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4. *Restudy on Manchuroceras with a Brief Note on the Classification of Endoceroids.*

By

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1. OZAKI'S Description of *Manchuroceras*.
2. Observation on OZAKI'S Specimen.
3. Internal Structure of the Endosiphuncle.
4. Asiatic Species of *Piloceras*.
5. Classification and Phylogeny of Endoceroids and Piloceroids.
6. Acknowledgement.

1. *Ozaki's Description of Manchuroceras*.—In 1927 K. OZAKI¹⁾ instituted a new genus, *Manchuroceras*, on the basis of a cephalopod from the Wolungian (Lower Ordovician) limestone of Manchoukou. The English translation of his description (not literal) is as follows:—

External Feature.

- 1) Siphuncle large, cylindrical, rounded near the apex, supposed to be terminated in a hemispheric shape. Its apical end is not preserved.
- 2) A constriction is seen at a point about 30 mm. from the apical end.
- 3) Many annulations oblique to the axis of the siphuncle, run on the surface. These, however, are obsolete in the apical portion.
- 4) At a point about 30 mm. from the apex the siphuncle measures 25 mm. in diameter; four annulations or so are distributed in a distance of 10 mm.

Internal Structure.

- 5) In the longitudinal section the siphuncle has a tubular alveolus on the dorsal side. (Here OZAKI uses a term "dorsal" for the ventral). In the cross section the inner margin of the alveolus arched and its outer

1) K. OZAKI (1927), On a New Genus of Ordovician Cephalopoda from Manchuria, (Jour. Geol. Soc. Tokyo, Vol. XXXIV), pp. 45-50.

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margin runs close to the outer margin of the siphuncle; and its interspaces filled with the stereoplasm.

6) The rest of the siphuncle is occupied by the main alveolus (i.e. endocone) which is communicated with the exterior of the siphuncle through an endosiphontube (i.e. endosiphuncle). It cannot be ascertained whether this has a mammillary sear at the apex or not.

7) The ventral side of the main alveolus is concave and not flat.

Further, he adds the opinion that *Manchuroceras* is distinguished from *Chihlioceras* GRABAU in the number and shape of the lateral alveoli. He missed, however, the assignment of a specific name to the genotype in his description.

2. *Observations on Ozaki's Specimen*.—The camerate portion is poorly preserved. The siphuncle is quite large, presumably as broad as half the shell-diameter or so. It has a weak constriction which, however, does not mark off the preseptal cones as that of *Proterocameroceras*, but both sides of the constriction are septate. In the transverse section (Pl. III, fig. 1, text-fig. 1,) a septum adnates with the shell on the flat venter; another septum does so with the preceding septum to some distance, outlining the siphuncle for 7 mm. Here it is detached from the siphuncle. Thus the siphuncular wall is understood to be composed of septal necks in double layers,—in other words, the feature reveals the invaginated septal funnel of the holochaoanitic type,—but no endosiphonolining of RUEDEMANN can be seen. Both above mentioned septa are broken off a short distance from the siphuncular wall. As it is the case of *Coreanoceras*,¹⁾ the shell and septa are rather thin and the camerae free from stereoplasmic deposits. These might be the reasons why the camerate portion was so easily destroyed.

On the external view of the siphuncle (Pl. III, fig. 1,) four septal sutures and three interspaces are distributed in 11 mm. where the dorso-ventral diameter of the siphuncle measures 29 mm. The

Text-figure 1. Cross section of
Manchuroceras wolungense
Kobayashi

1) T. KOBAYASHI (1931 A), Studies on the Ordovician Stratigraphy and Palaeontology of North Korea with Notes on the Ordovician Fossils of Shantung and Liaotung, (Bull. Geol. Surv. Chosen, (Korea), Vol. XI, No. 1), p. 45-48.

septal suture ascends from dorsum to venter for a distance of two and half septal distances, but they are obscured, though some of them traceable, on the venter.

In two cross section (Pl. III, figs. 2-3,) which are about 7 mm. apart from each other, the siphuncle is subcircular, more or less ovate, slightly depressed in the dorso-ventral direction and widely flattened on the venter; the endocone is off-center; the siphuncular wall increases its thickness from dorsum to venter and abruptly swells up inward, forming the "*ventral elevation*", in which respect *Manchuroceras* is more specialized than the Endoceratidae. As to its bearing on the animal life nothing is certain, but at least it is obvious that such an elevation serves for the mantle attachment very effectively.

