few fine growth lines.

If these respects be enough to separate these species from *Matherella* generically, I here propose a new generic name *Matherellina* for these species.

Formation and locality:—Rather common in the Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus CLISOSPIRA Billings, 1865.

Clisospira niuhsintaiensis, new species.

Plate IV, figure 6.

Description:—Shell of moderate size, conical sinistrally coiled; spire consisting of more than six volutions, gradually enlarging, its apical angle being about 63 degrees; body whorl depressed, triangular in cross section; surface of the whorl gently convex on the upper side which slopes down from a distinct suture and forms an acute angle of about 80 degrees at the periphery with a rather flat basal side; umbilicus narrow. Surface marked by a number of ribs which are directed backward on the upper side from the suture and sweep forward on the basal side, forming an acute angle at the periphery; several weak lineal striae parallel to the course of the ribs are sculptured on the undulations of the ribs.

A single specimen in hand measures 12 mm. broad and about 10 mm. high; its body whorl measures about 5.0 mm. and 4.7 mm. high.

Comparisons:—In its ornamentation and in the acute periphery of the whorl, this species closely resembles *Clisospira occidentalis* Whitfield[2] from the Black River of Wisconsin. But in the American species the apical angle attains 90 degrees and the spire consists of only two and half volutions.

Formation and locality:—Wanwanku dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

1) Walcott (1912), Cambrian Geol. and Palaeont., II, No. 8.
2) Whitfield (1882), Geol. Wisconsin, 4, p. 222, pl. 5, fig. 21.

Genus ARCHINACELLA Ulrich and Scofield, 1897.

Archinacella wanwanensis, new species.

Plate IV, figure 3. C 205 C 205 PM243

Description:—Shell small, gently and broadly convex, sub-elliptical in outline with a wide frontal margin; beak low, sharply pointed, slightly incurved and a little projecting beyond the frontal margin. A pair of rostal scars on both sides just behind the apex and one loop of muscular scars directed postero-outward from the lateral side of each rostral scar.

As the posterior part of the shell is broken off, the posterior course of the loop cannot be ascertained. Surface ornamentation is also uncertain.

Comparisons:—*Archinacella valida* Sardeson[1] from the Trenton of Minnesota much resembles this species, but our species has a more broad and smooth frontal margin.

This genus ranges from Ozarkian to Niagaran, and is common in the Black River—Trenton.

Archinacella similis (Whitfield),[2] the only described species known from the Ozarkian is quite distinct from it through its outline. *A. similis* has a narrow frontal margin as those of *Tryblidium* and *Proplina*.

Formation and locality:—The Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus PROPLINA Ulrich and Bridge (MS)

Remarks:—Ulrich and Bridge in the study of Ozarkian and Canadian gastropods are erecting this genus which is separated from *Tryblidium* s. str. by its high and projecting beak and the muscular scars which are represented by an impressed band near the aperture.

Genotype-*Proplina cornutaformis* (Walcott).

Proplina bridgei, new species.

Plate V, figure 2. C 206 C 206 PM244

Description:—Shell of medium size, moderately convex, nearly elliptical in basal outline; the maximum convexity lying at the middle

1) Ulrich and Scofield (1897), Geol. Minnesota, III, pt. 2, p. 832, pl. 61, figs. 14 & 15.
2) Whitfield (1882), Geol. Wisconsin, IV, p. 196, pl. 3, figs. 12–13.

point of the shell; apex prominent, projecting far beyond the frontal margin of the aperture, abruptly curving at its end, and reaching a little below the middle height of the shell; frontal margin of the shell forming a blunt angle between the convex upper surface and the frontal slope; anterior angle about 100 degrees. Surface smooth.

Holotype specimen, whose posterior portion is partly broken off, measures 6.2 mm. high, about 12 mm. broad and about 10 mm. long.

Comparisons:—No internal character can be observed in my specimens, however, the beak is much higher and more projecting than that of typical *Tryblidium* in which the beak reaches the place of aperture.

Formation and locality:—Two specimens from the Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Proplina ampla, new species.

Plate IV, figure 2; Plate V, figure 4.

Description:—Shell large and high, oval in outline with a pointed beak; aperture elliptical, the sides rising upward and outward and into the broad upper surface with a very blunt angle between; the maximum convexity of the shell lying a little in front of the center of the shell; the beak curving from the point, reaching about the middle height and projecting far beyond the frontal margin of the aperture; apical angle and anterior angle about 40 and 80 degrees respectively. Surface marked by numerous fine concentric growth lines.

The two figured specimens give the following dimensions:—

Dimensions \ Specimens	Large specimen (Pl. V, Fig. 4.)	Small specimen (Pl. IV, fig. 2.)
Length of the shell	ca. 27.5 mm.	20.0 mm.
Breadth of the shell	17.0 mm.	14.0 mm.
Height of the shell	13.0 mm.	9.5 mm.
Length of the shell	—	12.6 mm.
Breadth of the aperture	—	10.2 mm.
Height of the beak	ca. 5.5 mm.	3.5 mm.
Apical angle	40 degrees	—
Anterior angle	80 degrees	80 degrees

Comparisons:—This species is quite distinct from the preceding species by its high and convex shell with small aperture. Anterior slope in this species is not so well marked from the upper surface as that of *P. bridgei*.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Proplina (?), sp. indet.

Plate V, figure 1. C2209

This species is quite different from the preceding two by its eccentric conical form with a rather circular aperture. The beak of this specimen is broken off, but, if it were perfectly preserved, it would be two-thirds as high as the shell and would scarcely project beyond the frontal margin of the aperture. Surface is marked by gently concentric foldings.

Though the specimen is not complete, it is obviously another species probably belonging to this genus.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus SCENELLA Billings, 1872.

Scenella, sp. indet.

Plate IV, figure 8. C2210

A small conical shell with a subovate aperture. It measures about 3 mm. long, 2 mm. broad and 1 mm. high. Surface is marked by more than ten concentric ridges. Two species are described from the Middle Cambrian and one indeterminable species from the Upper Cambrian of North China among which *Scenella clotho* Walcott[1] somewhat resembles this species. But that species is distinct from it in the presence of radial carina and finer concentric lines.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus STENOTHECA Salter, 1872.

Stenotheca (?) *manchurica*, new species.

Plate V, figure 6. C2211

An imperfect specimen of a peculiar shell is in hand.

Description:—Shell with an eccentric beak from which a ridge runs backward; aperture ovately triangular; beak prominent, projecting

1) Walcott (1913), Cambrian Faunas of China. p. 86, pl. 5, figs. 3. 3a.

slightly beyond the frontal margin of the base and abruptly incurved. Surface marked by strong concentric foldings except the ridge, where another system of folding is running in a zig-zag manner and at its corners this fold is meeting with concentric foldings which are arranged alternatively on this side.

Comparisons:—This species is quite distinct from all of *Stenotheca* hitherto described from the Cambro-Ordovician of Europe and America through its somewhat pyramidal shell with a triangular base, prominent and incurved beak and ornamentation on the back-ridge. Abruptly incurved beak suggests some resemblance between this species and *Platyceras*, however, its ornamentation is quite distinct from that genus. It may most probably belong to a certain new genus taking a medium place between *Stenotheca* and *Platyceras*.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus SCAEVOGYRA Whitfield, 1878.

Scaevogyra ulrichi, new species.

Plate V, figures 5 & 7.

Description:—Shell sininstral and discoidal; spire depressed, consisting seven volutions, which increase the magnitude very rapidly; whorl covering about half of its preceding whorl on its upper side; the preceding whorl not elevated abruptly and prominently from the succeeding; section of the body-whorl describing a regular circle in its upper, outer and lower sides; the lower side continues to the umblical slope without any interruption of angular edge; umbilicus deep and wide and attains more than half the diameter of the shell in the adult; surface smooth.

Two figured specimens in which the larger one is imperfect, measure as follows;

Dimensions / Specimens	Height	Diameter of shell	Diameter of umbilicus
Small specimen (Fig. 5)	10.8 mm.	16 mm.	ca. 7 mm.
Large specimen (Fig. 7)	19.3 mm.	38.2 mm.	ca. 24.3 mm.

Comparisons:—Hitherto three species of this genus have been described by Whitfield[1] from the Ozarkian of Wisconsin, among

1) Whitfield (1878), Geol. Wisconsin, IV.

which *Scaevogyra swezeyi* is most closely allied to this species. This Manchurian species is, however, quite distinct from these three by its depressed spire in which respect it resembles *Maclurea*. But its spire is not so smooth as that of *Maclurea* and also its section of the whorl is quite different from that of *Maclurea*.

Formation and locality:—Five specimens collected from the Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Scaevogyra naticaformis, new species.

Plate V, figure 8. C2134 a b PM252

Description:—Shell small sinistral with a depressed spire consisting of five or six volutions which increase very rapidly in their height and breadth. The section of the body whorl is a high ellipse whose height is one and a half times the breadth of the whorl; umblicus very deep, its diameter about one-third of the length of the shell; surface smooth.

The holotype is 10.2 mm. long and 9.3 mm. high.

Comparisons:—This species is closely allied to the preceding species except for its very high whorl.

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Cephalopoda.

Genus ELLESMEREOCERAS Foerste, 1921.

Remarks:—In comparison with the genotype, *Ellesmereoceras scheii* Foerste, I grouped in 1931 under the name *Ellesmereoceras* the forms which have teretely tapering longicones with submarginal siphuncles, and cross sections slightly compressed laterally to sub-circular.

In their monographic study of the Ozarkian and Canadian cephalopods, Ulrich and Foerste are now examining a great deal of American material with great precision and defining the genera in a more restricted sense than I did. According to their taxonomy the species with circular cross sections formerly referred to *Ellesmereoceras* are grouped under new genus *Robsonoceras*, taking *E. robsononense* Walcott as its genotype. The gently curving forms referred to *Ellesmereoceras* using the expression in a broad sense are grouped under the new genus *Ectenoceras*. According to this classification *Ellesmereoceras amplum* Kobayashi should be placed in *Robsonoceras*, and *Ellesmereoceras curvatum* Kobayashi in *Ectenoceras*, which leaves to *Ellesmereoceras* in its restricted

PM253-1-4. *Ellesmereoceras elongatum* Kobayashi
PM254-1-7, " "
PM255-1-3. *Ellesmereoceras subcirculare* Kobayashi
PM256-1-5. " "

sense the Asiatic species, *Ellesmereoceras elongatum* Kobayashi, and *Ellesmereoceras subcircularis* Kobayashi, and the new species *Ellesmereoceras foerstei* and *Ellesmereoceras abruptum*. However, the body-chambers are a little longer in these four species than in *Ellesmereoceras scheii*, but this difference is of no more than specific value, because it does not attain to any considerable magnitude and shows intermediate gradations from *E. schei* to *E. abruptum* through *E. elongatum* and *E. foerstei*.

With much hesitation *Ellesmereoceras* (?) *flexuostriatum* Kobayashi and *Ellesmereoceras* (?) *multicameratum* Kobayashi had provisionally also been placed in this genus, but the latter species is here separated from the genus and elected as the genotype of the proposed new genus *Multicameroceras*, but the former species is still in question as to generic position.

Ellesmereoceras foerstei, new species.

Plate I, figures 1 and 11.

Description:—Slender orthoceracone slowly tapering at a rate of 1 mm. in about 12 mm.; cross section of conch elliptical, laterally compressed, its dorsal side being more rounded than its ventral one; siphuncle marginal, small and laterally compressed, elliptical in cross section, its diameter a little less than one-third that of the shell; camerae narrow and oblique to the axis of the conch, therefore with septal sutures ascending toward the antisiphonal side to twice the height of the camerae. In the longitudinal section the septa are separated about 1 mm. from one another, where the conch is 10 mm. or so larger in diameter; these setpa are concave on their upper side, descending from antisiphonal side to center and becoming horizontal or slightly ascending toward the siphonal side; septal neck at its junction with the septum almost rectangular; septal funnel straight and extending downward beyond the preceding neck. Body chamber long, having a tendency to diminish in its major diameter near the aperture; aperture entire and transverse.

The holotype (Plate I, figure 1) is 39 mm. long, of which 22 mm. belongs to the body chamber. Ten camerae are counted in a distance of 13.5 mm. At the apical end of the specimen the siphuncle is 3 mm. and 2.3 mm. in major and minor diameters respectively, where the corresponding diameters of the conch are 12.5 mm. and 9.7 mm. Four specimens are in hand, in three of which (not including the holotype) the body chambers do not diminish in their major diameter near the aperture. But other characters are practically same as in the holotype.

Comparisons:—This species is closely allied to *Ellesmereoceras elongatum* Kobayashi in the cross section of the conch and in other respects, but its septal sutures ascend considerably toward the antisiphonal side, while in the other species the septal sutures are transverse, curving slightly downward along the lateral sides. In *E. elongatum* the antisiphonal side is more rounded than in this species, and also, judging from the collection in hand, *E. foerstei* is much larger in its adult stage.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Ellesmereoceras abruptum, new species.

Plate I, figures 2 and 8.

Description:—Long orthoceracone, regularly and rather abruptly tapering for this genus; rate of expansion 1 mm. in a distance of about 5 mm.; conch compressed elliptical in cross section, with long and short diameters having a ratio of about 4 to 3; body chamber very long and tapering at the same rate as the camerated part of the conch; septa closely crowded; septal sutures gradually curving down on the lateral sides and arched up on the dorsal and ventral sides; siphuncle tubular and marginal, equalling about one-fourth or one-fifth of the diameter of the conch.

The holotype (Plate I, figure 2) measures 59 mm. long where the chamber is 31 mm. long. In this length of 31 mm. the body chamber enlarges its longer diameter from 9.3 mm. to 14.5 mm. Just below the body chamber ten camerae are counted in a distance of 11 mm.

Comparisons:—This species is allied to *E. elongatum* especially in its camerated portion, but in *E. elongatum* the body chamber is much shorter and more cylindrical. The conical form of the body chamber, the rapid tapering of the conch and the strong curvature of the septal sutures serve to distinguish this species from allied forms.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus ECTENOCERAS Ulrich and Foerste (MS)

Remarks:—Ulrich and Foerste erect this new genus for the ellesmereoceroids that curve slowly, the curvature being a little stronger in the earlier portion than at the later stage of growth. This genus is allied to *Burenoceras* and *Dakeoceras*, but differs from them in the less curving and slower tapering of the conch.

Three species found in the Wanwanian material are referable to this new genus, viz. *E. curvatum* (Kobayashi), *E. subcurvatum* new species and *E. ruedemanni* new species.

Ectenoceras curvatum (Kobayashi).

Plate II, figures 1 and 13.

1931. *Ellesmereoceras curvatum* Kobayashi, Cambro-Ordovician Formation of Hualien chai and Niuhsintai, South Manchuria, p. 161, pl. XVI, figs. 2a-c.

Description:—One specimen was collected by K. Mitsuishi from a white crystalline limestone, about forty meters above the limestone conglomerate-bearing Yingtzu series in a valley of Chiu-shu-kou.

The conch is about 29 mm. long of which the upper two-thirds is practically straight and the living chamber is 8 mm. long. The lower one-third of the conch curves more gradually than *E. subcurvatum*.

Formation and locality:—This species is common in the Wanwankou dolomite, but according to Mitsuishi, the horizon of the species should be the Wanwankou limestone porper; Chin-shu-kou in the Niuhsintai Basin, South Manchuria.

Ectenoceras subcurvatum, new species.

Plate I, figures 9.

Description:—The holotype is about 25 mm. long and the lower one-third curves gently; cross section of conch elliptical, laterally compressed; siphuncle small, endogastric and marginal; conch 4.5 mm. in longer diameter at its apical end; at the other end the siphuncle is 1.9 mm. and 1 mm. in longer and shorter diameters respectively where the corresponding diameters of the conch are 9.5 mm. and 6.5 mm.; four camerae occur in the upper portion of the phragmacone in a distance of about 3 mm. Septa strongly concave, their concavity equalling the height of about two camerae. Septal sutures transverse, curving downward laterally; shell rather thick and surface entirely smooth.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Ectenoceras ruedemanni, new species.

Plate II, figures 5 and 11.

Description:—Small and slowly expanding cyrtoceracone, compressed elliptical in cross section, with its minor diameter less than three-fourths

of its major diameter; siphuncle small, endogastric, elliptical, its major diameter about one-sixth that of the conch; camerae narrow, approximate and strongly convex, the depth of the septa corresponding to the height of about three camerae; siphuncle tubular; septa regularly concave, abruptly bending downward at the septal necks and extending to the preceding neck; course of septal sutures undulating, rising rather steeply in a antisiphonal direction and arching broadly upward on the antisiphonal side, but more acutely on the siphonal side of the conch; living chamber shorter than broad, expanding abruptly near the aperture; apertural margin transverse, curving downward on its lateral sides.

The holotype is 11 mm. in length and its body chamber is 5.5 mm. long. At its basal end the body chamber measures 7.5 mm. and 5.5 mm. in major and minor diameters respectively. Below it five camerae are counted in a distance of 3 mm.

Comparisons:—*E. ruedemanni* is distinguished from *E. curvatum* by its more rapid expansion, stronger curvature, small siphuncle and the curvature of the septal suture.

Formation and locality:—Wanwankou dolomite, Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus Wanwanoceras, new genus.

This genus is established for the Ellesmereoceroids which have breviconic orthoceracones.

Genotype W. peculiare, new species.

Geological and Geographical distribution:—At present this genus is known only from the Wanwankou dolomite in the Niuhsintai Basin, South Manchuria.

Wanwanoceras peculiare, new species.

Plate I, figures 6 and 10; Plate II, figure 12; Plate IV, figure 9.

Description:—Breviconic orthoceracone, expanding at a rate of 1 mm. in 3 mm., elliptical in cross-section, its major and minor diameters in a ratio of 7 to 6; camerae approximate, slowly increasing their septa; regularly convex toward the apex, the convexity corresponding to twice the height of the camera; septal sutures transverse, curving down on the lateral sides and arching more sharply upward on the siphonal than on the antisiphonal side; siphuncle marginal, tubular

and narrow, as broad as one-fifth the diameter of the conch; surface marked by fine transversal lines.

The holotype (Plate I, figure 10) measures 25 mm. long, in which distance its major diameter enlarges from 6.5 mm. to 14.5 mm. In its lower portion five camerae are counted in a distance of 4.5 mm., while in the upper portion the same number occurs in a distance of 5 mm. Twelve camerae are counted in a paratype (Plate I, figure 6) 11 mm. long, whose major and minor diameters are 19 mm. and 11.5 mm. respectively at its larger end. The siphuncular structure of this species is very important phyllogenetically, in relation to primitive cephalopods, and therefore, it is described with considerable detail on page 302.

Formation and locality:—Common in the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus BURENOCERAS Ulrich and Foerste, 1930

1930. *Burenoceras*, Ulrich and Foerste, in Bridge's Geology of the Eminence and Cardareva Quadrangles, p. 208.

Genotype:—*Burenoceras pumitum* Ulrich and Foerste.

Geological and Geographical Distribution:—Upper Ozarkian, central and eastarn North America; *Burenoceras* (?) *reticulatum* new species is possibly a representative of this genus in the Wanwanian series of Manchuria.

PM269-2-2 ○
PM270-2-3 ○
PM271-2-4 ♀

Burenoceras (?) *reticulatum*, new species.

C226, 227, 228

Plate II, figures 2, 3 and 4.

C226, 227, 228

Description:—Breviconic cyrtoceracone, ovately circular, with dorso-ventral diameter a little longer than the lateral diameter; body chamber large; aperture entire; surface marked by transversal lines only, but fine reticulate lines occur under the shell.

No specimen is in hand which preserves a phragmacone and therefore its true generic position remains doubtful, but judging from the present material, it is more closely allied to *Burenoceras* than to any other Ozarkian genus.

Formation and locality:—Common in the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus SINOEREMOCERAS, new genus.

1931. *Eremoceras* (part) Kobayashi, Cambro-Ordovician Formation of South Manchuria, pp. 157–158.

Formerly I referred the Asiatic fusiform ellesmereoceroids to *Eremoceras*, but the genotype *Eremoceras syphax* (Billings) has a siphuncle which is depressed in a dorso-ventral direction and whose magnitude is much larger than those of the Asiatic forms. As stated on page 57, the Asiatic forms are peculier in their siphuncular structure, and thereby differ much from all described cephalopods. Based upon these characteristics the new genns *Sinoeremoceras* is eastablished.

Genotype:—*Eremoceras wanwanense* Kobayashi.

Geological and Geographical distribution:—At present this group is known only in the Wanwankou dolomite in Manchuria.

Genus MULTICAMEROCERAS, new genus

Remarks:—In my previous paper *Ellesmereoceras* (?) *multicameratum* was provisionally placed in the genus *Ellesmereoceras*, but through a more accurate examination of new material, it was ascertained that *E.* (?) *multicameratum* is quite distinct from *Ellesmereoceras* s. str. in the following points.

1) In comparing the body chamber with the phragmacone, it is always much shorter in *Multicameroceras* than in *Ellesmereoceras*.

2) The siphuncular structure usually is simple and uniform in *Ellesmereoceras*, whereas in *Multicameroceras* it is more complicated by the presence of tabulae and other characters which are described in detail on page 303.

3) In *Multicameroceras* the camerae usually are approximate and very closely crowded.

In these respects this group is more closely allied to *Sinoeremoceras* than to *Ellesmereoceras*, but this genus obviously is distinct from *Sinoeremoceras* because of the general form of its conch. The conch is cylindrical to elongate conical in this genus, while in *Sinoeremoceras* it is somewhat fusiform, the siphonal side being nearly straight and the antisiphonal broadly curved.

Diagnosis:—Cylindrical to elongate conical orthoceracones with an elliptical to compressed ovate cross-section; body chamber short, scarcely longer than its breadth; camerae very closely crowded; septal suture transverse, curving laterally a little downward; siphuncle marginal, narrow, laterally compressed in cross-section; septal neck or funnel not always reaching beyond the preceding septal neck; sometimes tabulae exist in the siphuncle, and siphuncular bulbs in the camerae just inside of the septal neck; surface smooth, without any prominent annulation.

Genotype:—*Ellesmereoceras* (?) *multicameratum* Kobayashi.

Geological and Geographical distribution:—Wanwankou limestone and dolomite in South Manchuria.

PM272-2-8
PM273-3-1,3;4-1 *Multicameroceras multicameratum* (Kobayashi.)

Plate II, figure 8; Plate III, figures 1 & 3; Plate IV, figure 1.

1931. *Ellesmereoceras* (?) *multicameratum* Kobayashi, Cambro-Ordovician Formation of South Manchuria, p. 163, pl. XVI, Fig. 7 ; pl. XIX, Figs, 2 a-b, 3.

The description of this species is given in the cited paper, but here are recorded some additional observations on the new specimens.