A siphuncular channel runs along the ventral flattening some little distance and then traverses the ventral elevation, but it cannot be ascertained whether this channel has penetrated completely through the elevation or not, because on this specimen the stereoplasmic layers are crystallized on the inner side of the elevation. It is, however, certainly not a narrow tube, but has some longitudinal distance, since it can be seen in two sections 7 mm. apart. It is, therefore, a type of an "endosiphoblade" by RUEDEMANN¹⁾ or an "endosiphobladet" by HOLM. Through the research of *Coreanoceras* now being undertaken, I am inclined to believe that the endosiphoblade is a channel communicating the soft animal with the air chamber. In this regard it coincides with the diverticula in the actinoceroids. Further information will be presented in another paper which will appear in the future.

3. *Internal Structure of the Endosiphuncle*:—An important observation can be made in the clear cut longitudinal section of the endosiphuncle (Pl. III, fig. 4.) The endocone has an apical angle of 25 degrees. At the apex is seen a dark material irregularly outlined, precisely a small cone with a short cylindrical elevation. A guess is that it may be the last encrustation on the endocone wall which has not been completed by the death of the animal. Since the height and breadth of the endosiphuncular segment diminish abruptly in the later part of the endosiphuncle, it is

1) R. RUEDEMANN (1905), The Structure of some primitive Cephalopods, (N. Y. State Museum, Bull. 80), p. 304.

presumed that this portion reveals a senile stage of growth.

At the apical end, the endocone is connected with the so-called endosiphuncle, which in turn is divided into chains of *endosiphuncular segments* by a number of black tabulae. There is a tendency of the distance between the tabulae increasing from the apical side to another, but not regularly. (Text-fig. 2.)

J. F. WHITEAVES¹⁾ once stated that the endosiphuncle of *Endoceras crassisiphonatum* is partitioned by a few transverse concave dissepiments or "endosiphuncular partitions".²⁾ Although I have not examined his specimen, it might be said that the interspace between the dissepiments is left vacant, or is filled up with dirt or "Spiess", since he compared these dissepiments to the diaphragms of *Diphragmoceras*. Further the partitions are very widely separated from one another in his illustration. On the contrary, in the specimen at hand the spaces between the black tabulae which are close-set, are filled up with stereoplasm, instead of dirt. Another distinction from WHITEAVE's example is the cone-in-cone structure of the endosiphuncular segments which is very clearly seen in a few places in the apical portion (pl. IV), and thereby the endosiphuncle changes its breadth abruptly.

In the later part of the endsiphuncle 17 segments are to be counted in a distance of 4 mm., where the endosiphuncular breadth measures 0.58 mm. at the maximum. In the same distance about the same number of the endosheathes are distributed. As the endosheathes are not so clearly defined from one another as the endosiphuncular segments, I cannot convince that each endosheath corresponds exactly to each endosiphuncular segment, although this appears to

Text-figure 2. Diagrammatic longitudinal section of the endosiphuncle

1) J. F. WHITEAVES (1891), The Orthoceratidae of the Trenton Limestone of the Winnipeg Basin, (Roy. Soc. Canada, Trans. Vol. IX, Sect. IV,) p. 79, pl. VI, figs. 1-4, pl. VII, fig. 1.

2) For WHITEAVES' dissepiment I used the term "endosiphuncular partition" in my paper "On the Phylogeny of the Primitive Nautiloids, with Descriptions of *Plectronoceras liaotungense*, new species, and *Iddingsia* (?) *shantungensis*, new species," (Japan. Jour. Geol. Geogr. Vol. XII, 1935), p. 22.

be likely.

On this specimen the endosheathes are interrupted to trace in the whole length from the endosiphuncle to the siphuncular wall by the obstruction of a crystalline body. A careful observation of it located in the middle of the ventral elevation reveals that the body is composed of crystalline calcite, layer by layer, irregularly outlined, but defined by no definite wall. Some trace of the endosheath fragment is still retained in the body.