I) In well preserved specimens the cross section of the conch is rather more elliptical than elongately oval, the ratio of diameters ranging from 3 : 4 to 4 : 5.

II) As shown on Plate IV, fig. 1, the surface is marked by numerous transverse striae, and also weak annulations are perceptible on the body chamber of 25 mm.

III) For the siphuncular character see description on page 303.

Formation and locality:—Common in the Wanwankou limestone and dolomite, in the Niuhsintai Basin, South Manchuria.

PM274-2-14 *Multicameroceras cylindricum*, new species.
PM275-4-5

Plate II, figure 14; Plate IV, figure 5.

This species is closely allied to *Multicameroceras multicameratum* in its internal structure, but its conch is nearly cylindrical, teretely tapering at a rate of 1 mm. in 10 mm. In cross section the conch is compressed ovate, the dorsal side being more rounded than the ventral one. The ratio of the diameters is 5 to 4.

In the holotype (Plate II, figure 14) 23 mm. in length the body chamber is 15 mm. long and at its base the major and diameters are 17.7 mm. and 14.4 mm. respectively. Apertural margin transverse. Ten camerae occur in a distance of 6.5 mm. below the living chamber. Surface with fine transverse striae.

Paratype, figured on Plate IV, figure 5, measures 17.1 mm. and 13.5 mm. along the two diameters at the base of its living chamber where the siphuncle is 4 mm. and 2.5 mm. in the longer and short diameters respectively

Formation and locality:—Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus WOLUNGOCERAS Kobayashi 1931.

1931. *Wolungoceras* Kobayashi, Cambro-Ordovician of South Manchuria. p. 166.

Genotype:—*Wolungoceras foerstei*, Kobayashi.

Geological and geographical Distribution:—Wolungian and Wanwanian in Manchuria.

Wolungoceras chiushuense, new species. PM276

Plate III, figure 4. C238

Description:—Tumid orthoceracone 13 mm. long. Cross-section of conch uncertain, but the siphuncle obviously submarginal and of moderate size. Siphuncle measures 0.5 mm. across where the camera is 1 mm. high. The septa slope gently downward from their margin and are rather straight but turn at the septal neck so as to form obtusely rounded angles. The septal funnel extends about one-third of the height of a camera beyond the preceding septal neck. Inside of the funnel there is a siphuncular lining. The interior of the siphuncle is filled by a calcareous matrix and the camerae by crystalline calcite.

Comparisons:—As the siphuncle is submarginal, this species is distinct from *Ellesemereoceras*. The most closely allied species is *Wolungoceras foerstei*[1], but the siphuncle is situated closer to the less corvex margin in this species.

From *Wolungoceras minor* Kobayashi[2] in the Shorin bed of Wolungian age in North Korea, it is distinguished by its higher camerae and its more rounded conch in cross section.

Formation and locality:—Wanwankou limestone proper at Chiushu-kou in the Niuhsintai Basin, South Manchuria.

Genus CYRTENDOCERAS Remelé, 1886

1886. *Cyrtendoceras* Remelé. Über eigenthümlichen gekrümmten Cephalopoden (Cyrtendoceras) aus einen untersilur Geschiebe von Wriezen (Provinz Brandenburg). (Gesellschaft deutscher Natúr-forscher und Artzte. Tageblatt der 59 Versammlung für 1886, pp. 338–339.)

---

1) T. Kobayashi (1931), Cambrian-Ordovician of South Manchuria, p. 166, pl. XVIII, fig. 1.

2) T. Kobayashi, (1931), Studies on the Ordovician Stratigraphy and Palaeontology of North Korea, p. 40, pl. VI, fig. 1-2, 4.

Based upon a curved cephalopod in a moraine of Wriezen (Prov. Brandenburg), probably derived from the upper gray Orthoceras limestone of Sweden, Remelé established the genus *Cyrtendoceras* with a generic diagnosis as follows :—

"Bei starker sichförmiger Krümmung, ganz wie bei einem *Cyrtoceras*, zeigt die Rohre eine sehr allmälige Dickenzunahme, sowie sehr zahlreiche niedrige Kammern ; merkwürdig ist hierbei aber von allem, dass der Sipho hart an der Konkavseite durchbricht und nicht allein durch diese marginale Lage, sondern namentlich noch in seinem Bau mit demjenigen des vaginalen Orthoceren (*Endoceras* Hall) übereinstimmt, indem er in Abständen, welche denen der Kammerscheidewände gleich sind, von schrägen die Endigungen rückwarts gerichteter Siphonalduten bezeichneten Querreifen zumzogen wird."

But he gave neither a specific name to this *Cyrtendoceras* nor was any other species selected as genotype. Holm[1] described in 1892 *Endoceras* (*Cyrtocerina*) *hircus* from the gray Lituites limestone of Oeland and *Endoceras* (*Cyrtocerina*) *Schmidti* from Echinospherites limestone of Estland, both of which he placed in Billing's *Cyrtocerina*[2]. This genus, however, has a breviconic cyrtoceracone, while the Swedish species have gradually tapering gyroceracones, therefore it appears more suitable to place them in *Cyrtendoceras*. Ruedemann described *Cyrtendoceras* (?) *priscum* from the Beekmantown beds in New York. The present collection contains a species which certainly belongs to this genus.

As the Wanwankou limestone corresponds to a part of the Ozarkian formation, the horizon of *Cyrtendoceras holmi* new species is much older than those represented by the American and European species.

Cyrtendoceras holmi, new species.

Plate IV, figure 10.

Description :—Large and slowly tapering gyroceracone, slightly compressed circular in cross section ; siphuncle endogastric, about as broad as one-third the diameter of the conch and subcircularly ovate with a little flattening on its dorsal side ; camerae closely crowded ; septa

1) Gerhard Holm (1892), On two Gyroceras species curved like Endoceras (Om tvenne Gyroceras formight böjde Endoceras-arter.) Aftryck ur Geol. Fören i Stockhom Förhandl. Bd. 14, hft. 2.)

2) Billing (1865), Palaeozoic Fossils, I, p. 178.

3) Ruedemann (1906), Cephalopods of the Champlain Basin, p. 430, pl. 2, figs. 2-5.

curving rather strongly in the antisiphonal half, but very gently on the siphonal side; the septal neck roundly rectangular, or rather obtusely angular; septal funnel reaching to the preceding septal neck.

The holotype is 3.5 mm. across in the lower part where its siphuncle is 12 mm. in diameter. Septa are separated 2 mm. or so from one another. Body chamber and siphuncle are filled by the foreign matrix in association with many crustacean remains, but only the foreign matrix fills up the camerate portion. Since the apertural margin is uncertain, the length of the living chamber cannot be determined, but this chamber is not shorter than 40 mm.

Comparisons:—*Cyrtendoceras hircus* (Holm) is a closely allied species from which this one is distinguished by its broader siphuncle and more crowded camerae.

Formation and locality:—A single specimen was obtained from a boulder at San-chia-tzu which obviously was derived from the Wanwankou limestone proper, because in this boulder the *Cryptozoon*-like structure is preserved, which is characteristic of this limestone. And also the exposure of the Wanwankou limestone proper is a short distance of the point where the specimen was found.

Trilobita.

Genus KINGSTONIA Walcott, 1924.

Kingstonia was established by Walcott[1] with *Kingstonia apion* as the genotype. In my Cambro-Ordovician collections from South Manchuria I found four species belonging to this genus. They are *Kingstonia paichaiensis, K. semicircularis, K. convexa* and *K. humilis*. The first species was collected from the Chuangia zone of the Upper Cambrian in the Wuhutsui Basin at the neck of the Liaotung peninsula and will be described in my Upper Cambrian paper which will be published shortly. The other three were collected from the Wanwankou dolomite at Wan-wan-kou.

In comparing the Asiatic species with the genotype it may be noted that their cranidia are usually more convex with less in the way of furrows. But these differences are of such degree as to have only specific value. *Kingstonia*[1] is common in the early Upper Cambrian of the Appalachians, in Missouri, Oklahoma, and in the western Cordilleras and also a single species occurs in Ozarkian in northern

1) Walcott (1925). Smithsonian Misc. Coll. Vol. 75, Nos. 2 & 3.

Vermont. In Manchuria this genus is more common in Wanwanian than in the early Upper Cambrian as it is represented by three species in the Wanwanian, but only one in the early Upper Cambrian.

Kingstonia semicircularis, new species.

PA278-6-7 C235 C236
PA279-6-8

Plate VI, figures 7 & 8.

Description:—Cranidium semicircular and strongly convex, no trace of furrows; axial furrow more or less plainly indicated on the inner surface of test; glabella and fixed cheeks having nearly the same width at the basal margin where well defined pits clearly mark them off; frontal rim round and striated; eyes at the middle point of the cranidium; suture describes broad curve anterior to the eyes and behind them slopes diagonally with a slight convexity.

Pygidium roundly triangular, broader than high, moderately convex at the margin; axis and pleural lobes nearly of the same width, axis not clearly outlined, but axial furrows and segmentation are observable under the test.

Holotype (Pl. VI, fig. 7,) measures 5.1 mm. in height and 7. 2 mm. in width at the base where the glabella is 3 mm. wide.

Associated pygidium (Pl. VI, fig. 8,) measures 6 mm. long and 8 mm. wide; axis is 3 mm. in width at the frontal margin.

Formation and locality:—Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Kingstonia conveva, new species.

PA280-6-9 C237 C238
PA281-6-10

Plate VI, figures 9 & 10.

Description and comparisons:—This species differs from *Kingstonia semicircularis* in its strong convexity and trapezoidal outline. Frontal rim of the cranidium slightly rounded and striated by several lines; eyes about at the middle of the sutures which slope rather straight and diagonally; no occipital furrow; axial furrow more indistinct than in *K. semicircularis*.

Holotype specimen (Plate IV, fig. 10,) is 4 mm. high and 7 mm. wide at the base where the glabella is 2.5 mm. wide. Convexity is about 2.5 mm. in the middle point of the cranidium from which the test curves forward, but is straighter behind.

Formation and locality:—Very common in the Wanwanian dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Kingstonia humilis, new species.

Plate VI, figure 1.

Description:—This species is allied to *K. convexa* in its subtrapezoidal outline.

In this species the width of the cranidium is twice the height. The largest convexity is lying at the middle from which the surface curves regularly both to the front and back. Glabella and fixed cheeks are marked only by dents in the basal margin. The glabella is much wider than the fixed cheeks and the facial sutures are nearly straight.

Formation and locality:—Very common in the Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus STENOPILUS Raymond, 1924.

Stenopilus convexus, new species.

Plate VI, figure 4.

Description:—Cranidium small, slightly wider than long, strongly convex and sloping very steeply toward the margin; no glabellar, dorsal or occipital furrows; glabella marked off from the fixed cheeks only by small pits on the posterior margin; eyes situated a little forward of the middle of the head; fixed cheek narrow. Surface smooth.

The holotype specimen is 3.5 mm. long and 4 mm. wide.

Comparisons:—Raymond erected this genus which is considered to be derived from *Plethopeltis* through the obsolation of the furrows. In this characteristic this species undoubtedly belongs to this genus.

Hitherto three species of *Stenopilus* have been described, *Stenopilus pronus* Raymond and *Stenopilus brevis* Raymond[1] from the Main Zone of the Milton formation and *Stenopilus latus* Ulrich[2] from the Eminence dolomite among which *S. latus* is most closely allied to this species; but this Eminence species is less convex and more rounded in outline.

From smooth forms of *Plethometopus* it is easily distinguished by the absence of the triangular neck ring.

Formation and locality:—Wanwankou dolomite, at Wan-wan-kou, Niuhsintai Basin, South Manchuria.

---

1) Raymond (1924), New Upper Cambrian and lower Ordovician trilobites from Vermont. (Proc. Boston Soc. Nat. Hist. Vol. 37, p. 4,) p. 420.

2) Ulrich (1930), in Bridge's Geology of the Eminence and Cardareva Quardrangles, p. 222.

Genus PLETHOPELTIS Raymond 1913, emend. Ulrich, 1931.

PA284 *Plethopeltis orientalis*, new species. C247

Plate VI, figure 5.

Description:—Cranidium convex, wider than high; glabella well marked by the dorsal furrow and very slowly tapering toward the front: two pairs of indistinct lateral furrows visible on the glabella; neck furrow rather strong; basal margin of the fixed cheek nearly twice as broad as the height of the frontal border. Surface smooth.

The holotype measures 18 mm. high; its glabella and fixed cheek 11.5 mm. and 7 mm. wide at the base respectively; its frontal border and neck ring 4 mm. and 3 mm. high along the axis.

A free cheek found at the same locality is smooth and strongly convex. Its border is broad in front decreasing toward the genal angle.

As the inner side of the cheek is incomplete, it is not certain, if it belongs to this species or not. Posterior limb of the facial suture is diagonal as in the cranidium, the convexity of the cheek and its dimensions match those of the cranidium. Therefore the free cheek is presumed to belong to this species.

Comparisons:—*Plethopeltis buehleri* Ulrich[1] from the Eminence dolomite is very closely allied to this species in general outline, but the glabella of the Eminence species has much greater convexity.

Formation and locality:—Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

PA285 *Plethopeltis resseri*, new species. C242

Plate VI, figure 6.

Description:—Cranidium stronglly convex, especially in the frontal half and oblong in outline; extremities of the frontal margin roundly rectangular; glabella oblong convex and with a distinct dorsal furrow; neck ring transverse and the third lateral furrow oblique; brim and fixed cheek flat and narrow, nearly of equal breadth; eyes small, situated at about the middle.

The holotype measures 19 mm. high and about 16 mm. broad between the eyes. Frontal border is 2.5 mm. high.

This species is well characterized by its cylindrical glabella, narrow brim and fixed cheeks, as well as by its oblique glabellar furrows.

Formation and locality:—Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

1) Ulrich (1931), in Bridge's, Geology of the Eminence and Cardareva Quardrangles, p. 220, pl. XIX, figs. 18, 19, 25, 26.

Genus PLATYCOLPUS Raymond, 1913.

Platycolpus? granulatus, new species.

Plate VI, figures 2 & 3.

Description:—Cranidium subtrapezoidal, strongly convex in its frontal third; frontal margin slightly arched, rim narrow and striated by several transverse lines; glabella cylindrical, oblong, enlarging a little anteriorly and well defined by the dorsal furrows which reach to the rim; two sets of short glabellar furrows sloping obliquely toward the axis; neck ring not distinct; fixed cheeks narrow, their basal breadth being about half that of the glabella; eyes small at about the middle; eye-ridge directed obliquely toward the eye from a point in the dorsal furrow two-thirds the distance from the base; the anterior branch of the facial suture meets almost with the dorsal furrow at the rim; the posterior branch is diagonal; surface ornamented by granulation except on the frontal brim.

The associated free cheek is triangular; lateral margin broadly curving and ending in a minute spine; basal margin narrow; border increasing in breadth toward the genal angle; surface also granulated.

The holotype of the cranidium measures 6 mm. high; its glabella and fixed cheek are 4 mm. and about 2.5 mm. wide at the base respectively.

Comparisons:—Taking *Bathyurus capax* Billings for the genotype, Raymond erected the genus *Platycolpus* and said in its diagnosis, "trilobites with hemispheric, rather smooth cephalon, a depressed glabella extending to the anterior border, which is a flat, striated rim, glabellar furrows faint or absent, eyes small, situated midway on the length of the head; facial suture cutting the anterior margin in front of the eye." "Pygidium semicircular, without depressed border, and with faint traces of segmentation."

Most of the generic characters of this Manchurian species are in accord with this diagnosis, but the glabellar furrows are shorter, although distinct, and the surface is entirely covered by granulation. It has a distinct eye-ridge and the course of the facial suture is also somewhat different from that of *Platycorpus* s. str. For these reasons the reference of this species to *Platycholpus* must be somewhat in doubt.

Formation and locality:—Wanwankou dolomite, at Wan-wan-kou in the Niuhsintai Basin. South Manchuria.

Family RIBEIRIDAE, new family.

Genus WANWANIA, new genus.

Remarks:—The generic diagnosis of the new genus is given on page 315.

This is the oldest group of the ribeirioides and contains at present one Upper Cambrian species and two Wanwanian species, viz. *W. cambrica, W. ambonychiformis* and *W. compressa*. These are well characterized generically by their outline, terminal umbo, acute dorsal margin and smooth surface. In most of them the carapace is much compressed laterally, but in one specimen *W. cambrica* (Pl. VII, fig. 2) the carapace is much less compressed. Dorsal margin is almost straight to slightly convex and in its posterior portion there is a short wing.

In the well preserved specimen of *W. ambonychiformis* several linear impressions are observable on the keeled dorsal side which may have served for the attachment of the body to the carapace. Anterior, ventral and posterior margins are almost completely closed. In *W. ambonychiformis* the anterior side is flat as in the case of *Euchasma*, but to such a degree that it is no more than specific value. The tendency of flattening on the frontal side is also found in *W. cambrica*, in which every grade flattening may be observed in a series of specimens. In the internal casts there are usually radial impressions, but they are limited to the inside of the test. The surface of the carapace is mostly smooth except for lines of growth, but sometimes rather strong lines subparallel to the carapace margin, occur in the frontal portion (See *W. cambrica* on Pl. XI, fig. 7.)

Genotype:—*Wanwania. cambirica*, new species.

Geological and geographical distribution:—Upper Cambrian and Wanwanian; Liaotung and Taitzuho area in South Manchuria.

PA287-7-1 PA288-7-2 PA289-7-3 PA290-7-7 PA291-9-9

Wanwania cambrica, new species.

Plate VII, figures 1—3; Plate IX, figures 7 & 9. B32 33 34 35 36

Description:—Carapace strongly convex, inequilateral, subtriangular; anterior margin sharp and nearly straight, postero-ventral margin broadly rounded; umbo terminal. Cast shows a large clavicle; behind the umbo the dorsal margin has somewhat of a roof-shape. Surface smooth except the frontal part where several lines run parallel to the frontal margin.

This species is represented by a number of specimens among which the five figured specimens give the following dimensions:—

Specimens / Dimensions	Specimen 1. (Pl. VII, fig. 1)	Specimen 2. (Pl. VII, fig. 3)	Specimen 3. (Pl. VII, fig. 2)	Specimen 4. (Pl. IX, fig. 7)	Specimen 5. (Pl. IX, fig. 9)
Length of the dorsal margin.	9.4 mm.	8 mm.	12.2 mm.	5.5 mm.	7.8 mm.
Length between the umbo and the ventral angle.	14.6 mm.	12 mm.	16 mm.	10 mm.	10.8 mm.
Thickness.	5 mm.	5.6 mm.	9 mm.	—	—

The first specimen is taken for the holotype and the others for the paratypes. In the second specimen the posterior portion of the dorsal side is rather prominently compressed and tends to become a small wing; in the third specimen the lateral compression of the carapace is exceedingly weak; in the fourth specimen a rather obtuse ridge is running from beak to the dorsal angle; in the fourth specimen the frontal side is considerably flattened. These paratypes have some differences from the holotype, but in such degrees they are no more than of the varietal value, because these changes are all small amounts and occur gradually in a number of specimens in hand. This variable character is very interesting from the point that *W. cambrica* is the oldest and most primitive species of the Ribeiridae and has the tendency to specialize into many different directions. It is certain that *W. cambrica* is not far from the common ancester of the Ribeiridae, though it may not be the real common ancester.

Formation and locality:—Upper Cambrian, Tsinania zone, Pai-chia-shan, in the northern part of the Wuhutsui Basin and at Hsishan in the southern part of the same basin, at the neck of the Liaotung Peninsula, Manchuria.

Wanwania ambonychiformis, new species.

Plate VII, figure 4.

Description:—Carapace compressed, convex, inequilateral, somewhat semicircular; umbo terminal, projecting a little beyond the frontal side; dorsal margin nearly straight, compressed from both sides which causes the posterior part of the dorsal side to become thin and tends to differenciate it as a triangular area from the moderately convex body of the carapace; posterior and ventral margins regularly round; anterior margin somewhat convex, somewhat flattened and gapping narrowly in the middle as in the case of Euchasma. In cast, a long clavicle just beneath the umbo; faint radial furrows radiating from the umbo to the

postero-ventral margin. Surface smooth except for lines of growth.

Holotype specimen measures 21.3 mm. along the frontal side, 13 mm. along the dorsal side and 6.4 mm. thick at the thickest portion, at the middle of the carapace.

Comparisons:—The outline of this species makes it resemble that of *Ambonychia* for which reason this specific name is given. The shape of the front side recalls that of *Euchasma*, though it is quite distinct from *Euchasma* because of its compressed carapace and absence of radial ribs.

Formation and locality:—Common in the Wanwankou dolomite, Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Wanwania compressa, new species

Plate VII, figure 5.

Comparisons:—This species is represented by a single incomplete specimen, but it clearly represents another species of the genus.

This species is much compressed and has more rounded anterior and dorsal margins than the preceding species.

An important difference is in the absence of the flatness in front of the umbo which characterises *W. ambonychiformis* and in this respect this species is less specialized.

As the specimen is not perfect, a complete description is postponed until more perfect material will be procured.

Formation and locality:—Same as preceding.

Genus WANWANELLA, new genus.

Remarks:—The generic diagnosis is given on page 315.

The triangularly ovate outline, moderate convexity, central or subcentral umbo and radial ribs are the major characters of this genus. The umbo is usually directed forward, especially in *W. shoriensis* in which the beaks on both sides are abruptly and sharply twisted forward and joined to each other. Behind the umbo there is usually a scar, lenticular in outline and striated by several fine transversal lines. (See *W. striata* in Pl. VII, fig. 7 b.) At the posterior end of this scar there occurs a protuberance in most species. In *W. striata auriculata* this protuberance projects considerably in the postero-dorsal direction. This feature seems to indicate relationship between *W. striata* and *Eoischyrina billingsi*. Radial ribs are, I believe, very important character for some genera of the Ribeiridae, because this is very

common in the pelecypods and the brachiopods, but quite foreign to the crustaceans. The radial ribs are quite strong in *W. striata*; medium strength in *W. shorinensis* in which the marking becomes obsolete in the dorsal portion. *W. wanwanensis* has practically no radial ornaments, in which respects it is related to *Wanwania*, but instead has a subcentral umbo and a carapace not so strongly compressed. *W. tumida* has a reticulated ornamentation as in *Euchasmella multistriata*.

Genotype:—*Wanwanella striata*, new species.

Geological and geographical distribution:—Wanwanian of Taitzuho area in South Manchuria; the Wolungian of North Korea.

Wanwanella striata, new species.

Plate VII, figure 7; Plate IX, figure 6.