In examining a number of Asiatic endoceroids and piloceroids, I noticed that it was quite common that the endosheathes were partly altered into calcite, and that various stages of such an alternation could be seen in the majority of specimens. Therefore, it may be easily understood by nautiloid students that the crystalline body which OZAKI once called a tubular alveolus is not an original structure, but is brought forth from the endosheath through a secondary crystallization of the stereoplasm.

Whether the endosiphuncle is closed or open at the apex, and how far the soft part of the animal has penetrated the space in the endosiphuncle have been moot questions. It is, however, quite seldom that we are able to find specimens with their internal structure so well preserved that we may make such an investigation. Since the discussions of the previous investigators have been summarized by RUEDEMANN,¹⁾ a repetition here has been avoided.

So far as the present specimen of *Manchuroceras* is concerned, the so-called endosiphuncle can be divided into a short vacant tube and a series of endosiphuncular segments, the latter of which are residual structures. For the former I wish to employ a RUEDEMANN's term "endosiphotube" hereafter. My opinion is that it is the endosiphuncle proper, or the apical end of the vacant endocone and it is definite that the soft animal cannot be extended beyond it. OZAKI's observation with regard to this is therefore incorrect.

In the course of the animal growth, the body is pushed forward, and simultaneously the stereoplasmic layers are secreted in the space left behind the animal. Thus the speed of calcareous secretion depends upon the growth of the animal which in turn,

1) R. RUEDEMANN (1905), Op. cit., p. 300.

is controlled under the condition of the environment and other factors. If the condition is favourable, the growth of the animal, consequently the secretion of the stereoplasm, proceeds very quickly. It happens sometimes, however, that regular cessations of growth occur causing stereoplasmic secretion to proceed very slowly or even cease completely, thus resulting in stereoplasmic deposits which are demarcated by lines. This aspect is similar to the year-ring in plants. RUEDEMANN¹⁾ said that such a periodicity of growth depends upon the reproductive times and the rest between.

Anyhow we should take the endosiphuncular segment, instead of the black tabulae themselves, as the unit of structure, and so the same for the endosheathes. Thus it is not the black line itself, but the layer between the lines which should be considered the endosheath. If the siphuncular segment is so defined, its magnitude is the exponent of growth. On this specimen for example, the increasing size of the endosiphuncular segment is explained by normal growth and the decrease in the last stage of senility.

4. *Asiatic Species of Piloceras*:—Since GRABAU's description of *Piloceras platyventrum*²⁾ from the Lower Ordovician formation of Chihli, two species and one variety³⁾ have been added from North Chosen, South Manchuria and Shantung. These are as follows:—

Piloceras wolungense KOBAYASHI.

Piloceras wolungense, var. *compressum* KOBAYASHI.

Piloceras manchuriense ENDO.

Since no camerate portion of the conch of these Asiatic *Piloceras* have been discovered, the specific distinction among them is merely based upon the nature of the siphuncule, especially the

1) R. RUEDEMANN (1921), Observations of the Mode of Life of Primitive Cephalopods, (Bull. Geol. Soc. Am. Vol. 32), p. 319.

2) A.W. GRABAU (1922), Ordovician Fossils from North China, (Palaeontol. Sinica, Ser. B, Vol. I, Fasc. 1).

3) T. KOBAYASHI (1931 B), Studies on the Stratigraphy and Palaeontology of the Cambro-Ordovician Formation of Hua-lien-chai and Niu-hsin-tai, South Manchuria, (Japan, Jour. Geol. Geogr. Vol. VIII,); (1931 A), Op. cit. R. ENDO (1932), The Canadian and Ordovician Formation and Fossils of South Manchuria, (U. S. Nat. Mus. Bull. 164).

rate of tapering, curvature, septal suture, cross section and other features of the siphuncle.

In examining ENDO's types in the United States National Museum at Washington, D. C., I found two forms to be distinguished. In the holotype (ENDO, Pl. 32, figs. 5-7,) the siphuncle is straight and circular in the cross section, while it is distinctly curved and rapidly increases its lateral diameter. In the paratype its cross section is considerably depressed in the dorso-ventral direction. (ENDO, Pl. 33, figs. 14-15.) Therefore I propose here a new specific name, *Manchuroceras endoi*, for the latter form in honour of Dr. RYUJI ENDO of the Educational Institute, South Manchurian Railway Company, Mukden, Manchoukou.

When compared with *Piloceras* s. str. which is prevalent in eastern North America and in Scotland, typified by *Piloceras invaginatum* SALTER, these Asiatic species are totally different in the foll wing respects.

1) The siphuncle is subcircular or dorso-ventrally depressed into an ovate form in the Asiatic species, while it is subcircular or more commonly compressed laterally in *Piloceras* s. str. The lateral compression is very distinct in *Piloceras invaginatum*.

2) The siphuncle is marginal in the Asiatic form, instead of being submarginal as in the Atlantic one.

3) The siphuncle expands much more rapidly in *Piloceras* s. str. than in the Asiatic forms.

4) In the Asiatic forms the siphuncle is long and nearly straight, although curved to some extent, while it rapidly tapers in *Piloceras* s. str.

5) The mammillary scar frequently found at the apical end of the Asiatic form has never been observed in *Piloceras* s. str.

6) In *Piloceras* s. str. the endocone is subcentral, while it is off-center and its ventral side sometimes concave in the Asiatic form.

I consider these distinctions enough to segregate the Asiatic forms from *Piloceras* s. str. as a solid group. Ignoring the tabular alveolus, OZAKI's specimen of *Manchuroceras* which I have in hand, is, as far as I can see, identical with *Piloceras wolungense* KOBAYASHI. Therefore, to distinguish Asiatic species of *Piloceras* from *Piloceras* s. str. I recommend OZAKI's generic name, *Man-*

churoceras, whose genotype is naturally *Piloceras wolungense*. By the reason discussed above the generic diagnosis, however, requires some emendation in the following manner:—

Genus **Manchuroceras** OZAKI em. KOBAYASHI.

Breviconic orthoceracone, straight or little curved, subcircular to ovate in cross section; siphuncle large, cylindrical, straight or slightly curved, marginal, subcircular, or ovate and dorso-ventrally depressed in cross section; its ventral side frequently flattened; septa holchoanitic; septal suture oblique to the axis of the siphuncle, ascending from dorsum to venter; apical part of the siphuncle conical, sometimes provided with a mammillary sear; endocone off-center, close to the dorsum; its ventral wall mostly concave, forming the ventral elevation.

5. *Classification and Phylogeny of Endoceroids and Piloceroids*:—We paleontologists use a term “*primitive*” which is frequently rather subjective and ideal, but generally means either simple or archaic¹⁾. It is more real and objective only in the case that simplicity and archaism are combined. The *Holchoanites*, for example, was placed in the first suborder of the fossil nautiloids by HYATT. This idea was based presumably on the fact that the suborder was the oldest group available at that time and it was accepted by the nautiloid students until about ten years ago. If the organization is, however, considered, it is obvious that the *Orthochoanites* is much simpler than the *Holchoanites*. The situation naturally gives a chance for play of imagination as to which is really more primitive, *Holchoanites* or *Orthochoanites*.

In recognizing *Volborthella* as an ancestor of cephalopod, SCHINDEWOLF first argued on this regard. Since then the cephalopod-nature of *Volborthella* as well as *Salterella* of the Lower Cambrian have been discussed by TEICHERT, POULSEN, GÜRICH, SPATH and many others, but as yet none have arrived at a common agreement²⁾. On the other hand recent researches on primitive nautiloids date back to a period before the Canadian. Form the

1) The primitive characters are sometimes based on the observations of the earlier stage of the ontogeny.

2) I believe that *Volborthella* is most probably a cephalopod, and at least closest to Cephalopoda than anything else.

Asiatic side I¹⁾ discovered facts which led me to conclude that HYATT's classification does not apply to Wanwanian cephalopods in fundamental lines. Subsequently ULRICH and FOERSTE,²⁾ in dealing with Ozakian material, clarify that the Diphragmida which prevailed in that period comprises of not only the holochaoanoidal genera, but the ellipochaoanoidal ones. Further, I deem that *Plectronoceras liaotungense* Kobayashi from the Upper Cambrian of Liaotung is the oldest and simplest, and thus the most primitive and unquestionable for its cephalopod-nature. The study³⁾ on this progenitor, therefore, makes clear the original branching of nautiloid-evolution.