Description:—Carapace moderately convex, subequilateral, triangularly ovate in outline; its height being a little less than its length; umbo subcentral; frontal margin straight, ventral and posterior margins broadly rounded. Clavicle in front of the beak, large and strong; a small scar of elliptical shape behind the beak, is just an impression and not strong or deep; trace of a posterior wing behind the scar; in cast, a trace of a ridge directed vertically from the beak to the ventral side. Surface ornamented by a number of ribs, radiating from the umbo.

The two cotypes figured give the following dimensions:—

Dimensions / Specimens	Height	Length	Thickness
Specimen A. (Pl. VII, fig. 7.)	9.2 mm.	8.3 mm.	5.3 mm.
Specimen B. (Pl. IX, fig. 6.)	9 mm.	8 mm.	5.3 mm.

Comparisons:—The ovate, triangular outline and the central umbo make this species resemble *W. wanwanensis*, but it is much lower and has a number of radial striae, besides which it is also usually much smaller in size.

Formation and locality:—Most common member in the Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Wanwanella striata auriculata, new variety.

Plate VII, figure 6.

This variety differs from the type of this species only in its more

rounded outline and the posterior wing which projects in a postero-dorsal direction, and consequently is no more than a variety.

Formation and locality:—One specimen obtained in the same locality with *Wanwanella striata* s. str.

Wanwanella wanwanensis, new species.

PA297 C249

Plate VII, figure 8.

Description:—Carapace strongly convex, nearly equilateral, high, triangular in outline; umbo subcentral; dorsal margins sloping down on both sides from the umbo and making obtuse angles with both the anterior and posterior margins; anterior margin longer than posterior one, both of which are nearly straight; ventral margin regularly round. In cast, a strong clavicle occupying about the middle of the dorsal margin from the umbo to the frontal end; an obtuse ridge from the umbo to the antero-ventral corner marks off the triangular frontal area. Surface smooth except for some lines of growth.

Holotype specimen whose beak is broken a little, measures 19 mm. high, 13,6 mm. long and 10.7 mm. thick. Another specimen becomes a paratype.

Comparisons:—This species is a very convex form without ornamentation. It is distinguished from Wanwania through its sub-equilateral outline with a central umbo.

Formation and locality:— Wanwankou dolomite; Wanwan-kou, in the Niuhsintai Basin, Manchuria.

Wanwanella shorinensis, new species.

PA298 C250

Plate IX, figure 2.

Description:—Carapace very strongly convex, elongately ovate in outline; the maximum thickness at about one-third the distance from umbo to the ventral margin; from this point the umbonal portion is abruptly twisted toward the front; anterior margin nearly straight and gaping in its upper half, while the ventral portion of the carapace meets its fellow, making an acute angle between; both sides of the anterior gaping somewhat concave. In the cast a clavicle of moderate size is situated just beneath the twisted umbo; a narrow and rather long scar on the dorsal side a short distance behind the umbo. Surface marked by radial ribs.

Only the holotype is in hand and its posterior portion is partly broken off. So far as it is preserved, the specimen measures 17.3 mm.

high, 14 mm. long and 11.6 mm. thick.

Comparisons:—This species is the most convex form in this genus. It rather resembles *W. wanwanensis* in general aspect, but is distinguishable by its twisted umbo, the concavity of the frontal area and the radial striation.

Formation and locality:—This species is the latest representative of Ribeiridae in Eastern Asia which is found in the Shorin Bed of Shorinri, near Kenjiho Koshu-gun, Kokai-do in Northern Korea, in the same block with *Cameroceras* (*Proterocameroceras*) *mathieui* Grabau.

Wanwanella tumida, new species.

Plate VII, figure 10. C251 a b. PA299

Description:—Very small carapace, moderately convex and roundly triangular in outline; umbo round from which the dorsal margin sloping down on both sides, forming right angles with the ventral margin at its extremities; ventral margin circular, more rounded on the anterior side than on the posterior. A clavicle of medium strength lying just in front of the umbo. Surface reticulated by fine concentric and radial lines of nearly same strength.

Holotype specimen measures about 5 mm. in height as well as in length and 3 mm. in thickness.

Comparisons:—This species is allied to, or at least resembles, *W. striata*, but is distinguished by its reticulated ornamentation, the less height and less convexity of the carapace.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou, in the Niuhsintai Basin, South Manchuria.

Genus WANWANOIDEA, new genus.

Remarks:—The generic diagnosis is given on page 315.

The general form, strong radial ribs and an obtuse ridge from the umbo to the postero-ventral margin serve to distinguish this genus. As in *Wanwania* the umbo is terminal with a strong clavicle in front of it, and in a well preserved specimen of *W. trigonalis* two small elongated pits also occur in front of the clavicle which are set so that they diverge postero-dorsally from each other. On the dorsal side there is no linear impression as seen in *Wanwania*, but the portion behind the umbo is unusually elevated with respect to the posterior third.

Genotype:—*Wanwanoidea trigonalis* new species.

Geological and geographical distribution:—Wanwanian; Taitzuho area, in South Manchuria.

PA300

Wanwanoidea trigonalis, new species.

Plate IX, figure 3. C252

Description:—Carapace thick, inequilateral, triangular in outline; umbo terminal; ventral margin broadly curved and depressed a little within the posterior extremity; posterior margin broadly rounded; anterior side divided by an obtuse angle into two portions, the lower half being twice as long as the other; carapace closed at the frontal margin forming a sharp angle between, while on the posterior margin the sides gape a little for their whole length. An obtuse ridge is directed from the umbo to the middle point of the postero-ventral margin, dividing the carapace into two areas; this ridge describes a curve besides a long and strong clavicle, after which it straightens out. One or two somewhat linear scars are perceptible just in front of the clavicle and are directed rather perpendicular to the clavicle. Surface marked by strong radial ribs which number six or seven posterior to the obtuse ridge and more than ten anterior to the ridge; in the lower area the ribs and furrows decrease in breadth as they proceed from the ridge to the frontal margin.

Formation and locality:—Four specimens examined are all collected from the Wanwankou dolomite at Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Wanwanoidea trigonalis delicata, new variety.

PA301

Plate VIII, figure 6. C253

This variety differs from the typical form in the following respects:

1) Carapace is so strongly compressed laterally that the dosal margin makes a sharp angle.

2) The median ridge runs more closely to the antero-ventral side than to the postero-dorsal side, so that the upper area is broader than the lower area.

3) Radial ribs are finer and more numerous in this variety than in the typical form.

4) The variety has a smaller clavicle.

Many characters of this variety are not perfectly in accordance with those of the typical form, but the differences are not of large magnitude and therefore this form still belong to the species, for its general form and the mode of ornamentation are not much different.

Formation and locality:—A single specimen of this variety is found in the same horizon and locality of the type of this species.

Genus RIBEIRIA Sharpe, 1853.

1853. *Ribeiria* Sharpe, Q.J.G.S. Vol. 9, p. 157.
1864. *Ribeiria* Salter, Geol. Mag., Vol. I, p. 12.
1865. *Ribeiria* Billings, Pal. Foss., I, p. 339.
1874. *Ribeiria* Woodward, Manual of Mollusca, p. 497, App. p. 80.
1877. *Ribeiria* Miller, American Pal. Foss. Catal. p. 44.
1881. *Ribeiria* Karl A.v. Zittel, Hand. d. Palaeont. Vol. 2, p. 659.
1886. *Ribeiria* Whitfield, Bull. Am. Museum, Nat. Hist., Vol. I, p. 343.
1889. *Ribeiria* Miller, N.A. Geol. Paleont., p. 566.
1890. *Ribeiria* Jones, Rep. 59th Meeting British Assoc. Adv. Sci. p. 66.
1896. *Ribeiria* Kingsley & Calrk, in Zittel-Eastman's Text-Book of Palaeontology, 1st. Ed. p. 654.
1900. *Ribeiria* Cleland, Bull. Am. Palaeont. Vol. 3, No. 13.
1903. *Ribeiria* Schubert & Waagen, Janrb. d.k.k. geol. Reichsanst, 53, p. 33.
1904. ?*Ribeiria* Clarke, Mem. N.Y. State Mus., 6. p. 406, expl. pl.
1910. *Ribeiria* Grabau & Shimer, N.A. Index Fossils, Vol. 2.
1913. *Ribeiria* Bassler, in Zittel-Eastman's Text-Book of Palaeontology, p. 733.
1917. *Ribeiria* Bassler, Bibliogr. Index of Am. Ord. & Sil. Foss., p. 1130.
1924. *Ribeiria* Zittel-Broili, Grundzüge d. Palaeontologie. p. 627.
1924. *Ozomia* Walcott, Smithsonian Miscell. Coll. Vol. 67, No. 9.

Original diagnosis:—Test univalvis, elongata, lateraliter compressa; aperture elongatâ angustâ; intus laminâ transversali anterior et impressione musculari elevatâ elongataque munita.

Genotype: *Ribeiria pholadiformis* Sharpe. (Pl. X. fig. 1.)

Remarks:—In describing *Ribeiria? calcifera* and *Ribeiria? longiuscula*, Billings hesitated to place them in this genus and stated that if they had to be separated, he proposed *Ribeirina* as a subgeneric name for their reception. But, Bassler in his "Bibliographic Index" raised no question as to the position of the first mentioned species, but expressed doubt as to the latter.

Walcott erected a new genus, *Ozomia*, based upon *Ozomia lucan* from the Mons formation of Canada and other Ozarkian beds in Utah. At that time he placed it in the Technophoridae of the Notostraca and did not compare it with *Ribeiria*. In examining the specimens of *Ozomia lucan* kept in the U.S. National Museum, however, I failed to find any difference of generic value, therefore, *Ribeiria* and *Ozomia* are surely synonymous to each other and Billings' suggestion of *Ribeirina* may also not be necessary.

So far as I am aware, there are twelve species and one variety already described which are as follows:—

European species.

Ribeiria pholadiformis Sharpe. Lower Ordovician of Portugal. (Sierra de Mucela and Sierra de Bussaco) in the neighbourhood of Bussaco.

Ribeiria (*Redonia*) *complanata* Salter. In the Stiper Stones of the Llandeilo, England.

Ribeiria apuscoides Schubert et Waagen. (Ossek), d4 (Chrustenitz, Lodenitz, Levin, Stankowka bei Radotin, Kuchel, Stěrbohol, Prag, Lieben, Bohdatetz), d5 (Leiskow).

Ribeiria inflata Schubert et Waagen. d1 (Rokytzan) and d4 (Radotin, Lodentiz, Chrustenitz.)

American species.

Ribeiria? calcifera Billings. Canadian (Beekmantown); Leeds and Grenville Counties, Quebec.

Ribeiria? longiuscula Billings. Canadian (Beekmantown); Leeds and Grenville Counties, Quebec.

Ribeiria compressa Whitfield. Canadian (Beekmantown); Fort Cassin, Vermont.

Ribeiria ventricosa Whitfield. Canadian (Beekmantown); Fort Cassin, Vermont.

Ribeiria? nuculitiformis Cleland. Canadian. (Tribes Hill); Fort Hunter, New York.

Ribeiria ? *nuculitiformis equilatera* Cleland. Canadian. (Tribes Hill); Near Fort Hunter, New York.

Ribeiria turgida Cleland. Canadian (Tribes Hill); Fort Hunter and Tribes Hill, New York.

Ribeiria parva Colie. Canadian (Beekmantown); Bellefonte, Pennslyvania.

Ozomia lucan Walcott. Ozarkian (Mons Formation); Cordilleran area from Glacier Lake near the head of the Saskatchewan River, southeast 49 miles to Fossil Mountain and head of Douglas Lake Canyon, north of Bonnet Peak; Alberta, Canada; also about 800 miles south in Blacksmith Fort canyon in northern Utah.

Two new species and one variety from South Manchuria are added to these 12 species and these are *R. manchurica*, *R. manchurica pennata* and *R. bassleri*.

Geological and geographical distribution:—Two species and one variety are described from the Wanwanian of Manchuria and the Ozarkian of the Cordilleran area of North America, and seven species and one variety in the Canadian from Pennsylvania to Quebec through Vermont. In Europe two species are known from the Llandeilian in

England and Portugal and two species from Bohemia where they occur from the Tremadoc (?) to the Caradocian.

Ribeiria manchurica, new species. PA302

Plate XI, figure 5.

Description;—Carapace moderately convex, inequilateral, elliptical to roundly quadrate; length greater than one and half times the height; umbo subterminal, about one-sixth from the anterior extremity; frontal margin sinuate between the umbo and the anterior extremity, then curving regularly and continuing to the ventral and posterior margins; curvature of the ventral margin much weaker than those of the other margins; dorsal side narrow and flat, marked off from each lateral side by a blunt edge. Clavicle in cast represented by a semicircular sinuation, just beneath the umbo; a number of very faint lines radiating from the umbo are concave toward the ventral side. Surface smooth except for concentric lines of growth.

Holotype specimen measures 26.1 mm. long, 15.9 mm. high, and 8.8 mm. thick.

Comparisons—This species somewhat resembles *Ribeiria? calcifera*, but the latter species has a narrower posterior portion.

Formation and locality:—This species is one of the most common in the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Ribeiria manchurica pennata, new variety. PA303

Plate IX, figure 4.

This variety differs from the typical form in the following respects:—

1) Dorsal margin describes a gentle convexo-concave curve from the umbo to the posterior end.

2) A blunt ridge directed from the umbo to a little below the extremity of the dorsal margin, marks off a twisted and narrow triangular area on each side of the dorsal margin.

3) The convexity of the carapace much exceeds that of the typical form.

4) The clavicle is much smaller in the variety.

5) Posterior margin gapes to some extent.

Three imperfect specimens of this form are in hand which differ as indicated above from the species.

If complete specimens be procured, it may not be impossible to separate this specifically from the typical form.

Formation and locality:—Same as preceding.

Ribeiria bassleri, new species.

Plate IV, figure 4.

Description:—Small carapace with little convexity, elongate triangular, its length equaling approximately to one and half of the height; umbo eccentric, forming an angle of about 120 degrees at the beak, from which the dorsal margin slopes down on both sides, describing rather concave curves; postero-ventral margin rises a little near the posterior end; ventral margin regularly curved. Clavicle very small, rather vertical, situated just in front of the umbo; two or three blunt ridges are directed toward the ventral margin.

This species is represented by a single cast on which no fragment of surface is preserved. The specimen measures 8.5 mm. long and 5.5 mm. high.

Comparisons:—The umbo as well as the clavicle is vertical and not directed toward the front, which character points somewhat to *Ribeirella*.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus RIBEIRELLA Schubert et Waagen, 1903.

1903. *Ribeirella* Schubert and Waagen, Jahrb, d. K.K. Geol. Reichsanst, Bd. LIII, p. 45.

Original diagnosis:—Schale zart, stark concentrisch gestreift, vorn verabgeschlagen und am Ende nach rückwärts geknickt, im rückwärtigen Dorsaltheile gegen die Flanken kantig abgesetzt. Innenskelet senkrecht oder nach rückwärts geneigt.

Genotype:—*Ribeirella sharpei* (Barrande), (Pl. X, figs. 2–10.)

Geological and geographical distribution:—This genus is hitherto represented by only one Bohemian species, cited above.

Genus EUCHASMA Billings, 1865.

1865 *Euchasma* Billings, Pal. Fossil. I, p. 360.
1877 *Euchasma* Miller, Am. Pal. Fossil Catalogue, p. 191.
1889 *Euchasma* Miller, N. A. Geol. and Pal. p. 480.
1917 *Euchasma* Bassler, Bibliogr. Index of North American. Ord. and Sil. Foss. p. 1425.

Original diagnosis:—The only species of this genus known to me is strongly convex, triangular, inequilateral, equivalve, subcordiform. The posterior ? extremity is flat and gaping for the whole length. The anterior ? extremity is rounded angular and seems to be gaping also; but no species have been procured with this part perfect, and therefore this point remains doubtful. The hinge line is short, and seems to have an external ligament. When the flat side is ground down gradually, it is found that just below the umbones the shell of both valves has a large rounded protuberance on the inside. These leave an impression in the cast of the interior just behind the umbo.

Genotype:—*Conocardium blumenbachium* Billings. (Pl. X. fig. 11)

Remarks:—Billings described in 1859 *Conocardium blumenbachium* from the white Calciferous limestone of Mingan Island, but wondered at the appearance of this genus in strata of such great antiquity. Afterward (1865) he erected this genus, taking this species as the genotype.

Geological and geographical distribution:—Hitherto this genus was represented by only the single species from the Canadian of the Mingan Island, Canada, but now we have a species from the Orient.

Euchasma eopteriformis, new species.

Plate VIII, figure 4. PA305

Description:—Carapace strongly convex, the maximum convexity lying a little above the center of the carapace whose height nearly equals its length; outline of the carapace rounded rhombic, excepting the anterior wing; umbo broadly rounded; posterior half of the dorsal margin slopes down gently from the umbo and forms an angle of about 12 degrees at its extremity with the nearly straight posterior margin; ventral margin begins at a blunt obtuse angle at the end of the posterior margin, and describes a regular curve, continuing to the outer margin of the anterior ear without interruption of the curvature; anterior and ventral margins gaping to some extent; the body of the carapace somewhat flat on the anterior side, the flatness marking off the anterior ear in a small triangular shape. As seen in the apical view, dorsal side very wide and is divided into triangles by the line connecting the umbones of the two sides; impression of clavicle very weak as in *E. blumenbachia*. Surface marked by a number of strong radial ribs, radiating from the umbo and twisted somewhat in a sigmoidal course; about six ribs in the middle part anterior to the postero-ventral corner,

much stronger than the others on both margins, which are rounded and separated by flat furrows, broader than the ribs.

Holotype specimen measures 13.7 mm. high, 12.1 mm. long, and 11 mm. thick.

Comparisons:—This species is different from the genotype in respect to the outline, flatness of the frontal side and the presence of the frontal ear. In *E. blumenbachia*, the carapace is triangular, with a very long and flat frontal side which attains the maximum length of the carapace and forms an acute angle at its end with the postero-ventral margin. But the present species is in good accordance with the genotype in its major characters, namely the carapace of great thickness, the flatness in front of the umbo and the strong radial ribs. As shown in the dorsal view, the impression of the clavicle is very faint and a protuberance, though it is not so prominent as in the genotype, is present at the middle point between the umbones. Its anterior wing represents some affinity to that of *Eopteria* from which, as pointed out by Billings, the close relationship between *Euchasma* and *Eopteria* is well verified, but in *Eopteria* the dorsal margin is straight, protruding at both extremities into wings, the clavicle stronger and the radial ribs weaker than in this species.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus EUCHASMELLA, new genus.

Remarks:—The generic diagnosis is given on page 316. What is known about this genus is precisely described in the description of *E. multistriata*.

Genotype:—*Euchasmella multistriata*, new species.

Geological and geographical distribution:—Wanwanian; Taitzuho area, Manchuria.

Euchasmella multistriata, ~~new species.~~

Plate VIII, figure 5.

Description:—Carapace regularly convex, equilateral, nearly as long as high, triangular with rounded basal margin, bluntly angular from which both flat sides slope down; frontal side practically flat, gaping for its whole length. Clavicle on the flat side, situated about one-third the distance from the umbo on the flat side. Surface marked by numerous radial striae and growth-lines.

Holotype specimen measures 32 mm. high and 33 mm. long. The thickness may be about 20 mm.

Formation and locality:—Two specimens collected from the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus EOPTERIA Billings, 1865.

1865 *Eopteria* Billings, Pal. Foss. I, p. 221 & p. 306.
1877 *Eopteria* Miller, Am. Pal. Foss. Catal. p. 191.
1889 *Eopteria* Miller, N. A. Geol. & Pal. p. 480.
1917 *Eopteria* Bassler, Bibliogr. Index Ord. & Sil. Foss. p. 490 & p. 1425.

Remarks:—Billings established this genus taking *Eopteria typica* from the Canadian (Quebec group G) at Port au Choix, Newfoundland as the genotype. He illustrated this genus first in the description of *Eopteria richardsoni* from the Canadian (Quebec group) at St. Antonil above Quebec. He considerd this genus as a bivalve resembling *Pterinea*. It is the characteristic of this genus that "both valve are equally convex and hinge appears to have an external ligament like that of *Unio*."

As mentioned by Billings, *Eopteria* resembles *Euchasma* somewhat, but it is distinguished from " externally in having one extremity."

Billings also described in the same volume *Eopteria ? ornata* from the Ozarkian in the upper part of limestone No. 2, Quebec at Point Levis, Quebec. Clark[1] reported the latter species from the Beekmantown at Levis and he considered it to be a brachiopod.

Four species of this genus are found in the Wanwanian of South Manchuria which are named *E. asiatica, E. alta, E. obsolata* and *E. flora*. In comparing with the genotype, *E. asiatica* has much longer wings on both sides of the dorsal margin. Under the test several strong ridges radiating from the clavicle to the anterior margin, and the margin is serrated.

On the dorsal views of *E. obsolata* and *E. flora* the umbones are connected by a narrow ridge as in *Euchasma, Eoischyrina* and *Pseudotechnophorus*.

Genotype: *E. typica* Billings.
E. richardsoni Billings. (Pl. X, fig. 12.)

1) Clark, Thomas Henry (1924), Paleontology of the Beekmantown Series at Levis, Quebec. (Bull. Am. Paleont., Vol. X, No. 41.)

Geological and geographical distribution:—This genus has hitherto been restricted to the Canadian of eastern North America. My find in the Wanwanian series widens the distribution of the genus.

Eopteria asiatica, new species.

Plate VIII, figure 2.

Description:—Carapace convex, nearly equilateral, subcircular in outline with a large wing on each side; posterior wing sharper than the anterior one; ventral margin round, semicircular continuing to the posterior wing with a sinuation, but to the anterior wing without a sinuation; maximum convexity of the carapace lying about the middle point of the carapace; umbo central, projecting very little beyond the straight dorsal margin; a prominent clavicle in front of the umbo from which several furrows radiate in an antero-ventral direction.

A single specimen of an internal cast is in hand which measures 6 mm. high and 12.3 mm. long.

Comparisons:—This species is readily distinguished from all described species of the genus by its long and straight dorsal margin with prominent wings and by its umbo which projects very slightly beyond the dorsal margin.

Formation and locality:—A solitary specimen is in hand from the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Eopteria alta, new species.

Plate VIII, figure 7.

Description:—Carapace moderately and uniformly convex, nearly equilateral, slightly higher than long, ovate in outline, truncated by a straight dorsal margin; umbo subcentral, broadly rounded, projecting a little beyond the dorsal margin. Surface ornamented by numerous radial ribs.

Holotype measures 13.4 mm. high, 12.8 mm. long, and about 8.2 mm. thick.

Comparisons:—This species resembles *E. richardsoni* Billings, but it is much higher in outline and its dorsal margin is shorter as compared with the length of the carapace than in *E. richardsoni*.

Formation and locality:—One specimen obtained from the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Eopteria obsolata, new species.

Plate VIII, figure 8.

Descritpion:—Carapace regularly and moderately convex, the convexity being near the center of carapace; inequilateral, somewhat semicircular in outline; dorsal margin straight; umbo small, projecting a little beyond the margin; anterior margin, as far as it is preserved, vertical, forming an obtuse angle with the ventral margin; from this angle the ventro-posterior margin describes a regular curve. Umbo tumid, connected by a narrow ridge without a protuberance in the middle; clavicle rather large; a few furrows radiate from the umbo near the margin of the frontal area which is marked off from the postero-central portion by a blunt angle directed from the beak toward the antero-ventral corner. Lines of growth rather strongly impressed as concentric folds in the cast.

The antero-dorsal corner is cut off in the specimen which measures 9 mm. high and 5.2 mm. thick. The length of the carapace is indeterminable.

Comparisons:—This species is distinguished from others by its vertical frontal margin with an angle at its lower extremity.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in in the Niuhsintai Basin, South Manchuria.

Eopteria flora, new species.

Plate VIII, figure 1.

Description:—Carapace of medium size, moderately convex, its body somewhat elongately ovate in outline with a triangular wing in front; umbo round and projecting only a little beyond the slightly warped dorsal margin. Clavicle of moderate size, lying between the body and the wing. Surface marked by the radial ribs and concentric lines of growth; the radial ribs limited to the body of the carapace.

The holotype specimen gives the following dimensions:—

Height of the carapace.	13 mm.
Length of the body of the carapace.	11 mm.
Length of the anterior wing.	7 mm.
Thickness of the carapace.	7 mm.

This species is well characterized by the high body of the carapace with a very prominent frontal wing and the absence of a posterior wing.

Formation and locality:—Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Subfamily ISCHYRINAE, new subfamily.

Genus EOISCHYRINA, new genus.

Remarks:—The generic diagnosis is given on page 316. This genus is apparently similar to the auriculate variety of *Wanwanella striata*, but in this genus the umbones are directed in a dorsal direction and connected by a narrow ridge to each other, whereas in *Wanwanella* the umbones meet each other and are directed forwardly. In *E. billingsi* the clavicles on both sides of the umbones are very strong and on the inside of the test a vertical ridge runs from the umbo to the middle of the carapace.

Genotype:—*Eoischyrina billingsi*, new species.

Geological and geographical distribution:—Wanwanian; Taitzuho area, Manchuria.

Eoischyrina billingsi, new species.

Plate VII, figure 9.

Description:—Carapace strongly convex, the maximum convexity lying at a point about one-third from the beak; its outline nearly equilateral, somewhat like an overturned oval; ventral margin transversely semi-elliptical; umbonal region very thick; umbo subcentral, a little incurving at the beak and connected by a ridge with the beak on the other side; from this ridge the dorsal margin slopes down on both sides and forms a concave triangular area with laterally convex margins on which some transversal lines are impressed; anterior clavicle begins at a point two-thirds the distance from the umbo to the front margin; the posterior one begins at a little higher point than the anterior; a vertical ridge runs from the umbo to the middle of the carapace. Surface marked by very fine radial striae which are more strongly impressed on the posterior side than on the other.

Holotype specimen measures 9 mm. high, 7.8 mm. long and 5.3 mm. thick.

Comparisons:—This species is quite easily distinguished from any other of this section by its outline and its thick umbonal region.

Formation and locality:—Two specimens collected from the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus ISCHYRINIA Billings, 1866.

1866. *Ischyrinia* Billings, Catal, Sil. Foss. Anticosti, p. 16 & p. 52.
1889. *Ischyrinia* Miller, N. A. Geol. Pal., p. 483.
1894. *Ischyrinia*, Ulrich, Pal. Minn., Vol. III, pt. 2, p. 613.
1915. *Ischyrinia* Bassler, Bibliogr. Index, Vol. I, p. 670.
1928. *Ischyrinia* Twenhofel, W. H., Geology of Anticosti Island, (Geol. Surv. Canada, Mem. 154), p. 339.
1931. *Ischyrinia* Teichert, Curt, Der erste europische Vertreter der Gattung *Ischyrinia* Billings (Eucrustacea, *Notostoraca*,) in der Lycholm-Stufe von Estland. (Palaeont. Zeitschr. Bd. 12.) pp. 130–134.

Original diagnosis:—Equivalve, inequilateral, two strong ridges radiating from the beak in the interior of each valve.

Genotype:—*Ischyrinia winchelli* Billings. (Pl. X, fig. 13.)

Remarks:—Billings established this genus *Ischyrinia winchelli* from the Richmond (English Head and Charleton) at Macastry Bay, Anticosti Island. At the same time he described *I. plicata* from the Gamachian (Ellis Bay) at Junction Cliff, Anticosti Island. But the latter species is considered by Ulrich to be more suitably placed in *Technophorus*. A few years ago these species were redescribed by Twenhofel as *I. winchelli* and *Technophorus plicatus*. Teichert in 1931 described *Ischyrinia schmidti* from the Lychholm-stage of Estonia.

Geological and geographical distribution:—One species in the Richmond stage of Canada and the other one in the Lycholm stage of Estonia.

Genus TECHNOPHORUS Miller.

1889. *Technophorus* Miller, N. A. Geol. Pal. p. 514.
1894. *Technophorus* Ulrich, Geol, Minnesota, Vol. III, pt. 2, p. 612.
1904. *Technophorus* Clarke, John, M. Naples Fauna in Western New York (Mem. New York State Museum, Vol. III, No. 6.) p. 406, expl. pl. 9.
1915. *Technophorus* Bassler, Bibliographic Index, Vol. 2, p. 1257.

Original diagnosis:—Shell small, equivalve, inequilateral; anterior end short, broadly rounded; two or more furrows arising near the beak extend to the postero-basal margin; beak small, upright; surface concentrically lined; umbonal rib in front of the beak represented in the cast by a transverse sulcus; no external ligament, escutcheon, or lunule.

Genotype:—*Technophorus faberi* Miller. (Pl. X, fig. 14.)

Remarks:—A more detailed description was given by Ulrich in

which he noticed that this genus has a close resemblance to *Ischyrinia*. In the latter genus, however, "the internal ribs are better developed, the posterior one especially." Further on he said, "There are posterior (Billings calls the side anterior) furrows and ridge, but the wing is very short." At that time Miller and Ulrich considered *Technophorus* as well as *Ischyrinia* to be bibalves. Clarke was the first to compare *Technophorus* with the ribeiroid crustacea. He described *Ribeiria? prosseri* from the Oneonda sandstone at Livingstoneville, Schoharie Co., New York, but it seems that this shell, so far as the figures and description are concerned, is more closely allied to *Technophorus* than to *Ribeiria*; at any rate it may belong to the Ischyrinae, because he describes "the presence of two clavicles on the interior, a small one directed forward and a stronger pointing backward." But, there is no species of Technophorus described from such higher horizon. Putting aside this species for a while, there are twelve species belonging to the genus as follows:—

T. bellistriatus Branson, Black River, Missouri.
T. cancellatus Ruedemann, Trenton, New York.
T. cincinnatiensis Miller and Faber, Eden.
Cincinnati, Ohio and vicinity.
T. divaricatus Ulrich, Balck River, Minnesota.
T. extenuatus Ulrich, Black River, Minnesota.
T. faberi Miller, Maysville, Ohio.
T. fillistriatus Ulrich, Balck River Minnesota.
T. plicatus (Billings), Gamachian, Anticosti.
T. punctostriatus Ulrich, Mayville, Kentucky.
T. subacutus Ulrich, Black River, Minnesota.
T. yoldiaformis (Ulrich), Eden, Kentucky.
T. quicuncialis Foerste, Lorraine, Quebec.

Geological and geographical distribution:—This genus is widely distributed over central and eastern Nortn America in the Black River and disappears in the Anticosti Island in the Gamachian age.

Genus PSEUDOTECHNOPHORUS, new genus.

Remarks:—Generic diagnosis is given on page 317.

Two sets of narrow clavicles mark off the dorsal portions into two narrow areas which look like the external ligaments of bivalves, but this is surely an internal structures as the demarcation of these areas is quite obscure on the surface of the test, as seen in figure 8 on plate VIII.

Genotype:—*Pseudotechnophorus typicalis*, new species.

Geological and geographical distribution:—Wanwanian; Taitzuho area, Manchuria.

Pseudotechnophorus typicalis, new species.

Plate VIII, figure 8; Plate IX, figures 1 & 8.

PA312-8-8
PA313-9-1
PA314-9-8

Description:—Carapace moderately convex, inequilateral, frontal half semicircular, posterior half, twice as long as the length of the frontal portion, elongately semi-elliptical; umbo bluntly pointed; a protuberance occurs at the middle point on the ridge which connects the umbones at a little posterior to them; anterior as well as posterior clavicles long and are marking off the dorsal areas like external ligaments of bivalves. Surface marked by a number of delicate radial striae.

In the specimens examined the carapace is strongly twisted. Usually the posterior part of the carapace is twisted to the left side.

The following dimensions are given by the three figured specimens.

Dimenions / Specimens	Height	Length	Thickness.
Specimen 1. (Plate IX, fig. 8.)	7 mm.	—	4.7 mm.
Specimen 2. (Plate IX, fig. 1.)	9.3 mm.	14.7 mm.	6. mm.
Specimen 3. (Plate VIII, fig. 8.)	9.0 mm.	15.0 mm.	—

Comparisons:—This species is quite distinct from *Eoischyrina* by its depressed outline and from *Ischyrinia* and *Technophorus* by the absence of the umbonal ridge.

Formation and locality:—Very common in the Wanwankou dolomite; Wan-wan-kou in the Niuhsintai Basin, South Manchuria.

Genus PSEUDOEUCHASMA, new genus.

Remarks:—The generic diagnosis is given on page 317. This form is quite specialized, especially with respect to the flat posterior side with a heart-shaped opening. In *Wanwania*, *Euchasma* and *Euchasmella* the lateral flattening occurs in the anterior portion, but in this genus it is on the posterior side. As to the clavicles, a very imperfect depression is observed in the internal cast just in front of and below the umbo and another heart shaped linear depression surrounds the posterior opening behind the umbo, hence, this belongs to the Ischyrinae. The anterior clavicle of this genus is unusually obsolescent. Therefore the

lateral flattening in this genus is entirely different in origin from that of Euchasma. The umbo of this genus unlike that of Euchasma is a simple beak directed forward. In this feature it resembles *Wanwania* and *Ribeiria*.

Genotype:—*Pseudoeuchasma typica*, new species.

Geological and geographical distribution:—Wanwanian; Taitzuho area, Manchuria.

Pseudoeuchasma typica, new species.

Plate IX, figure 10.

Description:—Carapace convex, inequilateral; umbo pointed, in front of which there is a weak linear clavicle in well preserved specimens; posterior side flat, projecting below and twisted to one side; the ventral margin a little concave in its posterior half. As seen in the posterior view, an elongate heart-shaped gap occurs in the upper part of the posterior side which is surrounded by the scar of the clavicle, parallel to the outline of the gap. Surface smooth except for delicate radial striae and lines of growth.

Holotype specimen whose anterior margin and posterior wing are partly broken off, measures 10mm. long, 7.3mm. high and 4.7mm. thick.

Comparisons:—The peculiar outline of this species allows no confusion with other species of the Ribeiridae.

Formation and locality:—Two specimens found in the Wanwankou dolomite: Wan-wan-kou in the Niuhsintai Basin, Manchuria.

IV) On the Ellesmereoceroids.

i) ***Internal structures observed in some Wanwanian cephalopods***:—

1) The holotype (Plate IV, fig. 9.) of *Wanwanoceras peculiaris* is 25 mm. long, in which length twenty-nine camerae are present. The internal structure cannot be well determined in the lower two camerae, but in the eight following ones their septa obviously are of the *Armenoceras* type, namely they bend sharply back at their necks, their brims being as long as about 0.5 mm. or less. A rather thick connecting ring begins at about the end of the septal brim, assumes a nummuloidal form and reaches as far as the preceding septal neck. Such a connecting ring does not occur in the following six camerae. The form of these upper septal necks is, however, still of the Cyrtochoanitic type, but the angle between the septum and septal brim becomes successively

larger in proceeding from lower to upper camerae. This change in septal structure in the same specimen corresponds to that seen in the genera *Armenoceras* and *Sactinoceras*, but in the last thirteen camerae an angle between the septum and the septal brim becomes sucessively larger until the later septa becomes subparallel to the siphonal margin of the conch. The length of the septal brim never exceeds the height of the camera, therefore, the septal funnel does not reach to the preceding neck.

If as a rule the ontogeny corresponds to the phyllogeny on a miniature scale, the conclusion suggested by the preceding observations is that the Orthochoanites were derived from Cyrtochoanites.

2) In a paratype (Pl. III, figs. 3a—b) of *Multicameroceras multicameratum* from the Wanwankou limestone proper at Chiu-shou-kou there is observed an entirely new structure of cephalopod characterized by siphuncular bulbs and tabulae. The specimen is about 27.7 mm. long, in which length twenty-eight camerae occur and the major diameter of the conch enlarges from 10.5 mm. to 15 mm.

In a longitudinal section the septa are regularly concave and curve at the septal necks, forming rounded rectangles, so that the septal funnels usually are not parallel to the siphonal margin. Some septal funnels extend a little beyond the preceding septal necks, but others are shorter than the height of the camerae. Some space always intervenes between the septal funnels and the immediately preceding septal necks. Although the septal funnel is long enough to imbricate with its preceding funnel, yet there is a narrow channel between them.

A kind of lining composed of a white and homogeneous calcareous material backs the siphonal side along the septal funnel. On the side of the camerae this siphuncular lining is connected with a series of small, round bulbs, through the channels or openings mentioned above. Within the siphuncle, the lining is connected with series of of transverse tabulae which are irregular films cutting across the siphuncle.

As this figured section was made a little oblique to the dorsoventral axis, a section of camerae is shown on the siphonal side. The septa on this side slope steeply downward, are obtusely rounded at the neck, become subparallel to the siphonal margin, and then terminate near the septal necks.

In a transverse section the siphuncular lining and the sections of the tabulae are found within the siphuncle, and from the lining a small and circular siphuncular bulb swells out into each camera through the channel.

The camerae are filled with white crystalline calcite and the interior of the siphuncle with a foreign matrix.

The theory noticed in the previous chapter, that Cyrtochoanites was derived from Orthochoanites, cannot be supported in this specimen because the lengths of the septal funnels are different from one another and there is no regularity from earlier to later stages as observed in *Wanwanoceras peculare*.

Ruedemann[1] first observed and described the siphuncular lining in *Cameroceras* (*Proterocameroceras*) *brainerdi* Whitfield. Hyatt first discovered diaphragms in his genus *Diphragmoceras* from the lowest Calciferous of Newfoundland, and stated that its siphuncle was crossed by transverse tabulae alternating with the septa of a camerated shell[2].

As pointed out by him, it is an important character that "the partition (or diaphragm) is not pierced by any endosiphucle[3]."

I have not seen the original specimen studied by Hyatt, but Ulrich and Foerste kindly showed me several specimens of *Clarkoceras* in which they recently found the same structure. As these specimens were collected from the cherty rock of the Gasconade member of the Ozarkian at a locality 4 miles west of Shelbyville, Missouri, the observation of the internal structure is sometimes pretty difficult. At a first glance this *Clarkoceras* seems to have a holochoanitic siphuncle, but as shown in diagrammatic sections of *Clarkoceras newton-winchelli* (Clarke)[4] a septum terminates a short distance from the septal neck and a siphuncular margin is completely backed by a siphuncular lining which can be observed in tolerably well preserved specimens from the Gasconade. Diaphragms develop in the earlier portion of the siphuncle where they alternate regularly with the septa in some specimens, but in others two diaphragms develop in a space of one camera.

All the diaphragms observed in the specimens of *Clarkoceras* cross the siphuncle regularly and curve down a little toward the apical side.

Another important feature is that the diaphragm of *Clarkoceras* is composed of a material similar to the septum, but different from the siphuncular lining. The end of the diaphragm touches the siphuncular lining, but there is a distinct boundary between and the diaphragm does

1) Ruedemann, Rudolf (1904); Structure of some primitive Cephalopoda. (Report of New York State Palaeontologists.)

2) Hyatt, A. (1896) in Zittel-Eastmann's Text-book of Palaeontology.

3) Hyatt, A. (1894) Phylogeny of an Aquired Characteristic. (Proc. Amer. Phil. Soc., vol. XXXII, no. 143), pp. 363-364.

4) Clarke. J.M. (1897), Lower Silurian Cephalopoda of Minnesota, p. 768, text-figs. 8-9.

not continue into the lining. In these respects there is an unmistakable difference between the tabulae of *Multicameroceras* and the diaphragm of *Clarkoceras*. So far as I am aware, the structure of the siphuncular bulb and the siphuncular tabulae here described are entirely new for cephalopod structure.

PM316-2-6
PM317-2-7
PM318-2-9;3-5
PM319-2-10

3) In a paratype specimen (Plate III, fig. 5.) of *Sinoeremoceras wanwanense* (Kobayashi) 28 mm. long are thirty camerae among which thirteen from the smaller end have the same siphuncular bulbs as are observed in *Multicameroceras multicameratum*, but in the remaining camerae the septa are simply orthochoanitic, the length of their septal funnels being usually shorter than the height of a camera.

PM320-3-2
2(K)

These upper camerae, without siphuncular bulbs, usually are filled with homogeneous calcareous matter of gray colour, while the lower thirteen camerae are filled with white crystalline calcite, and if the calcareous matter in the camerae is not entirely recrystallized, the siphonal part of the camerae at least is filled with recrystallized calcite. From this it appears that the recrystallization of the calcareous filling in the camerae has some intimate relation to the formation of the siphuncular bulb.

The siphuncle of the specimen is filled with crystalline calcite in its lower part which includes nine and a half camerae, but farther up, the interior of the siphuncle is filled with a foreign matrix. The upper surface of the white crystalline part is distinctly defined from the vacant part which is now filled by the dark coloured foreign matrix.

A solid black surface occurs at the center of the siphuncular bulb and steeply ascends toward the siphonal side, the curvature described by it being similar to that shown by the septa and camerae. Below it there are several solid planes of the same kind of crystalline contents as in the siphuncle. When the shell grew to these levels, these solid planes separated the crystalline part from the empty space to which the end of the mantle extended. Since they look something like a pseudoseptum in the camerae, they will be called by the name of pseudodiaphragm.

This is of course genetically different from the tabulae and diaphragm. In my opinion some relation exists between the pseudodiaphragm, the siphuncular bulb and the recrystallization of the calcareous matter in the camerae, and if they have any mutual relation and if they are formed one after another, then it may be presumed that they came into existence in the following order:— first, the recrystallization of the camerae filling; second, the siphuncular bulb; and last, the pseudodiaphragm.

Incidentally it is necessary to see, if these structures are primary or secondary in origin, that is to say, if they were formed before, or after, the death of the animal. It appears certain that these structures originated while the animal was living, because the pseudodiaphragm, the latest creation among them, clearly marks off the empty space of the siphuncle where the end of the siphon was located. If further conjecture is allowed, the pseudodiaphragm and siphuncular bulb may possibly be products secreted from the mantle from time to time, according to the growth of the animal.

4) In the holotype (Plate III, fig. 2.) of *Sinoeremoceras wanwanense* (Kobayashi) the same structure as in the paratype of this species can be observed, but another characteristic can also be seen. Its dimensions will be omitted here, for they are given in my previous paper[1]. In the present specimen the siphuncular bulbs exist only in the earlier ten camerae where white calcareous, but not perfectly recrystallized material fills the space. It cannot be overlooked that there is a remarkable boundary between these earlier ten camerae and the later ones, at which the camerae filling abruptly changes and the siphuncular bulb disappears. Gray coloured calcareous matter fills the later camerae and the septal necks change in this specimen from holochoanitic to cyrtochoanitic, that is to say, in the earlier stage the septal neck extends a little beyond the preceding neck, but the septa near the body chamber curve abruptly at the septal neck.

5) *The diaphragm, pseudodiaphragm, tabulae and siphuncular bulb.*

In regard to their biological function, the diaphragm in *Diphragmoceras* and *Clarkoceras* and the pseudodiaphragm in *Sinoeremoceras* may be the same thing, because they are the back wall of the siphon but genetically they may be different from each other, since their features and structures are entirely distinct. The pseudodiaphragm is a thin film which would be produced by a special solidification in the course of calcareous secretion by the animal, so that the space between the pseudodiaphragms usually is filled with the same kind of calcareous matter while in the case of a real diaphragm the space between consecutive diaphragms is a chamber which is filled up with the same matrix as that filling the space above the last diaphragm. Another difference is that the diaphragm of *Clarkoceras* is transverse, while the pseudodiaphragm isoblique to the axis of the siphuncle and begins within a siphuncular bulb. If we get the similarity of these structures in the Wolungian or

1) Kobayashi (1931), Cambrian-Ordovician of South Manchuria, p. 164.

later genera, the pseudodiaphragm is possibly comparable to the endosheathes in endoceroids and the diaphragm to the flat end of *Neopiloceras*, a new genus which will be described shortly in another paper.

The tabulae in *Multicameroceras* and the siphuncular bulbs in *Multicameroceras* and *Sinoeremoceras* are entirely new things, but if we may rely on similarities the partition in *Chihlioceras* may have some analogy to the tabulae in that genus.

To the siphuncular bulb the nummuli of actinoceroids and nepionic bulb of *Proterocameroceras* seem to have apparent resemblances, but for the time being, these are of course no more than tentative comparisons. It is also an important fact that except for *Volborthella tenius* and a few old species, the Wanwanian and Ozarkian cephalopods are at present the oldest representatives of primitive nautilian groups, although they show already moderately advanced forms with complicated structural elements; in other words, represent various nuclei which have the possibility of improving into the structural elements found in the later groups of cephalopods.

ii) ***Taxonomic value of the siphuncular and septal structures:—***

In former times the general form and involution of conch were considered to be most important criteria for the classification of Nautiloidea. Barrande was the first to call special attention to the form of the aperture, the direction of the septal neck, and the structure of the siphuncle, but special emphasis was given by the revolutionary work of Hyatt to the septal neck and the structure of the siphuncle. In the year 1883 he[1] proposed to classify the Nautiloidea into the Holochoanoidea and the Ellipochoanoidea, but in 1896 he[2] modified this taxonomic scheme in the following way:

Order Nautiloidea Zittel.
- Suborder A. Holochoanites Hyatt.
  1. Diphragmida Hyatt.
  2. Endoceratida Hyatt.
- Suborder B. Mixochanites Hyatt.
- Suborder C. Schistochoanites Hyatt.
- Suborder D. Orthochoanites Hyatt.
- Suborder E. Cyrtochoanites Hyatt.
  1. Annulosiphonata.
  2. Actinosiphonata.