In summarizing the results of my observations on Asiatic materials, it can be said with certainty that;

- 1). the length and curvature of the septal neck is variable even in one individual of the Plectronoceratidae,
- 2). the Upper Cambrian nautiloid is not a Holochaoanites in the sense of HYATT, and
- 3). Holochaoanites is not primitive, but highly specialized.

Further, as seen in the Plectronoceratidae, most of the archaic nautiloids have laterally compressed conchs with crowded septa and narrow marginal siphuncles on the ventral side. These primitive aspects are equally as well seen on the Ellesmereoceratidae. Further, most of the archaic cephalopods are straight or a little curved; quite a few gyroceratonic; and none nautilonic. If the conch is cyrtotonic, the siphuncle is endogastric or located on the concave side.

Except for *Volborthella* and *Salterella*, the archaic cephalopods are distributed most abundantly on both sides of the northern Pacific where the center of the dispersal or migration is naturally expected. Only a few specimens of the basal Ordovician i.e. late Ozarkian cephalopods are procured from the Arctic region which are exclusively ellesmereoceroids. The Tremadocian strata in

1) T. KOBAYASHI (1933), Faunal Study of the Wanwanian (Basal Ordovician) Series and Special Notes on the Ribeiridae and the Ellesmereoceroids, (Jour. Fac. Sci. Imp. Univ. Tokyo, Sect. II, Vol. III, Pt. 7), pp. 302-309.

2) E. O. ULRICH and AUG. F. FOERSTE (1933), The Earliest known Cephalopods, (Science Vol. 78), pp. 288-289.

3) T. KOBAYASHI (1935), Op. cit., pp. 17-26, pl. VI.

northern Europe, since it is distant from the center of origin, yields little material. *Orthoceras* (?) *attavus* BRÖGGER¹⁾ in Norway is a tiny orthoceracone with a submarginal narrow siphuncle and crowded septa; *Orthoceras* (?) *sericeum* SALTER and *Cyrtoceras* (?) *praecox* SALTER²⁾ have also close-set septa, but their siphuncles are not well preserved. At any rate these primitive characteristics referred to above cannot be overlooked in Tremadocian cephalopods.

So far as I am aware, it appears to be a rule that, if the siphuncle is narrow, its internal structure is simple, and complicated structure like endoceroids are found only in those forms whose siphuncles are expanded to a certain magnitude. Since the structure of the siphuncle was simple at the beginning, it did not require much space in the siphuncle. The highly camerate forms are later appearance. The reasons are that the primitive nautiloid did not have the ability to push its body forward at one bound in the course of its growth.

Thus the complicacy of the siphuncular structure depends upon the specialization of the siphuncle, or the soft part of the animal occupying the space of the siphuncle,—in other words, the increase of the siphuncular space, that is, the magnitude of the endocone advances in accordance with the complicacy of the viscera.

As a result of this specialization the siphuncle increases its weight and consequently the animal presumably takes on a crawling habit. For this benthonic adaptation the cross section of the shell changes from a laterally compressed form into a dorso-ventrally depressed and ovate outline with a flattened venter. If the stereoplasmic deposits increase in the camerae as well as in the siphuncle, the animal is, after all, hardly capable of swimming. I, therefore, agree with TROEDSSON³⁾ and TEICHERT⁴⁾ in their interpretation that the heavy shelled cephalopod are benthos.

Thus, not only the length and curvature of the septal neck,

1) W.C. BRÖGGER (1882), Die Silurischen Etagen 2 und 3, p. 53, pl. IV, fig. 9-10, pl. X, fig. 6.

2) J.F. BLAKE (1882), A Monograph of the British Fossil Cephalopoda, Part I, Introduction and Silurian species.

3) T. TROEDSSON (1926), On the Middle and Upper Ordovician Faunas of Northern Greenland, I. Cephalopods (Julilaemsekspeiditionen Nord om Grønland 1920-23, Nr. I,) p. 65.

4) C. TEICHERT (1935), Structures and Phylogeny of Actinoceroids, (Am. Jour. Sci. Vol. XXXIX,) p. 15.

but the coiling of the shell, cross section of the conch, position and size of the siphuncle, stereoplasmic deposits in the siphuncle and camerae, and other characteristics should be counted on for the natural classification. Unless the combination of these evolutionary characteristics are brought into consideration, we cannot read through the story of nautiloid evolution.