1) Hyatt (1884), Genera of Fossil Cephalopods.
2) Hyatt (1896), Cephalopoda in Zittel-Eastman's Text-Book of Palaeontology.

Since then many students of the Nautiloidea supporting his ideas, attempted to revise and complete his classification. I also followed Hyatt's classification in my previous works, but now I am astonished to find that the length and the direction of the septal funnel, which were considered of the first importance in Hyatt's classification, are of no more than specific value in the forms described, above since the septal funnel changes from Cyrtochoanitic to Holochoanitic, or the reverse, in a single specimen.

Furthermore in one specimen there is no regularity in the change of the septel funnal, for which reason the specified criteria have no effect on the classification and phylogeny of Ellesmereoceroids.

iii) ***Structure of the siphuncle.***

Most students of the Nautiloidea hold the opinion that the siphuncles of Holochoanites are homologous to those of Orthocoanites, but a new idea was established independently by Grabau[1] and Daqué,[2] according to whom the siphuncle of Holochoanites is comparable to the whole conch of Orthochoanities ; consequently the endosiphuncle of the former corresponds to the siphuncle of the latter.

But, as described above, holochoanitic, orthochoanitic and cyrtochoanitic siphuncles are not entirely different from one another and the siphuncles of Ellesmereoceroids have various nuclei, possessing the possibility of developing into many structural elements in the later forms. It is especially noticeable that the pseudodiaphragm has close relationship with the endosheaths, if the siphuncular lining corresponds to the endosipholining of Holochoanitic genera. In this consideration the writer finds it difficult to accept the new idea proposed by Grabau and Daqué.

iv) ***Characteristics of the Wanwanian cephalopods.***

As discussed in the preceding chapters, the Wanwanian cephalopods raise difficult questions as to the value of Hyatt's taxonomic criteria of the Nautiloids, but at present there is nothing better than his classification. But a more natural classification should be established, in connection with which should be considered certain characteristics common in the Wanwanian cephalopod genera :—

---

1) Grabau (1919), Relation of the Holochoanites and the Orthochoanites to the Protochoanites and the significance of the Bactritidea (Bull. Geol. Soc. Am. 30); (1922) Ordovician fossils from North China, pp. 53-63; (1929), Terms for the shell-elements in the Holochoanites, (Bull. Geol. Soc. China, Vol. VIII, No. 2.)

2) Daqué (1921), Vergleichende biologische Formenkunde der fossilen niederen Tiere, Berlin.

1) Orthoceracones and cyrtoceracones are common, but gyroceracones are rather few in the Wanwanian cephalopods. No nautilicone is known from that period at present.
2) Most conchs are laterally compressed in cross section, their forms being ovate or elliptical.
3) In most cases the siphuncle is located at, or near, the flatter margin, if the section of the conch is ovate and the siphuncle marginal. The subcentral siphuncle is rather rare in this period. If the conch curves, its siphuncle is chiefly endogastric.
4) The breadth of the siphuncle in reference to the conch is quite narrow in Ellesmereoceroids.
5) In most species, the camerae are approximate and crowded.
6) The diaphragm, pseudodiaphragm, tabulae and siphuncular bulb are known only in archaeic forms of cephalopods.

V. On the Ribeiridae, New Family.

i) *Historical review.*

The known genera of Ordovician ribeirioids are seven, viz. *Eopteria* Billings, *Euchasma* Billings, *Ischyrina* Billings, *Ozomia* Walcott, *Ribeirella* Schubert et Waagen, *Ribeiria* Sharpe and *Technophorus* Miller. Nearly all were first considered to be peculiar gastropods or pelecypods.

In describing *Ribeiria*, Sharpe[1] wrote as follows:

"Shell univalve, elongated, laterally compressed into the form of a *Pholas* or *Lithodomus*; open at both ends and along the pedal margin, with a thick transverse internal plate near the anterior extremity, behind which is a very large corrugated boss for the attachment of a muscle."

"This curious shell appears related to the family of Calyptræidæ, but it shows no trace of a spiral growth; as far as can be judged from the imperfect specimens seen, it is equilateral, and both the transverse internal plate and the muscular attachment are placed along the middle of the back of the shell; the external form may be described as a *Calyptræa* pressed together laterally till the sides nearly meet, leaving only a narrow opening for the foot of the animal."

1) Daniel Sharpe (1853), Description of New Species of Zoophyta and Mollusca, in Senhor Carlos Ribeiro's "On the Carboniferous and Silurian Formation of the neighbourhood of Bussaco in Protugal, Appendix B. (Quart. Jour. Geol. Soc. London, Vol. IX) p. 157.

Salter[1] first considered *Ribeiria* as a crustacean, writing as follows in the description of *Myocaris lutraria* :—

" *Ribeiria pholadiformis* Sharpe may very possibly be a crustacean of this group (*Myocaris*), with a remarkable thickened dorsal region and strong interior cervical ridge."

Billings[2] placed this genus in *Incerta sedis* and said,—" Just beneath the umbo, and in front of it there is a small aperture of a semicircular shape, which appears to be the entrance to a tubular passage running backwards over the transverse plate into the general cavity of the body," and " it (the aperture) served the function of a byssal orifice and these species were anchored by a byssus passing through the beak."

In the same volume he erected *Eopteria* and *Euchasma*, taking *Eopteria typica* and *Euchasma blumenbachia* as their genotypes respectively. The latter species was previously described by him as *Concardium blumenbachium*, but in 1865 he distinguished it from *Conocardium* by stating," that genus (*Conocardium*) has not the two large posterior teeth (?) possessed by this shell,"[4] also that *Eopteria* is in general form "precisely like that of *Pterinea*, except that both valves are equally convex, and the hinge appears to have an external ligament like that of *Unio*."[5] Billings was of opinion that *Eopteria* and *Euchasma* are not so much different from each other, since the latter differs only " externally in having one extremity flat " and " this may not be sufficient to separate the genera and should it hereafter turn out that the internal structure is the same in all the species, I beg that the name *Euchasma* be retained for the group and *Eopteria* withdrawn from science."[6]

In the next year he[7] erected a new genus *Ischyrinia* taking *Ischyrinia winchelli* as the genotype. This genus has " two strong ridges radiating from the beak in the interior of each valve." Billings placed all these genera in the Pelecypoda.

---

1) J.W. Salter (1884), On some points in Ancient Physical Geography, illustrated by fossils from a Pebble-Bed at Budligh Salterton, Devonshire. (Geol. Mag. Vol. I) p. 12.

2) E. Billings (1865), Paleozoic Fossils, Vol. I. (Geol. Survey Canada,) p. 339.

3) E. Billing (1859), Fossils of the Calciferous Sandrock including those of a deposit of white limestone at Mingan, supposed to belong to the formation, (Canadian Naturalist and Geologist and Proceedings of the Natural History Society of Montreal, Vol. IV,) p. 350.

4) Billing (1865), Op. cit. p. 361.

5) Billings (1865), Op. cit. p. 221.

6) Billings (1865), Op. cit. p. 361.

7) E. Billings (1866), Catalogue of the Silurian Fossils of the Island Anticosti. (Geol. Surv. Canada.)

Miller[1] placed *Eopteria* and *Euchasma*, in the family *Ambonychidae* and *Ischyrinia* in the *Trigonidae*. Afterward he[2] erected a new genus *Technophorus* taking *T. faberi* for the genotype. In regard to these peculiar genera he then modified the plan of classification as follows :—

Order Siphonida.

Family Eopteriidae. *Eopteria, Euchasma.*
Family Technophoridae. *Technophorus.*
Family Trigoniidae. *Ischyrinia ?*

In describing several new species of *Technophorus*, Ulrich considered that it might be a peculiar form of pelecypod, even though *Technophorus* differs " more or less decidely from all known Paleozoic representatives of the class, with the possible exception of *Ischyrinia* Billings."[3] He also pointed out the internal resemblance between *Technophorus* and *Ischyrinia* and added that Billings' *Ischyrinia plicata* may belong to *Technophorus*.

In regard to *Ribeiria*, authors continued to discuss its proper position, some regarding it as a gastropod, others as a pelecypod or a crustacean. Woodward[4] placed *Ribeiria* in the *Anatinidae*, taking the anterior notch for a cartilage plate as in *Lynosia ?* Miller, however, placed it in *Incerta sedis* in the subkingdom Protista.[5] Zittel[6] put *Ribeiria* with *Myocaris* Salter in Phyllocaridae in his " Handbuch der Paläontologie." Whitfield supported this opinion and said " I think there can be no question about their relationship to the Ceratiocaridae (or Phyllocaridae, if we adopt Prof. Packard's new name.)"[7]

In the first edition of Zittel-Eastman's Text-Book of Palaeontology, Kingsley and Clark[8] placed *Ribeiria* provisionally in the Hymenocaridae of the Phyllopoda Packard with the statement, " There is no satisfactory

1) S. A. Miller (1877), American Paleozoic Fossils Catalogue, Cincinnati, Ohio.

2) S. A. Miller (1889), North American Geology and Palaeontology. Cincinnati, Ohio.

3) E. O. Ulrich (1897), The lower Silurian Lamellibranchiata of Minnesota. (Geology of Minnesota, Vol. III, Pt. 2,) p. 613.

4) S. P. Woodward (1875), Manual of Mollusca.

5) S. A. Miller (1877), Op. cit.

6) Karl. A. von Zittel (1881), Handbuch der Paläontologie.

7) R. P. Whitfield (1886), Notice of geological investigations along the Eastern shore of Lake Champlain, conducted by Prof H. M. Seely and Prest. Ezra Brainerd, of Middlebury College, with descriptions of the new fossils discovered. (Bull. of the American Museum of Natural History, Art. XVII.)

8) Karl, A. von Zittel and Ch. R. Eastman (1896), Text-Book of Palaeontology, 1st Edition.

evidence of their crustacean nature." Cleland[1] again put the genus in the Pelecypoda.

In 1903 Schubert and Waagen[2] published an important article on *Ribeiria* in which they discussed thoroughly the systemmatic position of the genus. Formerly *Ribeiria* was grouped in the Gastropoda or Lamellibranchiata, but they stated that there was no good reason to keep it in the gastropods and its dorsal curvature is quite different from that of Lamellibranchiata, that is to say, it is not a bivalve but a univalved shell. In comparing it with *Apus conicirformis*, they also said that *Ribeiria* is safely placed with the *Apodidae* of the *Phyllocaridae*. Although the shell of *Ribeiria* has a stronger curve than that of *Apus*, it has close affinity to *Apus* in internal structure. Quoting, "Der vordere Oberrand der Schalen schlitz-förmigen Oeffnung, die von älteren Forschern als Austrittstelle des Fusses gedeutet, von anderen zu einem Byssusrohre in Beziehung gesetzt wurde, ist daher nichts anderes als die vordere Unterrand der gegenwärtig seitlich zusammengepressten Schalen von *Ribeiria*."[3] They also erected a new genus, *Ribeirella* taking *R. sharpei* (Barrande) as the genotype.

Grabau and Shimer[4] placed *Ribeiria*, next to *Stenotheca* Salter, in the Phyllopoda. Bassler[5] was the first to place *Eopteria, Euchasma, Ribeirella, Ribeiria* and *Technophorus* in the Notostraca of Eucrustacea.

To sum up this long discussion, *Ribeiria* and *Ribeirella*, together with *Apus*, appear to belong to the Notostraca Sars and in the later edition from Zittel-Eastman's Text-Book of Palaeontology[6] *Euchasma, Eopteria, Ischyrinia* and *Technophorus* are also placed in the same order. The reference of the latter four genera to the Notostraca is, however, tentative, for in the new edition of Zittel-Broili's Grundzüge der Paläontologie we read :—

"Unsicher in ihrer systematischen Stellung sind *Ribeiria* Sharpe und *Ribeirella* Schub. und Waagen aus den unteren Silur Europas und

---

1) H. F. Cleland (1900), The Calciferous of the Mohawk Valley. (Bull. American Palaeontology, Vol. 3, No. 13).

2) Richard Johann Schubert & Lukas Waagen (1903), Die untersilurischen Phyllopodengattungen *Ribeiria* Sharpe und *Ribeirella* nov. gen. (Jahrbuch k.k. Geol. Reichsanstalt, Bd. LIII.)

3) Schubert & Waagen (1913), Op. cit. p. 38.

4) A. W. Grabau & H. W. Shimer (1910), North American Index Fossils, Vol. II, Invertebrate.

5) Ray S. Bassler (1915), Bibliographic Index of American Ordovician and Silurian Fossils. (U.S. National Museum, Bull. 92,) p. 1425.

6) Zittel-Eastmann's Text-Book of Palaeontology, (1913)

Nordamerikas,[1] but nothing is mentioned of the American genera,—*Euchasma, Eopteria, Ischyrinia* and *Technophorus.*

A few years ago Walcott[2] erected the new genus *Ozomia,* based upon *O. lucan* from the Mons formation and placed it in the family Technophoridae Miller, but this form is likely synonymous with *Ribeiria.*

ii) ***Taxonomic position of Ribeiridae, new family.***

The ribierioids have such a close resemblance to the pelecypods in general form and surface marking that they were usually referred to them. For instance *Eopteria* and *Euchasma* are much like *Pterinea* and *Conocardium,* but there must remain considerable question as to whether this resemblance bears any phylogenetical meaning. In my opinion, it is rather possible that this similarity is due to an adaptation that amounts merely to a homoeomorphic resemblance, because the ribeirioids have no internal characters common to the pelecypods; thus they have no teeth, adductor scars, pallial lines or ligaments. One thing only is found common to both, the clavicle, very common and important in the ribeirioids, but rare in the pelecypods occurring only in such genera as *Nuculites* and *Cleidophorus* where there is a clavicle in front of the umbo. More important differences lie in the symmetry and the number of the valves. All of the pelecypods consist of two separate valves, having unlike structure, whereas the ribeirioids have single carapaces folded along a dorsal line which in most cases becomes a plane of true symmetry.

Pseudoeuchasma and *Pseudotechnophorus* have no true plane of of symmetry, but still in these genera the internal structure of both sides are the same, as the lack of symmetry does not arise from internal differences, but is due solely to twisting of the carapace.

However the ribeirioids are quite distinct from all other crustaceans in this respect, and therefore, I believe it is fitting to group them in a new family, Ribeiridae, and place them only provisionally in the Notostraca. And it should be added that there is considerable possibility that the Ribeiridae should be separated from Notostraca (s. str.) and placed in an independent and new order.

The Ribeiridae therefore, contain those forms which have a single carapace with one or two clavicles and with carapaces usually quite similar in general form and surface ornaments to the shells of pelecypods. To the seven previously described genera are added seven new

1) K. A. v. Zittel & F. Broili (1924), Grudzüge der Paläontologie, p. 627.

2) Ch. D. Walcott (1924), Cambrian and Ozarkian Brachiopoda, Ozarkian Cephalopoda and Notostraca. (Smithsonian Miscellaneous Collections, Vol 67, No. 9)

genera, namely *Wanwanella, Wanwania, Wanwanoidea, Euchasmella, Eoischyrina, Pseudoeuchasma,* and *Pseudotechnophorus.* Contrary to the difficulty of tracing the taxonomic relation of these to other crustacean groups, it is rather easy to ascertain the mutual relations of these fourteen genera and these will be discussed in the following chapter.

iii) ***Classification.***

As far as I know, seven genera and thirty species of Ordovician ribeirioids have been described, but no one has yet pointed out their mutual relations. As previously stated, I collected many ribeirioids from the Upper Cambrian in the Wuhutzui Basin at the neck of the Liaotung Peninsula[1], from the Wanwanian series of the Niuhsintai Basin in South Manchuria[2] and the Wolungian Shorin Bed of North Korea[3]. These materials are not only interesting for the new occurrences of this group in eastern Asia, but are also important for the taxonomy of the group among which are contained various forms, some intermediate and some very specialized.

Terminology:—In this group it is not difficult to distinguish dorsal and ventral sides of the carapace, because the carapace, ususally like a bivalve shell, gapes on the ventral side, but it is rather difficult to decided, which is the anterior, or the posterior end, for no impressions of these animals themselves have been discovered. However, if Schubert and Waagen's interpretation is right[4], a clavicle exists just in front of the umbo in some genera, such as *Ribeiria* and *Ribeirella.* The umbo is, if not central, located usually on the anterior side. Billings[5] was inclined to take the flat side for the posterior one in *Euchasma,* but there is no sound reason that the flat side should be either anterior or the posterior side. Though provisional, it is more convinient for the sake of comparison to take this side for the anterior end, as there is a clavicle here. More difficulty is found in the groups with double clavicles,—such as *Ischyrinia* and *Technophorus.* One side with furrows and ridges is taken for the anterior by Billings[6], but for the posterior by Ulrich[7]. In these group, as in the case of bivalves, the umbo lies usually closer to the anterior end than to the posterior end.

1) T. Kobayashi (1929–1930), On the Ordovicican Formations in South Manchuria and North Korea. (Jour. Geol. Soc. Tokyo, Vols. XXXVI–XXXVII.)
2) T. Kobayashi (1931) (Japan. Jour. Geol. Geogr. Vol. VIII.)
3) T. Kobayashi (1929–1930), Op. cit.; (1931), (Bull. Geol. Surv. Chosen (Korea), Vol. X, pt. 1.)
4) Schubert & Waagen (1903), Op. cit. pp. 36–41.
5) Billings (1865), Op. cit. p. 613.
6) Billings (1866), Op. cit. p. 16.
7) Ulrich (1897), Op. cit. p. 316.

These crustacean remains appear to have bilateral symmetry, but it is not always so, for in the specialized form belonging to the Ischyrinæ the posterior extremity is strongly curved to one side.

Criteria of Classification:—From a morphological point of view the carapace and their internal casts each show some sort of specialization, such as the outline, clavicle, surface and others. The outlines of the ribeirioids are various. *Ribeiria* and *Ribeirella* are elliptical, while *Euchasma* and *Wanwanella* are triangular to triangularly ovate. Special attention must be paid to the flatness in front of the umbo in *Euchasma*. In *Eopteria* the dorsal margin is nearly straight with prominent wings on both extremities. Some genera, such as *Ribeiria*, *Ribeirella*, and *Wanwanella* have nearly smooth surfaces except for faint concentric or radial striae, while in the other genera, such as *Eopteria*, *Ischyrinia* and *Euchasma*, strong or moderate ribs are developed.

More important is the number of clavicles. One group has a single clavicle whereas the other double.

Proposed Classification:—Based upon these criteria the following plan of classification is suggested, to increase the convenience of tracing the phylogenetical relation particularly from a stratigraphic standpoint.

Family RIBEIRIDAE, new family.

Subfamily RIBEIRINAE, new subfamily.

Carapace with a single clavicle.

Group of *Wanwania.*

1. *Wanwania*, new genus. (*W. cambrica*, new species.)
   Carapace moderately convex, ovately triangular in outline with a straight dorsal margin; umbo terminal; clavicle just below the umbo; surface smooth.
2. *Wanwanella*, new genus. (*W. striata*, new species.)
   Carapace subcircular to ovate, moderately convex, umbo central; extremities of dorsal margin tending to project into wings; surface smooth, or ornamented by numerous radial ribs.
3. *Wanwanoidea*, new genus. (*W. trigonalis*, new species.)
   Carapace triangular, convex, somewhat rhomboidal in lateral section; umbo terminal; clavicle just below the umbo; surface marked by several strong radial ribs.

Group of *Ribeiria*.

4. *Ribeiria* Sharpe. (*R. pholadiformis* Sharpe.)
Carapace elliptical, not so convex; umbo subterminal; clavicle in front of the umbo; surface nearly smooth except for faint concentric lines of growth.
5. *Ribeirella* Schubert and Waagen. (*R. sharpei* (Barrande)).
Carapace subtriangular with a semi-circular ventral margin; posterior end projecting into a triangle; umbo prominent, sharp, just behind which there lies a clavicle-like depression; clavicle just in front of the umbo, very strong, vertical, passing into a deep furrow, parallel to the ventral margin.

Group of *Euchasma*.

6. *Euchasma* Billings (*E. blumenbachia* (Billings)).
Carapace roundly triangular, inequilateral, strongly concave; anterior side flat and gaping the whole length; surface ornamented by strong radial ribs.
7. *Euchasmella*, new genus. (*E. multistriata*, new species.)
General form nearly same as that of *Euchasma*, but anterior clavicle stronger; surface marked by numerous weak radial striations.

Group of *Eopteria*.

8. *Eopteria* Billings. (*E. typica* Billings.)
Carapace moderately convex, transversely circular to obliquely ovate in outline with a wing on each side; umbo central to subterminal on the straight dorsal margin; surface smooth, or with weak radial ribs.

Subfamily ISCHYRINAE, new subfamily.

Carapace with double clavicles.

9. *Eoischyrina*, new genus. (*E. billingsi*, new species.)
Carapace convex, nearly equilateral, equivalve, subovate in outline; umbo arched; clavicle not so strong, long, or narrow as those of *Ischyrinia*; surface with weak radial ribs.
10. *Ischyrinia* Billings. (*I. winchelli* Billings.)
Carapace convex, elongate triangular, inequilateral, frontal end short and round; clavicles long and strong; surface marked by a number of radial ribs.

11. *Technophorus* Miller. (*T. faberi* Miller.)
Carapace compressed convex, inequilateral, subtriangular to subquadrate with a short round anterior end; umbonal ridge prominent, directed from the umbo toward the postero-ventral corner which marks off the posterior portion as a long triangular area; surface marked by concentric lines except the area where lines are arranged in an haphazard manner.

12. *Pseudotechnophorus*, new genus (*P. typicalis*, new species.)
Carapace compressed convex, elongate triangular, round except the umbo which is obtusely angular; inequivalve, postéro-ventral portion somewhat twisted to one side; clavicles strong; posterior clavicle long, marking off a long area on the postero-dorsal side in the form of an external ligament of the bivalve; surface marked by a number of radial ribs.

13. *Pseudoeuchasma*, new genus (*P. typica*, new species.)
Carapace convex, inequilateral; ventral margin semicircular in its anterior half and concave in its posterior half; posterior side flat, projecting into a sharp angle in a postero-ventral direction; anterior clavicle very weak; posterior clavicle heart-shaped, lying on both sides of the gap on the flat side.

iv) ***Phyllogenetical relations.***

Wanwania is considered to be the most primitive genus among the Ribeiridae which begins to appear in the Tsinania zone of the Upper Cambrian. *Wanwanella* and *Wanwanoidea* are derived from *Wanwania*. *Wanwanella* represent one trend of specialization in which the carapace tends to become somewhat equilateral wih a subcentral umbo and the surface ornamented by radial striae. *Wanwanoidea* represent another trend from the same stock in which the convexity of the carapace is much increased and the radial ribs are strengthened.

Ribeiria and *Ribeirella* are other persistent genera which have simple outlines with no radial ribs on the surface. These genera may have been derived from a common stock with *Wanwania* and survived for a rather long time in Ordovician.

Euchasma and *Euchasmella* represent still another trend of specialization. All of these genera have triangular outlines with flat sides in front of the umbones. Such a tendency begins already in *Wanwania* to some degrees, but the flatness on the anterior side is more pronounced among these genera. *Euchasmella* is quite equilateral in outline, while *Euchasma* is somewhat inequilateral. In respect to the ornamentation, the latter genus is, however, much more advanced and their relations in this matter are like these between *Wanwania* and *Wanwanoidea*.

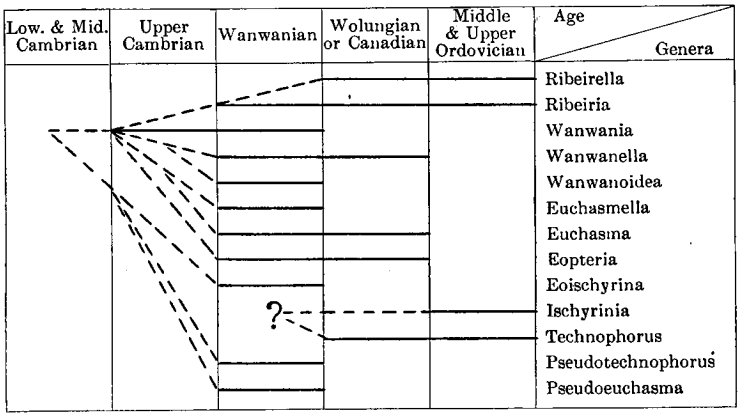
As noticed by Billings and Miller, *Euchasma* and *Eopteria* are closely related to each other. *Eopteria* surely represents another line of specialization which was likely derived from the common stock with *Euchasma*. *Euchasma eopteriformis* is intermediate in character between the two genera; its general form, flat frontal side and strong ribbing suggest its belonging to *Euchasma*, while its short frontal wing does not occur in any *Euchasma*. In spite of this variation this species, however, may really belong to *Euchasma*, though it shows a tendency towards transition to *Eopteria* in respect to its auriculation.

The forerunners of the subfamily Ischyrinae appear first in the Wanwanian period and are called *Eoischyrina*, *Pseudotechophorus* and *Pseudoeuchasma*. The general form of *Eoischyrina* is similar to that of *Wanwanella striata auriculata*, but it is entirely different in the presence of the double clavicles. In this genus these clavicles are not yet so improved as in *Ischyinia* and *Technophorus*, and also its outline is by far different from those of the latter two genera. *Pseudoeuchasma* is a peculiar and very specialized form. It has a lateral flattening like *Euchasma*, but its flattening is genetically different from that of *Euchasma*, since the flattening is located on the anterior side in *Euchasma*, while on the posterior in *Pseudoeuchasma*, and the forms of the clavicles and heart-shaped gaping on the flat sides in the two genera are entirely different from each other. What genus *Pseudoeuchasma* is derived from, is a question. So far as our present knowledge goes, *Eoischyrina* and *Pseudoeuchasma* are limited to the Wanwanian, whereas the latter two genera range in the middle and upper Ordovician, but as no representative of the subfamily has yet been reported from the Canadian or Wolungian, we therefore have to recognize that there is a missing link between *Eoischyrina* and the later members. I presume, if this link will be discovered, the transformation between the Wanwanian forms and the middle or later Ordovician forms may be more thoroughly explained.

Judging from the morphological characters, *Pseudotechnophorus* is a much specialized genus. It has very prominent clavicles, and well marked posterior area of a ligament-like shape and has no plane of symmetry. Though its general form apparently resembles that of *Technophorus*, this genus is not the direct ancester of *Technophorus*, but may be a branch from a common stock.

Based on the proposed classification and phyllogeny, the tentative genealogical tree or "Stammbaum" of the Ribeiridae may be drawn as below:—

Table showing the genealogical tree of the Ribeiridae.



v) ***Geological and geographical distribution :—***

The proposed classification and the "Stammbaum" are well supported by the geological distribution of the genera.

Table showing the geological and geographical distributions of the Ribeiridae.

Time / Region / Genera	Upper Cambrian			Wanwanian			Wolungian or Canadian			Middle and Upper Ordovician		
	EA.	NA.	E.	EA.	NA.	E.	EA.	NA.	E.	EA.	NA.	E.
Ribeirella												1
Ribeiria				2					2			3
Wanwania	1			2	1			8				
Wanwanella				3			1					
Wanwanoidea				1								
Euchasma				1				1				
Euchasmella				1								
Eopteria				4	1			2				
Eoischyrina				1								
Ischyrinia											1	1
Technophorus								6			6	
Pesudotechnophorus				1								
Pseudoeuchasma				1								

Note 1. Number in this table shows the number of the species.
Note 2. Breviations: EA. Eastern Asia; NA. North America; E. Europe.

As shown in the above table, the Ribeiridae appeared first in the Upper Cambrian in the Far East and reached its acme in *Wanwania*, *Euchasma* and *Eopteria* of the succeeding Wanwanian period. From that time these genera begin to migrate from Eastern Asia to North America. *Ribeiria lucan* (Walcott) is widely distributed in the Mons formation of the Cordilleran trough. Several species of *Eopteria* and *Euchasma* are found in the Canadian and later, in central and eastern North America. In Eastern Asia the ribeirioids decline in the Wolungian, when only one species of *Wanwanella* in the Shorin Bed of the North Korea is known as a remnant. *Ribeiria* continued to migrate in the same direction and reached western and central Europe in the early Ordovician. *Ischyrinia* and *Technophorus* may have followed a similar route of migration. *Eoischyrina* appears in the Wanwanian of Far East, while *Technophorus* and *Ischyrinia* attain their acme after the Canadian, the former being very abundant in central North America and the latter on both sides of the Atlantic Ocean in Cincinnatian time.

We now have no data on the Ribeiridae of Arctic regions, but as brought out in my previous paper,[1] the Arctic faunas, as well as the North American faunas have close relationship to that of the Tsinania Basin,[2] for which reason we may possibly expect important information from the Arctic with regard to the development of Ribeiridae which will also perhaps throw some light on the route of migration. So far as present knowledge is concerned, however, the Ribeiridae apparently appeared first in Eastern Asia, then migrated toward the east and reached to central and northern Europe as well as central and eastern portion of North America through the Cordilleran trough disappearing finally in the Atlantic region in the Cincinnatian period.

Postscript.

I) Upon examining the type of *Ribeiria ventricosa* at the American Museum of Natural History, made available to me through the courtesy of Dr. C. A. Reeds, I found out that this species is quite distinct from *Ribeiria* in the following respects which suggest its reference to *Eopteria* :—1) The general form is much similar to *Eopteria* except for a little round dorsal margin. 2) A rouud, elevated tubercle is situated between the umbones. 3) Tne anterior clavicle is not so distinct as that of *Ribeiria*, and 4) Several transverse pits are strongly impressed on the cast along the anterior margin.

II) The genera *Proplina* and *Ectenoceras* are to be accredited to Ulrich and Foerste and Ulrich and Bridge respectively, having been adopted from their manuscripts with their concent. The genotype of *Ectenoceras* has been selected by the authors to be *Ectenoceras pergracilis*, new species.

1) T. Kobayashi (1929-30), Op. cit; (1931), Op. cit.
2) T. Kobayashi (1930), Op. cit. (Proc. Imp. Acad., VI, 10).

List of the Wanwanian Fauna.

Wanwanian Fauna	Wanwankou limestone	Wanwankou dolomite	Chiushukou shale	Hsia pin g-chou dolomite	Description(p.)	Illustration
Brachiopoda.						
1. Lingulella liui.			×			
2. Huenella wanwanensis.		×			259	VI, 11, 12.
Gastropoda.						
3. Helicotoma wanwanensis.		×			260	V, 3.
4. Matherella walcotti.		×			261	IV, 7; V, 9.
5. Clisospira niuhsintaiensis.		×			262	IV, 6.
6. Archinacella wanwanensis.		×			263	IV, 3.
7. Proplina bridgei.		×			263	V, 2.
8. Proplina ampla.		×			264	IV, 2; V, 4.
9. Proplina (?) sp.		×			265	V, 1.
10. Scenella sp. undt.		×			265	IV, 8.
11. Stenotheca (?) manchurica.		×			265	V, 6.
12. Scaevogyra ulrichi.		×			265	V, 5, 7.
13. Scaevogyra naticaformis.		×			267	V, 8.
Cephalopoda.						
14. Ellesmereoceras elongatum.	×	×				I, 4, 7.
15. Ellesmereoceras subcirculare.	×	×				I, 3, 5.
16. Ellesmereoceras foerstei.		×			268	I, 1, 11.
17. Ellesmereoceras abruptum.		×			269	I, 2, 8.
18. Ectenoceras curvatum.	×	×			270	II, 1, 13.
19. Ectenoceras subcurvatum.		×			270	I, 9.
20. Ectenoceras ruedemanni.		×			270	II, 5, 11.
21. Wanwanoceras peculiare.		×			271, 302.	I, 6, 10; II, 12; IV, 9.
22. Burenoceras (?) reticulatum.		×			272	II, 2, 3, 4.
23. Sinoeremoceras wanwanense.		×			305	II, 6, 7, 9, 10; III, 2, 5.
24. Multicameroceras multicameratum.	×	×			274, 303.	II, 8; III, 1, 3; IV, 1.
25. Multicameroceras cylindricum.		×			274	II, 14; IV, 5,
26. Wolungoceras chiushuense.	×				275	III, 4.
27. Clarkoceras poulseni.	×					
28. Cyrtendoceras holmi.	×				276	IV, 10.
29. Proterocameroceras mathieui.				×		

Wanwanian Fauna	Wanwankou limestone	Wanwankou dolomite	Chiushukou shale	Hsiaping-chou dolomite	Description	Illustration
Trilobita.						
30. Agnostus chiushuense.			×			
31. Koldinioidia typicalis.			×			
32. Prosaukia argutula.			×			
33. Calvinella walcotti.		×				
34. Calvinella bella.			×			
35. Tellerina chinhsiensis.			×			
36. Tellerina suni.			×			
37. Kingstonia semicircularis.		×			278	VI, 7, 8.
38. Kingstonia convexa.		×			278	VI, 9, 10.
39. Kingstonia humilis.		×			279	VI, 1.
40. Stenopilus convexus.		×			279	VI, 4.
41. Plethopeltis orientalis.		×			280	VI, 5.
42. Plethopeltis resseri.		×			280	VI, 6.
43. Platycolpus (?) granulatus.		×			281	VI, 2, 3.
Ribeiridae.						
44. Wanwania ambonychiformis.		×			283	VII, 4.
45. Wanwania compressa.		×			284	VII, 5.
46. Wanwanella striata.		×			285	VII, 7; IX, 6.
47. Wanwanella striata auriculata.		×			285	VII, 6.
48. Wanwanella wanwanensis.		×			286	VII, 8.
49. Wanwanella tumida.		×			287	VII, 10.
50. Wanwanoidea trigonalis.		×			288	IX, 3.
51. Wanwanoidea trigonalis delicata.		×			288	VIII, 6.
52. Ribeiria manchurica.		×			291	IX, 5.
53. Ribeiria manchurica pennata.		×			291	IX, 4.
54. Ribeiria basaleri.		×			292	IV, 4.
55. Euchasma eopteriformis.		×			293	VIII, 4.
56. Euchasmella multistriata.		×			294	VIII, 5.
57. Eopteria asiatica.		×			296	VIII, 2.
58. Eopteria alta.		×			296	VIII, 7.
59. Eopteria obsolata.		×			297	VIII, 3.
60. Eopteria flora.		×			297	VIII, 1.
61. Eoischyrina billingsi.		×			298	VII, 9.
62. Pseudotechnophorus typicalis.		×			301	VIII, 8; IX, 1, 8.
63. Pseudoeuchasma typica.		×			302	IX, 10.

Explanation of Plates.

Plate I. Wanwanian Cephalopoda.

Ellesmereoceras foerstei, new species. . . . . p. 268

PM1259 — Figure 1. (×1) 1a) Antisiphonal view; 1b) Side view; 1c) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM1258 — Figure 11. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

Ellesmereoceras abruptum, new species. . . . . p. 269

PM1259 — Figure 2. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

PM1260 — Figure 8. (×1½) Weathered surface. Wanwankou dolomite, Wan-wan-kou.

Ellesmereoceras subcirculare Kobayashi. . . . . p. 268

PM1255 — Figure 3. (×1½) 3a) Side view; 3b) Basal view. Wanwankou limestone proper, Chiu-shu-kou.

PM1256 — Figure 5. (×1½) Side view. Wanwankou limestone proper, Chiu-shu-kou.

Ellesmereoceras elongatum Kobayashi. . . . . p. 267

PM1253 — Figure 4. (×1½) 4a) Side view; 4b) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM1256 — Figure 7. (×1½) Siphonal view. Wanwankou dolomite, Wan-wan-kou.

Wanwanoceras peculiare, new species. . . . . p. 271

PM1266 — Figure 6. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

PM1267 — Figure 10. (1½) Side view. Wanwankou dolomite, Wanwankou.

Ectenoceras subcurvatum, new species. . . . . p. 270

PM1263 Figure 9. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

Plate II. Wanwanian Cephalopoda.

PM1261 *Ectenoceras curvatum* (Kobayashi) . . . . . p. 270

PM1262 — Figure 1. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

PM1269-2 — Figure 13. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

PM1270-3, PM1271-4 *Burenoceras* (?) *reticulatum* new species. . . . . p. 272

Figures 2,3 and 4. (×1½) Side views. Wanwankou dolomite, Wan-wan-kou.

Ectenoceras ruedemanni new species. . . . . p. 270

PM1264 — Figure 5. (×3) 5a) Side view of the upper part; 5b) Basal view of the upper part; 5c) Upper view of the lower part; 5d) Side view of the lower part. Wanwankou dolomite, Wan-wan-kou.

PM1265 — Figure 11. (×3) 11a) Side view; 11b) Basal view. Wanwankou dolomite, Wan-wan-kou.

Sinoeremoceras wanwanense (Kobayashi). . . . . p. 305

PM1316 Figure 6. (×1½) 6a) Side view; 6b) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM1317-7 Figure 7. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

PM1318-9 Figures 9 and 10. (×1½) Side views. Wanwankou dolomite, Wan-wan-kou.

PM1319-10

PM272 *Multicameroceras multicameratum* (Kobayashi). . . . . p. 274
Figure 8. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

PM268 *Wanwanoceras peculiare* new species. . . . . p. 271
Figure 12. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

PM274 *Multicameroceras cylindricum* new species. . . . . p. 274
Figure 14. (×1½) Side view. Wanwankou dolomite, Wan-wan-kou.

Plate III. Wanwanian Cephalopoda.

PM273-1 *Multicameroceras multicameratum* (Kobayashi). . . . . p. 303
Figure 1. (×3) Polished longitudinal section. Wanwankou dolomite, Wan-wan-kou.

PM273-3 Figure 3. (×3) 3a) Polished longitudinal section slightly oblique to the dorsal-ventral direction; 3b) Polished transverse section. Wanwankou limestone proper at Chiu-shu-kou.

PM320-2 *Sinoeremoceras wanwanense* (Kobayashi). . . . . p. 305
Figure 2. (×3) Polished longitudinal section. Wanwankou dolomite, Wan-wan-kou.

PM318-5 Figure 5. (×3) Polished longitudinal section. Wanwankou dolomite, Wan-wan-kou.

Wolungoceras chiushuense new species. . . . . p. 275

PM276 Figure 4. (×3) Polished longitudinal section. Wanwankou limestone proper, Chiu-shu-kou.

Plate IV. Wanwanian Fauna.

PM273-1 *Multicameroceras multicameratum* (Kobayashi). . . . . p. 274
Figure 1. (×1½) 1a) Side view; 1b) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM245 *Proplina ampla*, new species. . . . . p. 264
Figure 2. (×1½) 2a) Frontal view; 2b) Upper view; 2c) Side view. Wanwankou dolomite, Wan-wan-kou.

PM243 *Archinacella wanwanensis*, new species. . . . . p. 263
Figure 3. (×1½) 3a) Frontal view; 3b) Upper view. Wanwankou dolomite, Wan-wan-kou.

PA304 *Ribeiria bassleri*, new species. . . . . p. 292
Figure 4. (×3) 4a) Umbonal view; 4a) Side view. Wanwankou dolomite, Wan-wan-kou.

Multicameroceras cylindricum, new species. . . . . p. 274

PM275 Figure 5. (×1½) 5a) Side view; 5b) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM242 *Clisospira niuhsintaiensis*, new species. . . . . p. 262
Figure 6. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

Matherella walcotti, new species. . . . . p. 261

PM240 Figure 7. (×3) 7a) Apical view; 7b) Side view. Wanwankou dolomite, Wan-wan-kou.

Scenella sp. undt. . . . . p. 265

PM248 Figure 8. (×3) Apical view. Wanwankou dolomite, Wan-wan-kou.

Wanwanoceras peculiare, new species. . . . . p. 302

PM267 Figure 9. (×3) Polished longitudinal section. Wanwankou dolomite, Wan-wan-kou.

Cyrtendoceras holmi, new species. . . . . p. 276

PM 277 Figure 10. (×1) Polished longitudinal section of the cephalopod with *Cryptozoon*. Wanwankou limestone proper, San-chia-tzu.

Plate V. Wanwanian Gastropoda.

Proplina (?) sp. . . . . p. 265

PM247 Figure 1. (×1½) 1a) Upper view; 1b) Side view. Wanwankou dolomite, Wan-wan-kou.

Proplina bridgei, new species. . . . . p. 263

PM244 Figure 2. (×1½) 2a) Frontal view; 2b) Side view; 2c) Upper view. Wanwankou dolomite, Wanwankou.

Helicotoma wanwanensis, new species. . . . . p. 260

PM239 Figure 3. (×1½) 3a) Side view; 3b) Upper view. Wanwankou dolomite, Wan-wan-kou.

Proplina ampla, new species. . . . . p. 264

PM246 Figure 4. (×1½) 4a) Fronatl view; 4b) Side view; 4c) Upper view. Wanwanku dolomite, Wan-wan-kou.

Scaevogyra ulrichi, new species. . . . . p. 266

PM250 Figure 5. (×1½) 5a) Side view; 5b) Apical view; 5c) Basal view. Wanwankou dolomite, Wan-wan-kou.

PM251 Figure 7. (×1½) 7a) Apical view; 7b) Side view. Wanwankou dolomite, Wan-wan-kou.

Stenotheca (?) *manchurica*, new species. . . . . p. 265

PM249 Figure 6. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

Scaevogyra naticaformis, new species. . . . . p. 267

PM252 Figure 8. (×1½) 8a) Apical view; 8b) Side view. Wanwankou dolomite, Wan-wan-kou.

Matherella walcotti, new species. . . . . p. 261

PM241 Figure 9. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

Plate VI. Wanwanian Trilobita and Brachiopoda.

Kingstonia humilis, new species. . . . . p. 279

PA282 Figure 1. (×3) 1a) Frontal view; 1b) Dorsal view; 1c) Side view. Wanwankou dolomite, Wan-wan-kou.

Platycolpus (?) *granulatus*, new species. . . . . p. 281

Figure 2. (×3) 2a) Frontal view; 2b) Dorsal view of the cranidium. Wanwankou dolomite, Wan-wan-kou.

Figure 3. (×3) Associated free cheek. Wanwankou dolomite, Wan-wan-kou.

Stenopilus convexus, new species. . . . . p. 279

Figure 4. (×3) Dorsal view. Wanwankou dolomite, Wan-wan-kou.

Plethopertis orientalis, new species. . . . . p. 280

Figure 5. (×1½) 5a) Dorsal view; 5b) Side view. Wanwankou dolomite, Wan-wan-kou.

Plethopertis resseri, new species. . . . . p. 280

Figure 6. (×1½) 6a) Side view; 6b) Dorsal view; Wanwankou dolomite, Wan-wan-kou.

Kingstonia semicircularis, new species. . . . . p. 278

Figure 7. (×3) Dorsal view of the cranidium. Wanwankou dolomite, Wan-wan-kou.

Figure 8. (×3) Dorsal view of the associated pygidium. Wanwankou dolomite, Wan-wan-kou.

Kingstonia convexa, new species. . . . . p. 278

Figure 9. (×3) Dorsal view. Wanwankou dolomite, Wan-wan-kou.

Figure 10. (×3) 10a) Frontal view; 10b) Dorsal view. Wanwankou dolomite, Wan-wan-kou.

Huenella (?) *wanwanensis*, new species. . . . . p. 259

Figure 11. (×1½) 11a) Top view; 11b) Side view. Wanwankou dolomite, Wan-wan-kou.

Figure 12, (×1½) 12a) Side view; 12b) Top view. Wanwankou dolomite, Wan-wan-kou.

Plate VII. Wanwanian Ribeirioids.

Wanwania cambrica, new species. . . . . p. 282

Figures 1–3. (×1½) 1a) Upper view; 1b) Lateral view; 2a) Upper view; 2b) Lateral view; 2c) Frontal view. 3a) Frontal view; 3b) Lateral view. Upper Cambrian of the Paichiashan hill, Wuhutsui Basin.

Wanwania ambonychiformis, new species. . . . . p. 283

Figure 4. (×1½) 4a) Upper view. 4b) Lateral view; 4c) Frontal view. Wanwankou dolomite, Wan-wan-kou.

Wanwania compressa, new species. . . . . p. 284

Figure 5. (×1½) 5a) Upper view; 5b) Frontal view; 5c) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella striata auriculata, new variety. . . . . p. 285

Figure 6. (×3) 6a) Lateral view; 6b) Umbonal view; 7) Posterior view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella striata, new species. . . . . p. 285

Figure 7. (×3) 7a) Side view; 7b) Posterior view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella wanwanensis, new species. . . . . p. 286
PA 297 Figure 8. (×1½) 8a) Side view; 8b) Frontal view. Wanwankou dolomite, Wan-wan-kou.

Eoischyrina billingsi, new species. . . . . p. 298
PA311 Figure 9. (×3) 9a) Umbonal view; 9b) Posterior view; 9c) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella tumida, new species. . . . . p. 287
PA299 Figure 10. (×3) 10a) Umbonal view; 10b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Plate VIII. Wanwanian Ribeirioids.