For example, if we follow HYATT, *Baltoceras* is an Orthoceratidae, but it is, in fact, quite distinct from other genera of the family. It is certainly better explained, as an orthochoanitic endoceroid. The feature of the septal neck in *Baltoceras* is simply due to that it improves more rapidly than it does in other endoceroids in this respect. Therefore, I myself believe that *Baltoceras* is derived from the stock of the Endoceratidae rather than from that of the Orthoceratidae.

By the same reason *Polygrammoceras endoceroides* TROEDSSON¹⁾ is segregated from the Kionoceratidae and here a new generic name *Troedssonella* is attached to it. Its generic significance is in the polygrammoceroid with the ellipchoanoidal septa, endosheathes and endosiphuncle, its genotype being *P. endoceroides*.

On the other hand I am inclined to recognize that *Protocycloceras* or *Orygoceras*²⁾ is a Cycloceratidae or an Orthoceratidae with a holochaoanitic siphuncle in which the evolution in reference to the septal character is retarded. Therefore the Protocycloceratidae (nov.) is so defined here that the cycloceroid has a siphuncle of the holochaoanitic type and sometimes partitions within the siphuncle.

From these points of view I am led to be sceptic as to whether the septal nature on which HYATT's major divisions are founded is of prime importance, or we can have a better explanation of the phylogeny and classification from other basis. The latter attempt has been initiated in my preceding paper³⁾ in which I have dealt with the initial branching of the Plectronoceratidae, Elles-

1) G. T. TROEDSSON (1932), Studies on Baltic Fossil Cephalopods, II, Vertically Striated or Fluted Orthoceracones in the *Orthoceras* Limestone, (Lund Universitets Arsskrift, N. F. Avd. 2, Bd. 28, Nr. 6,) p. 30. pl. III, figs. 2, 3, pl. IV, fig. 6.

2) A. F. FOERSTE (1924), Notes on American Paleozoic Cephalopods, (Jour. Sc. Lab. Denison, Univ. Bull. Vol. XX), pp. 202-203.

3) T. KOBAYASHI (1935), Op. cit., pp. 20-25.

mereoceratidae and Endoceratidae. Here the consideration is extended into the endoceroids and piloceroids and their relation to the orthoceroids.

In the majority of the Canadian and later Ordovician cephalopods it is quite easy to recognize two major groups, endoceroids and orthoceroids, but whether the former is derived from the latter or vice versa is a moot question. Between the two groups there are essential distinctions which cannot be overlooked. Besides the septal character, the former has mostly a narrow subcentral and simple siphuncle whereas the latter has a broad marginal or submarginal and complicate siphuncle. As discussed elsewhere¹⁾, the presence of the endosheath and endosiphuncle should be much more important characters for the latter group than the holocheanitic nature of the septa.

It is really quite seldom that we find the Holochoanites with a narrow and subcentral siphuncle. There are, however, a few exceptions, such as *Wolungoceras*²⁾ and *Chisiloceras*³⁾ which have subcentral siphuncles. These two genera differ mainly in the length of the septal neck. If the length diminishes still more than that of the *Wolungoceratidae* without endosheathes, it is quite possible that the *Orthoceratidae* will be introduced. *Chisiloceras*⁴⁾ in Caracorum is accompanied by *Nileus armadillo*, *Illaeus esmarki*, and other fossils, and the fauna, according to GORTANI, is the upper Arenigian or lower Llandeilian; *Wolungoceras* in

1) T. KOBAYASHI (1935), Op. cit., p. 20-25.

2) T. KOBAYASHI (1931 B), Op. cit. p. 166.

3) M. GORTANI (1934), Fossili Ordoviciani del Caracorum, pp. 68.

4) According to GORTANI, *Chisiloceras* is an orthoceracone without any transverse annulation and longitudinal costae; its cross section circular or only a little elliptical; siphuncle large, central or subcentral; the septal funnel prolonged beyond the preceeding septal neck. In short, *Chisiloceras* is an *Orthoceras* in outline, but has a siphuncle of *Vaginoceras* type; in other words, it is *Vaginoceras* except for the central siphuncle.