Eopteria flora, new species. . . . . p. 297
PA 310 Figure 1. (×1½) 1a) Umbonal view; 1b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Eopteria asiatica, new species. . . . . p. 296
PA 307 Figure 2. (×3) 2a) Umbonal view; 2b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Eopteria obsolata, new species. . . . . p. 297
PA309 Figure 3. (×1½) 3a) Umbonal view; 3b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Euchasma eopteriformis, new species. . . . . p. 293
PA305 Figure 4. (×1½) 4a) Umbonal view; 4b) Side view; 4c) Posterior view. Wanwankou dolomite, Wan-wan-kou.

Euchasmella multistriata, new species. . . . . p. 294
PA306 Figure 5. (×1½) 5a) Umbonal view; 5b) Side view; 5c) Frontal view. Wanwankou dolomite, Wan-wan-kou.

Wanwanoidea trigonalis delicata, new veriety. . . . . p. 288
PA301 Figure 6. (×3) Side view. Wanwankou dolomite, Wan-wan-kou.

Eopteria alta, new species. . . . . p. 296
PA308 Figure 7. (×1½) 7a) Umbonal view; 7b) Lateral view; 7c) Posterior view. Wanwankou dolomite, Wan-wan-kou.

Pseudotechnophorus typicalis, new species. . . . . p. 301
PA312 Figure 8. (×3) Lateral view. Wanwankou dolomite at Wan-wan-kou.

Plate IX. Wanwanian Ribeirioids.

PA313-1 *Pseudotechnophorus typicalis*, new species. . . . . p. 301
PA314-8 Figures 1 & 8. (×3) 1a) Umbonal view; 1b) Lateral view; 8) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella shorinensis, new species. . . . . p. 286
PA 298 Figure 2. (×1½) 12a) Umbonal view; 12b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Wanwanoidla trigonalis, new species. . . . . p. 288

PA300 Figure 3. (×3) 3a) Umbonal view; 3b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Ribeiria manchurica pennata, new variety. . . . . p. 291

(R) PA303 Figure 4. (×1½) 4a) Upper view; 4b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Ribeiria manchurica, new species. . . . . p. 291

PA302 Figure 5. (×1½) 5a) Upper view; 5b) Lateral view. Wanwankou dolomite, Wan-wan-kou.

Wanwanella striata, new species. . . . . p. 285

PA295 Figure 6. (×4) 6a) Umbonal view; 6b) Lateral view; 6c) Frontal view. Wanwankou dolomite, Wan-wan-kou.

PA290-7 *Wanwania cambrica*, new species. . . . . p. 282

PA291-9 Figures 7 & 9. (×3) Lateral views. Upper Cambrian, Paichiashan hill, Wuhutsui Basin.

Pseudoeuchasma typica, new species. . . . . p. 302

PA315 Figure 10. (×3) 10a) Posterior view; 10b) Lateral view; 10c) Anterior view. Wanwankou dolomite, Wan-wan-kou.

Plate X. Described Genotype Species of the Ribeiridae.

Fig 1. *Ribeiria pholadiformis* Sharpe. (From Q.J.G.S. Vol. IX, 1853, pl. IX, figs 17a–b) . . . . . p. 289

1a. Exterior; 1b. Interior cast, side view; 1c. Interior cast, dorsal view.

Fig 2–10. *Ribeirella sharpei* (Barr.) (From Jahrb. k.k. Geol. Reichsandst. LIII. Bd. 1903, Taf. I, fig. 12–20) . . . . . p. 292

2. The species from D4 at Zahoran; 3. from D 5 at Cross-Kuchel, interior cast ×3; 4–6, 7a, interior casts, side views; 7b. interior cast, dorsal view; 8, surface sculpture, magnified; 9 and 10 after Barrande-Perner.

Fig 11. *Euchasma blumenbachia* (Billings.) (From Billings' Paleozoic Fossils, Vol. I, 1861–65, p. 361, fig. 348.) . . . . . p. 293

11a. Side view of a small specimen; 11b. The flat anterior extremity showing the long narrow gap.

Fig. 12. *Eopteria richardsoni* Billing. (From Billings' Paleozoic Fossils, Vol. I, (1861–65), p. 306, fig. 298.) . . . . . p. 295

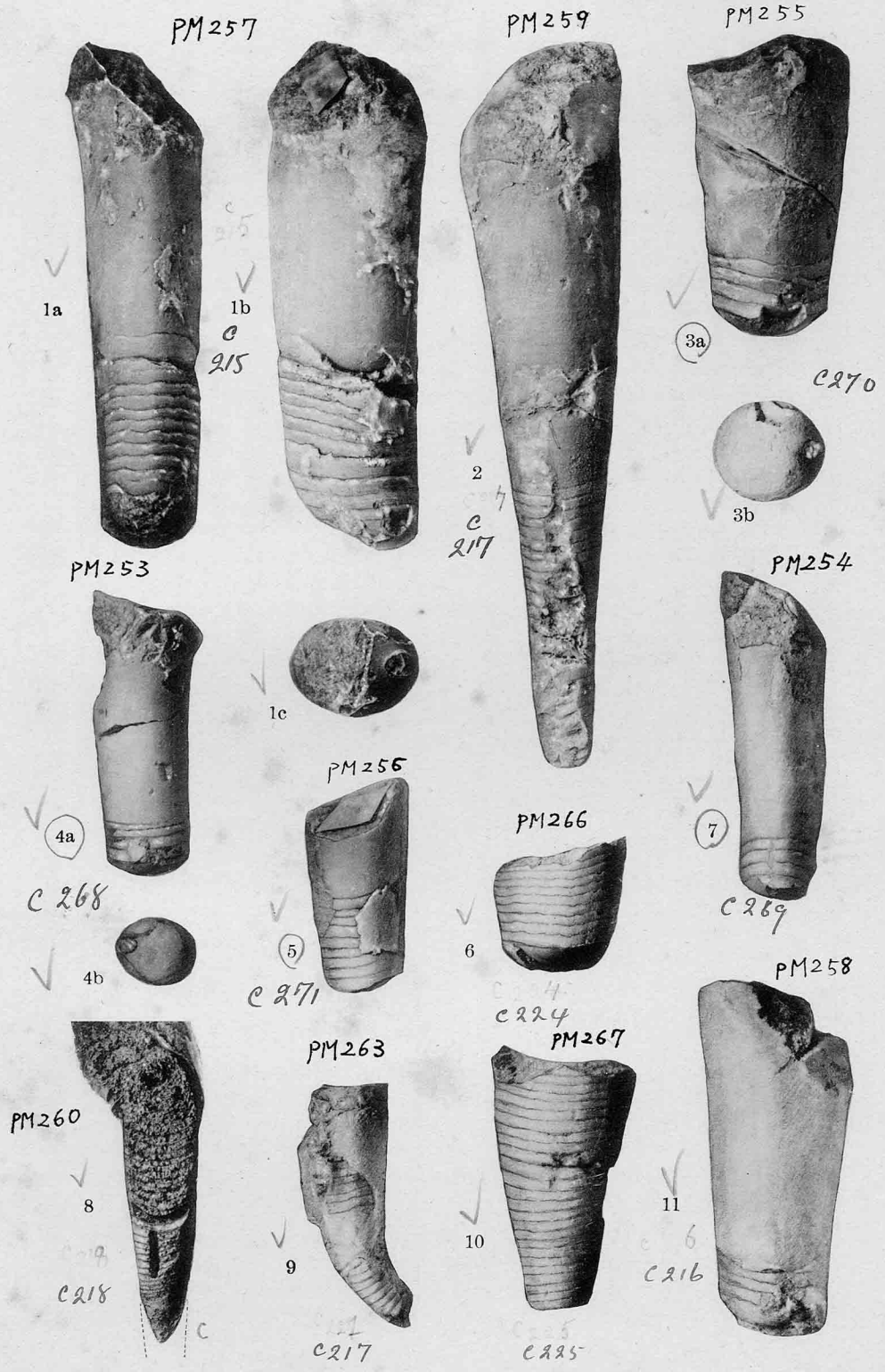
12a. Left valve; 12b. Cardinal view.

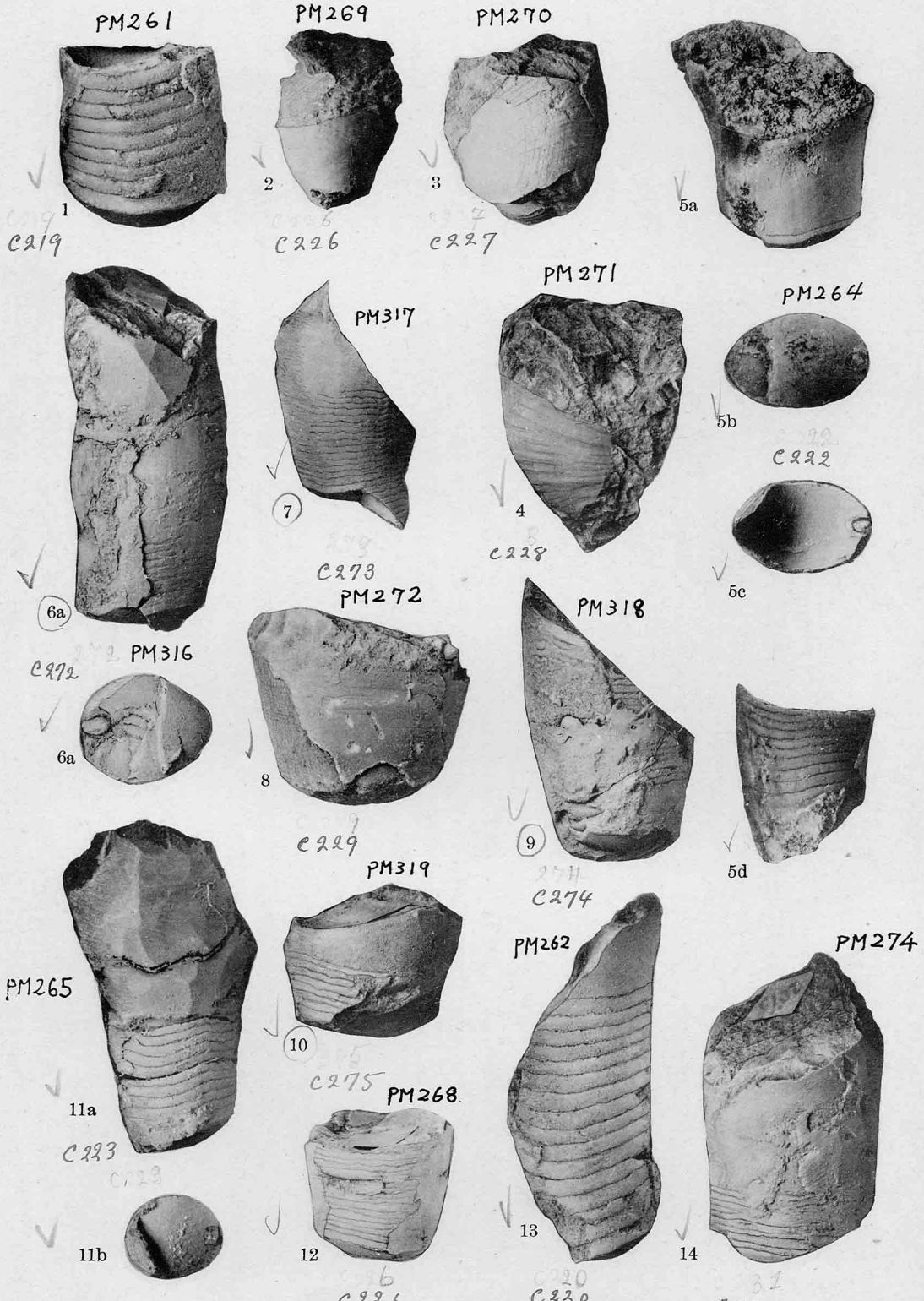
Fig. 13. *Ischyrinia winchelli* Billings. (From Billings' Cat. Sil. Fossil Anticosti, (1866), p. 16, fig. 4.) . . . . . p. 299

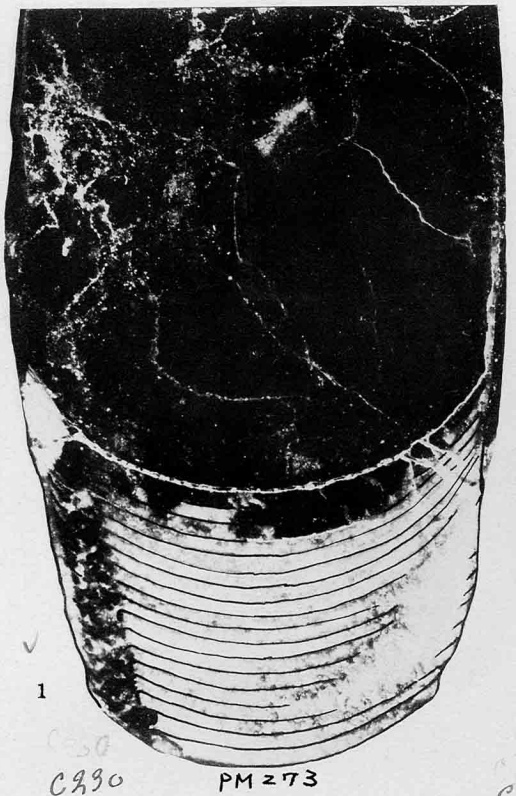
13a. Left side; 13b. Cast of the interior of left side; 13c. Cast of the interior of right side.

Fig 14. *Technophorus faberi* Miller. (From Millers N.S. Geol. and Palaeontol. (1889) p. 514, fig. 930.) . . . . . p. 299

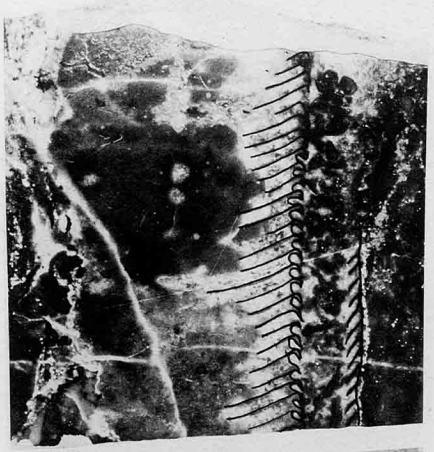
14a. Left side with a small piece broken from the posterior end; 14b. a well-preserved cast; 14c. dorsal view.

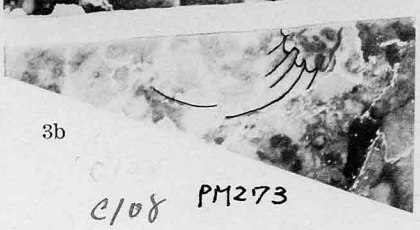

PM257
1a
1b
C 215
PM259
2
C 217
PM255
3a
C270
3b
PM253
4a
C 268
4b
1c
PM256
5
C 271
PM266
6
C224
PM254
7
C 269
PM260
8
C218
PM263
9
C217
PM267
10
C225
PM258
11
C216


PM261
PM269
PM270
1
2
3
5a
C219
C226
C227
PM271
PM317
PM264
5b
C222
7
4
C228
C273
6a
5c
PM272
PM318
PM316
C272
6a
8
9
5d
C229
C274
PM319
PM265
PM262
PM274
10
C275
PM268
11a
C223
13
14
11b
12
C226
C220
C231

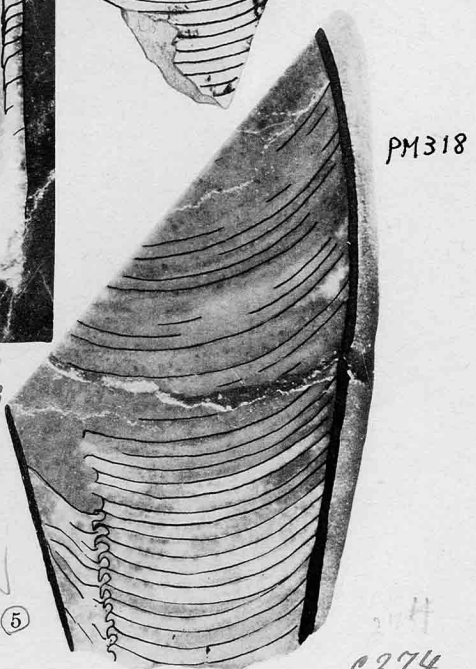

1
C230
PM273

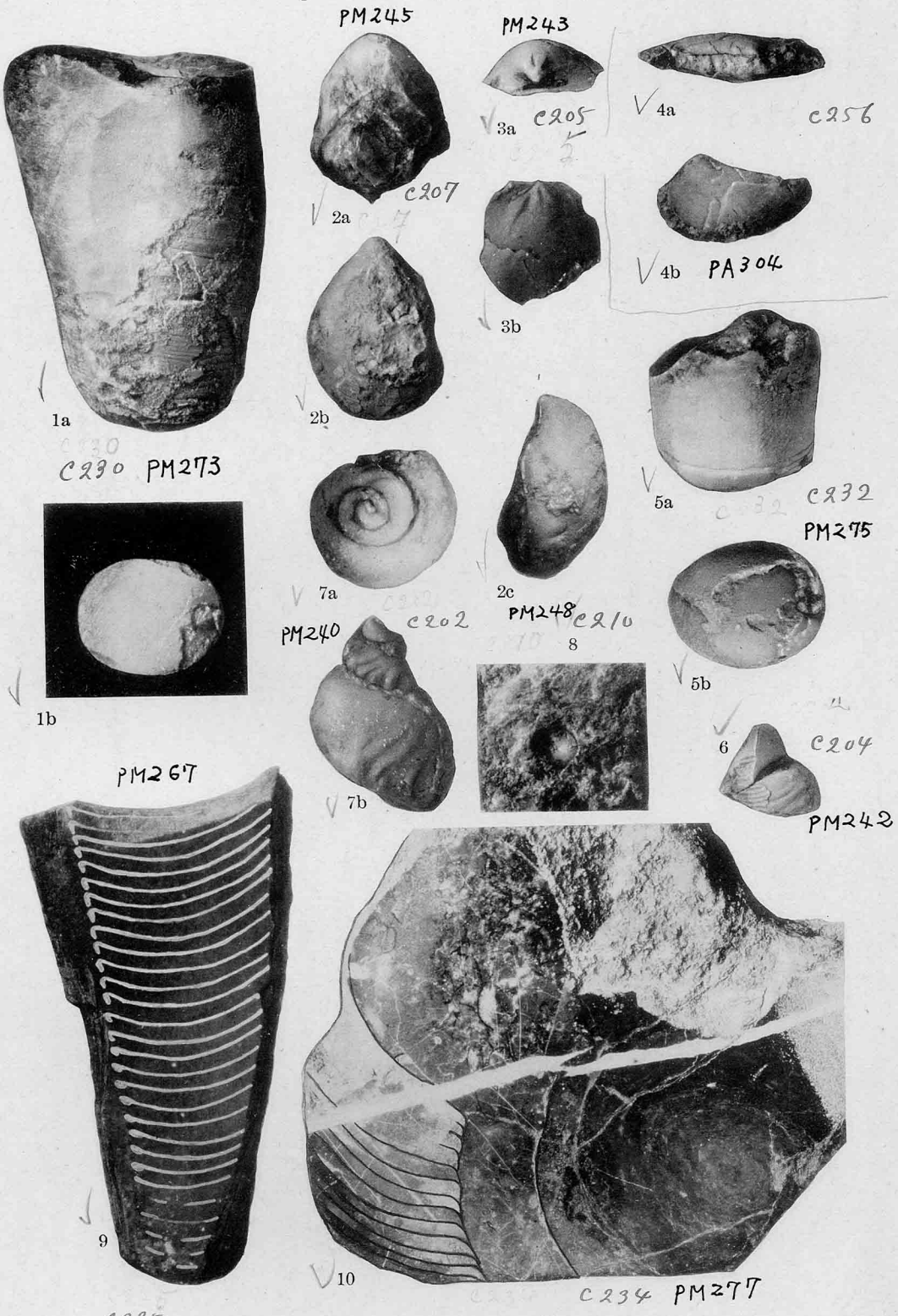

PM320
2

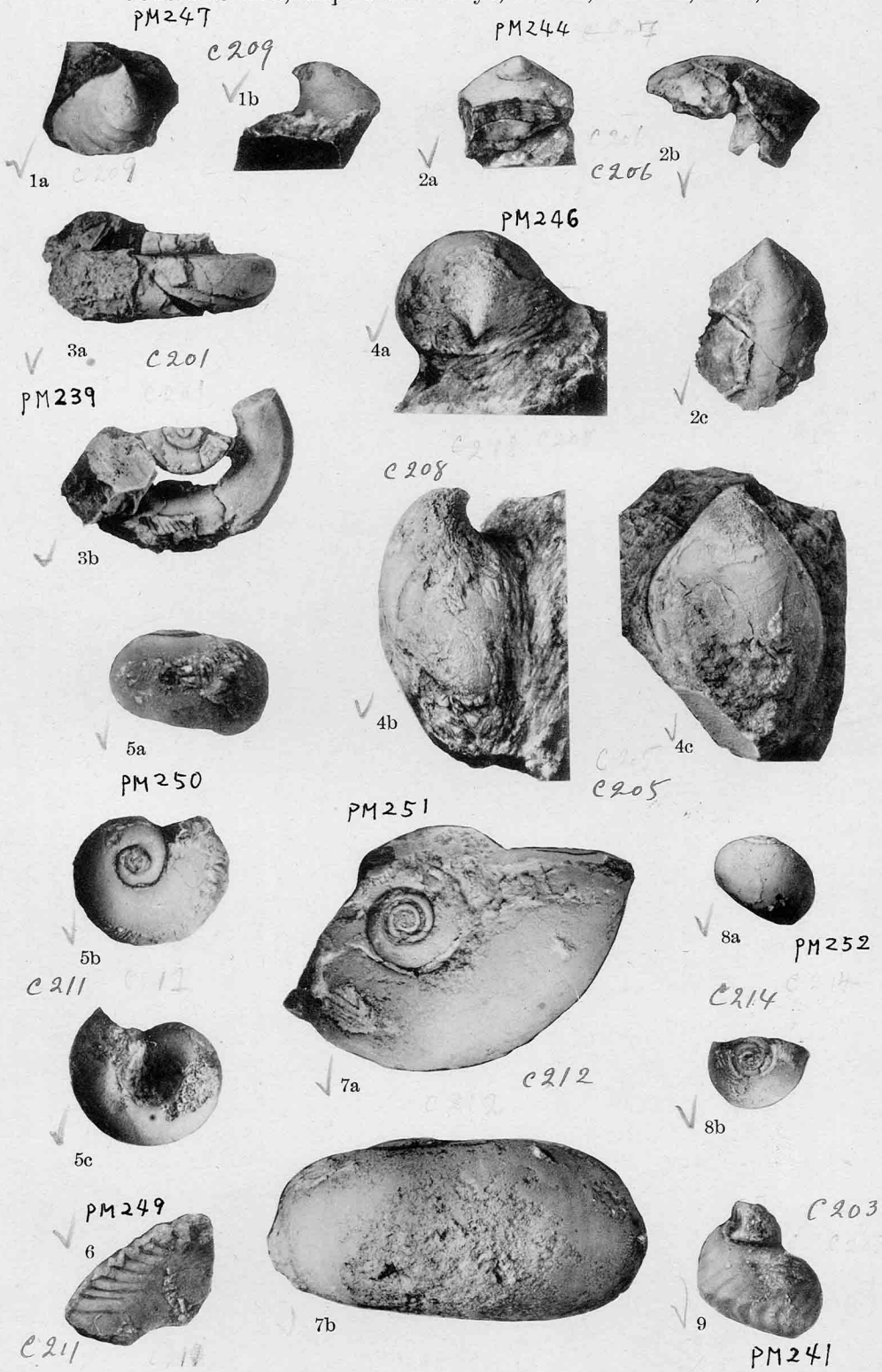

3a


3b
C108
PM273

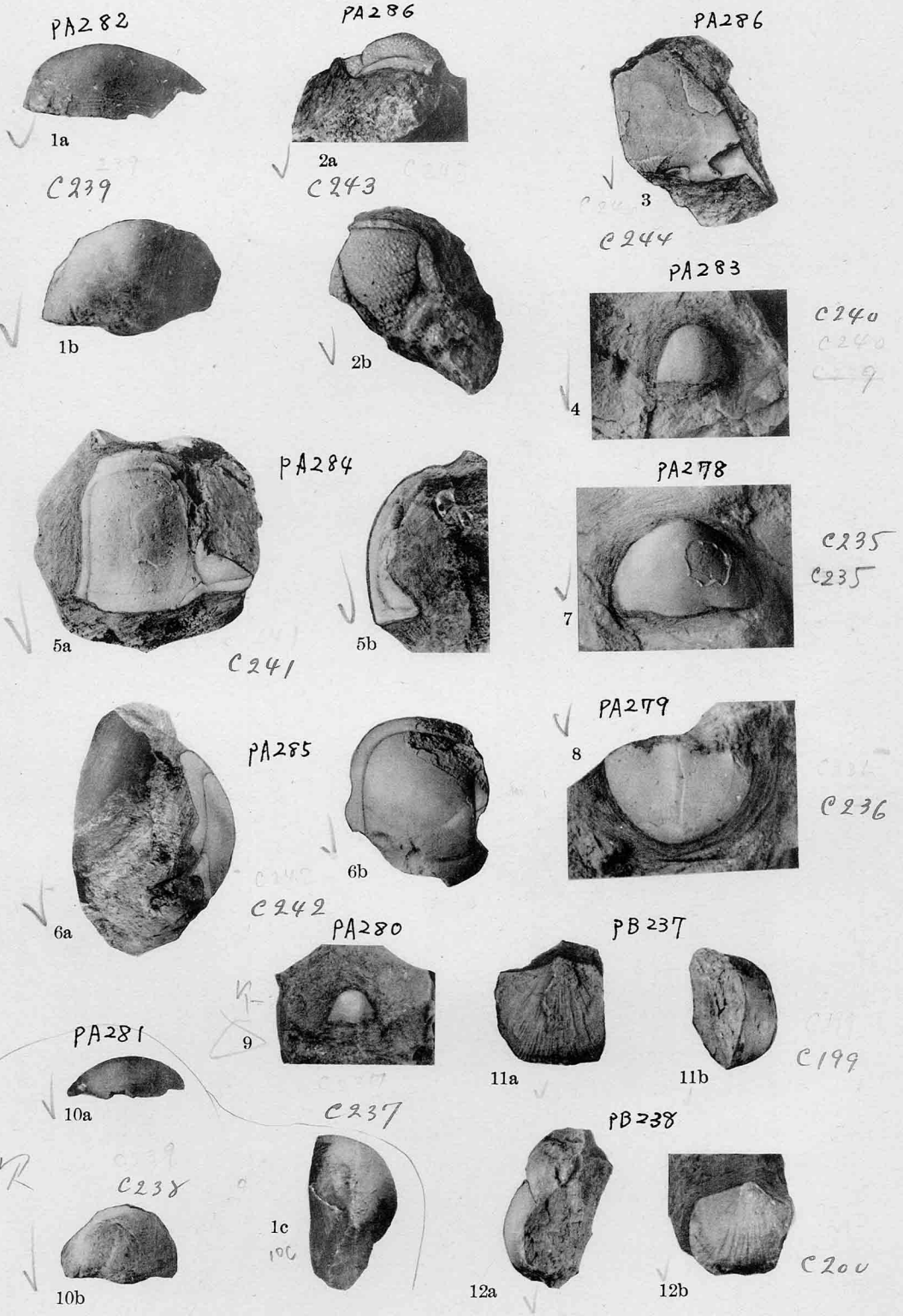

C110
PM276
4
C233


PM318
5
C274

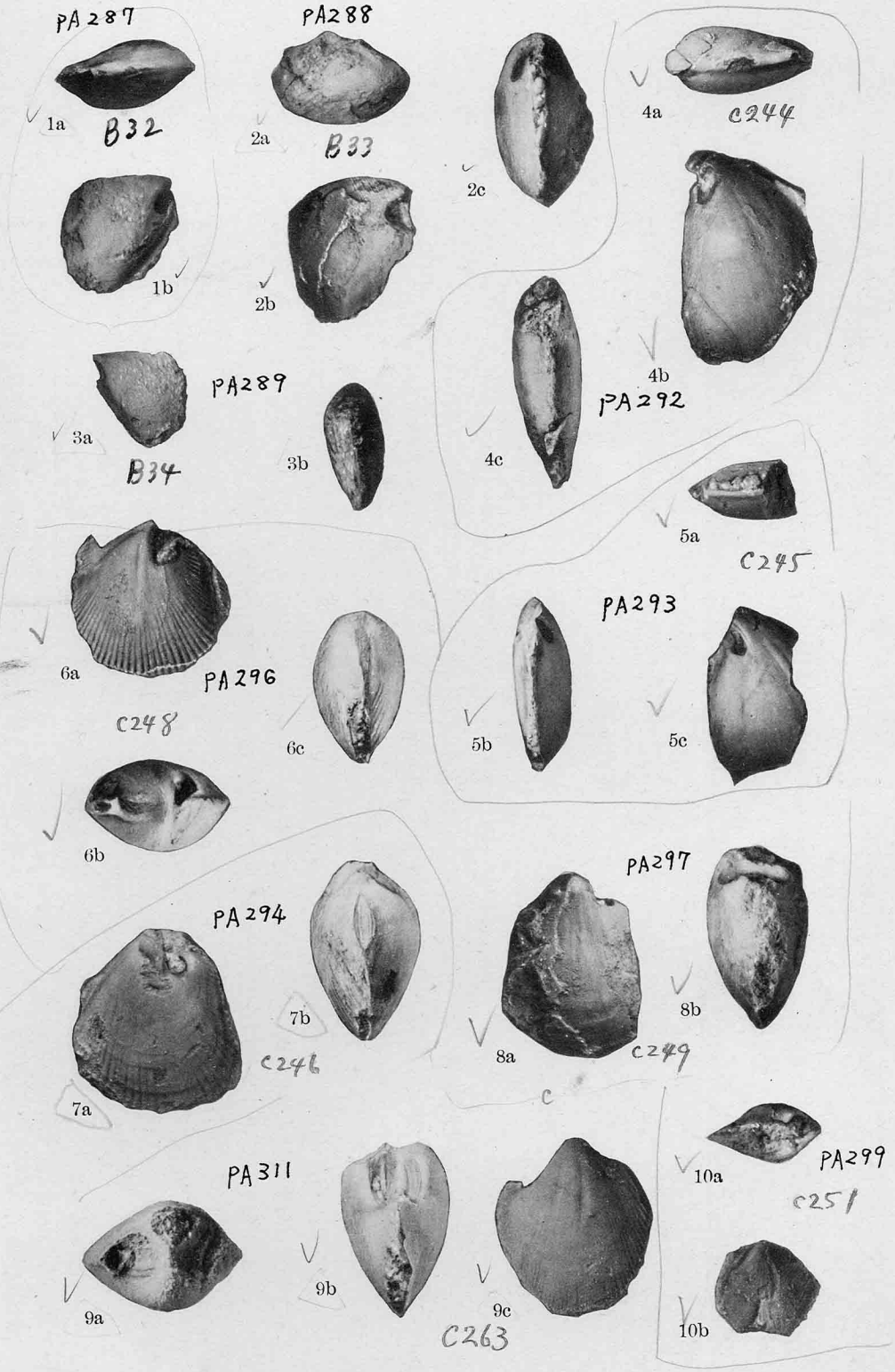

PM245
PM243
C205
C256
C207
2a
3a
4a
3b
4b
PA304
1a
2b
5a
C232
C230
PM273
PM275
7a
2c
1b
PM240
C202
PM248
C210
8
5b
6
C204
7b
PM242
PM267
9
10
C234
PM277
C225

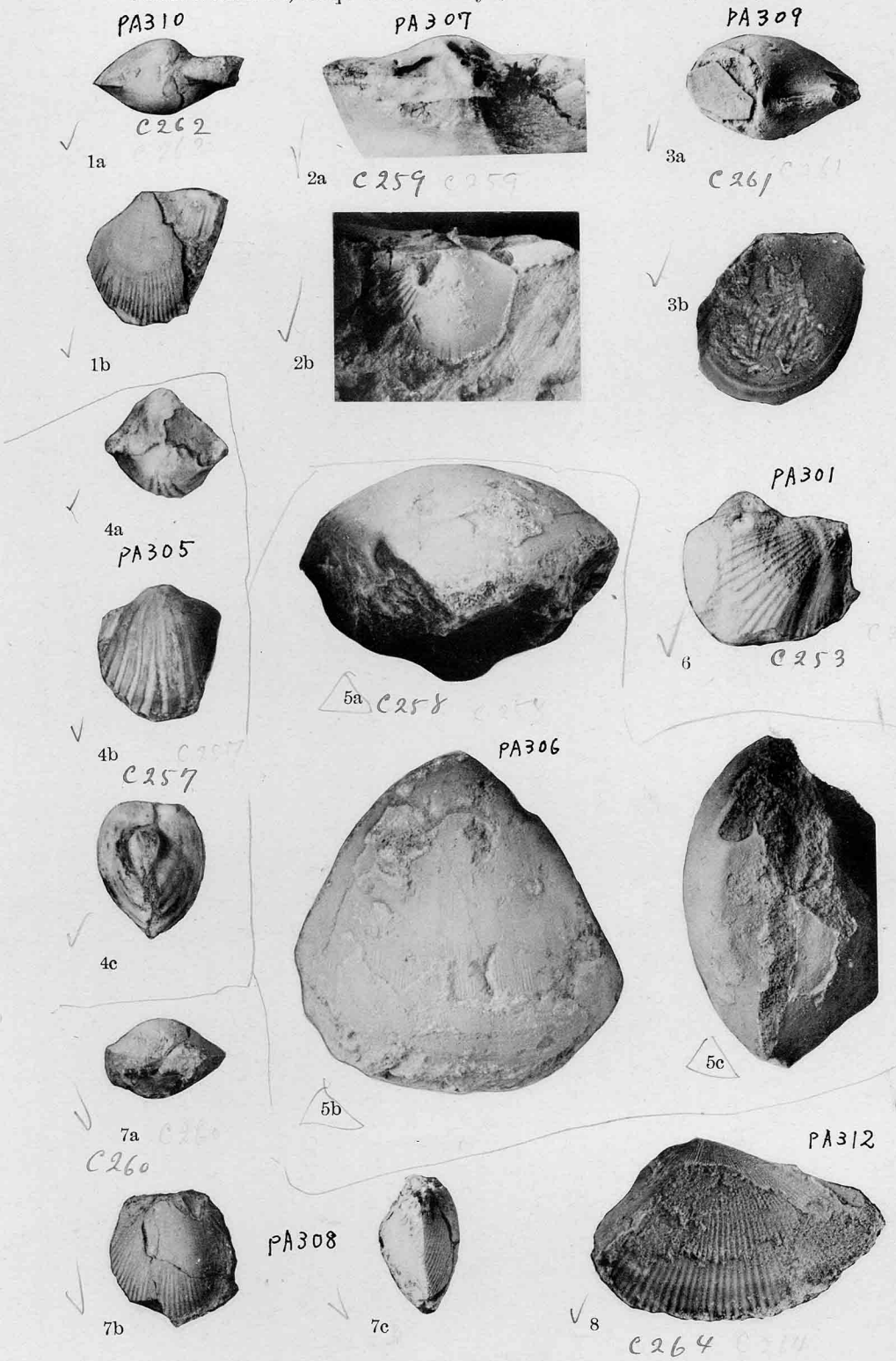


T. KOBAYASHI: Faunal Study of the Wanwanian, etc.

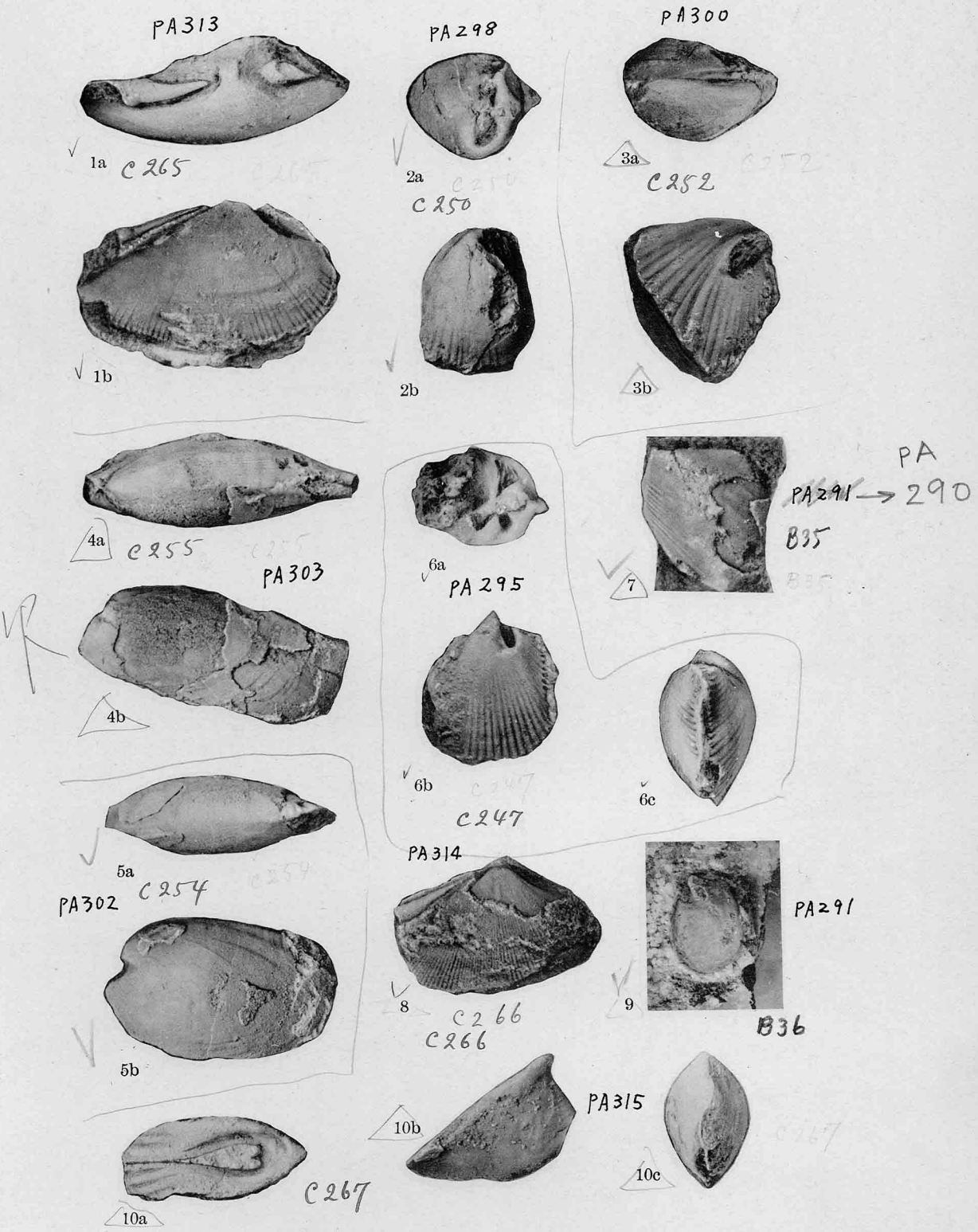


T. KOBAYASHI: Faunal Study of the Wanwanian, etc.

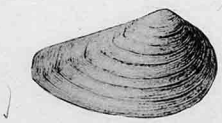

PA287
1a
B32
1b
PA288
2a
B33
2b
2c
4a
C244
4b
PA289
3a
B34
3b
PA292
4c
5a
C245
PA293
5b
5c
PA296
6a
C248
6b
6c
PA294
7a
C246
7b
PA297
8a
C249
8b
PA311
9a
9b
9c
C263
PA299
10a
C251
10b



T. KOBAYASHI: Faunal Study of the Wanwanian, etc.



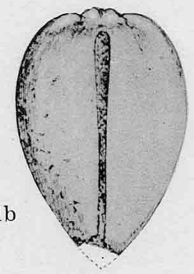
T. KOBAYASHI: Faunal Study of the Wanwanian, etc.


1a


1b


1c

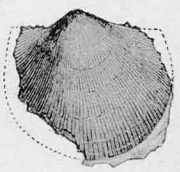

11a


11b


7b


7a


2


12a


12b


3


8


9


10


6

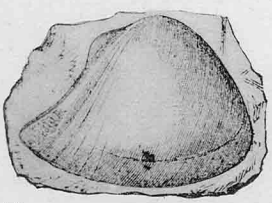

5

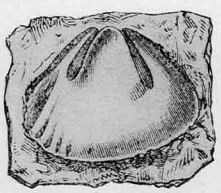

4

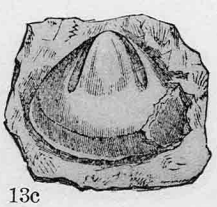

14a


14b


14c


13a


13b


13c

JOURNAL OF THE FACULTY OF SCIENCE
IMPERIAL UNIVERSITY OF TOKYO

SECTION I. MATHEMATICS, ASTRONOMY, PHYSICS, CHEMISTRY

Vol. I, Completed.

Vol. II, Part 1. Z. Suetuna, Ueber die Anzahl der Idealfaktoren von n in einem algebraischen Zahlkörper. Price ¥ 0.60

" Part 2. K. Shoda. Ueber die Automorphismen einer endlichen zerlegbaren Gruppe. Price ¥ 0.60

" Part 3. K. Shoda, Ueber direkt zerlegbare Gruppen. Price ¥ 0.40

" Part 4. S. Fujiwhara and others, The Lunar Influence on the Atmospheric Pressure in The Far East. Parts I, II and III. Price ¥ 0.90

" Part 5. H. Hasse und Z. Suetuna, Ein allgemeines Teilerproblem der Idealtheorie. Price ¥ 0.40

" Part 6. Z. Suetuna, Ueber die Anzahl der Idealteiler Price ¥ 0.40

" Part 7. K. Shoda, Ueber die irreduziblen Substitutionsgruppen, deren Grade Primzahl sind. K. Shoda, Bemerkungen über vollständig reduzible Gruppen. Price ¥ 0.50

SECTION II. GEOLOGY, MINERALOGY, GEOGRAPHY, SEISMOLOGY

Vol. I, Completed.

Vol. II, Completed.

Vol. III, Part 1. B. Kotô, The Iwatsuki Seismic Zone as a Factor of the Habitual Tokyo Earthquake. B. Kotô, The Physiographic Division of Pacific North America. Price ¥ 1.00

" Part 2. N. Nasu, A Stereometrical Study of the Aftershocks of the Great Tango Earthquake with Special Reference to the Mechanism of their Occurrence. Price ¥ 1.90

" Part 3. B. Kotô, The Rocky Mountain Arcs in Eastern Asia. Price ¥ 1.20

" Part 4. M. Yokoyama, Neogene Shells from Karafto and Hokkaido. M. Yokoyama, Tertiary Mollusca from Iwaki. Price ¥ 0.60

" Part 5. B. Kotô, The Seven Islands of Izu Province: A Volcanic Chain. Price ¥ 0.70

" Part 6. M. Yokoyama, Tertiary Mollusca from the Coalfield of Uryu, Ishikari. Price ¥ 0.70

" Part 7. T. Kobayashi, Faunal Study of the Wanwanian (Basal Ordovician) Series with Special Notes on the Ribeiridae and the Ellesmereoceroids. Price ¥ 1.70

SECTION III. BOTANY

Vol. I, Completed.

Vol. II, Part 1. G. Yamaha, Experimentelle zytologische Beiträge. I. Mitteilung. Orientierungsversuche an den Wurzelspitzen einiger Pflanzen. Price ¥ 4.60

" Part 2. G. Yamaha, Experimentelle zytologische Beiträge. II. Mitteilung über die Wirkung des destillierten Wassers auf die Wurzelspitzenzellen von *Vicia Faba* bei verschiedenen Temperaturen. Price ¥ 1.60

" Part 3. M. Kumazawa, Studies on the Structure of Japanese Species of *Ranunculus*. Price ¥ 1.00

" Part 4. M. Kumazawa, Morphology and Biology of *Glaucidium palmatum* Sieb. et Zucc. with Notes on Affinities to the Allied Genera *Hydrastis*, *Podophyllum* and *Diphylleia*. Price ¥ 0.60

" Part 5. Y. Ogura, On the Structure and Affinities of Some Cretaceous Plants from Hokkaido. Price ¥ 0.80

" Part. 6. M. Kumazawa, Morphological Studies of *Anemonopsis*, *Actaea* and *Cimicifuga*. Price ¥ 0.70

" Part. 7. Y. Ogura, On the Structure and Affinities of Some Cretaceous Plants from Hokkaido. Second Contribution. Price ¥ 0.70

Vol. III, Completed.

SECTION IV. ZOOLOGY

SECTION V. ANTHROPOLOGY

CONTENTS

This JOURNAL is on sale at

MARUZEN Co., LTD.
6, Nihonbashi Tori-Nichome, Tokyo

R. FRIEDLÄNDER & SOHN
Karlstr. 11, Berlin, N.W. 6

Price in Tokyo: Yen 1.70 for this Part

昭和八年三月一日印刷
昭和八年三月三日發行

編纂兼發行者
東京帝國大學

印刷者 東京市深川區白河町四丁目一番地一
星野錫

印刷所 東京市深川區白河町四丁目一番地一
東京印刷株式會社

賣捌所 東京市日本橋區通二丁目六番地
丸善株式會社