Further *Chisiloceras* is allied to *Wolungoceras* KOBAYASHI in the Ordovician of Manchuria, but in comparison with it, *Chisiloceras* has a much more prolonged endocone and a greater number of endosheathes. We can say exactly that the relation of *Chisiloceras* to *Wolungoceras* is just like the relation of *Vaginoceras* to *Endoceras*.

The genus comprises of *Chisiloceras marinellii* and *Chisiloceras dainellii* among which the former is selected for the genotype, because it shows the diagnostic characters more clearly than the latter.

Eastern Asia is the Wolungian and older formations.

It is interesting to note that the Wanwanian *Wolungoceras chiushuense*¹⁾ has a siphuncle shifted from the center to the ventral side to some distance, in which respect it is intermediate between the Plectronoceratidae and Wolungoceratidae.

FOERSTE once claimed that no ellipchoanoidal cephalopod has been found before the Chazyan, and this result is still accepted, if the ellipchoanoidal cephalopod is not taken in the sense of HYATT, but with a substitution of absent siphuncular partition. The Chikunsan, approximately contemporaneous with the Llan-deilian of Europe and Chazyan of North America, is a period of Orthoceroid-divergence.

Based upon these grounds I found it reasonable to consider that from the stock of the Wolungoceratidae the Orthoceratidae is branched off, from which in turn the Actinoceratidae is brought forth through *Sactorthoceras*. Regarding the latter account I have already discussed on some occasion.²⁾ It must, however, be remembered that the Orthoceratidae and Wolungoceratidae should have diverged from the common evolutionary line before the time when the latter acquired the endosheath structure.

Another question not yet well clarified is whether the Wolungoceratidae is derived from the Ellesmereoceratidae, or derived directly from the common ancestral stock with the Plectronoceratidae and Ellesmereoceratidae. It is, however, more certain that excepting the Wolungoceratidae branch, most of the endoceroids and piloceroids are descendants from the Ellesmereoceratidae. These two groups are more advanced and complicated than the Ellesmereoceratidae with regard to the siphuncular structure.

Since the Piloceratidae is characterized by a lateral compression of the conch, it is presumed that it branched off from the Ellesmereoceratidae line and not through the Endoceratidae. The Cyrtendoceratidae and Baltoceratidae are side off-shoots from the Endoceratidae. The former is improved in regard to coiling of conch; the latter in regard to septal nature.

1) T. KOBAYASHI (1933), Op. cit., p. 275, pl. III, fig. 4.

2) T. KOBAYASHI (1934), The Cambro-Ordovician Formations and Faunas of South Chosen, Palaeontology Pt. I, Middle Ordovician Faunas, (Jour. Fac. Sci. Imp. Univ. Tokyo, Sect. II, Vol. III, Pt. 8,) pp. 429-432.

In my opinion it is hard to group *Chihlioceras* and *Piloceras* s. str. in one family and GRABAU is correct to establish the Chihlioceratidae for the former in which *Coreanoceras* should be involved. The question is in *Manchuroceras* which is intermediate in character between the Endoceratidae and Chihlioceratidae. It differs from the Endoceratidae in its large complicate siphuncle and small mammillary scar, but it is certainly a Holochoanites. Nothing definite is known as yet of the septal nature of the Chihlioceratidae but well preserved specimens of *Coreanoceras* which I am now studying, project a doubt that it may not be a normal Holochoanites. Therefore, I consider that it is wise to separate the Manchuroceratidae from the Chihlioceratidae.

A question of the endoceroid to be left for future research is the bearing of the apical bulb on the phylogeny and classification. At any rate there are a group of endoceroids which have a siphuncular bulb at the apex and they are well known in Europe and North America. *Penhsihoceras* is an example of this kind known from Eastern Asia. ENDO¹⁾ has established *Penhsihoceras* out of *Penhsihoceras fusiforme* ENDO which is a long, straight and cylindrical siphuncle with an apical bulb. He compared it with *Piloceras* and *Chihlioceras* and placed it in the Piloceratidae, but by some unknown reason he missed to compare it with *Nanno* and *Sueccoceras* with which it should be put in array. As a result, the phylogenetical relation of the Cambro-Ordovician nautiloids is demonstrated in the following table (on page 49.)

Finally the Upper Cambrian and Ordovician ellesmereoceroids, endoceroids, and piloceroids are classified as follows:—

- I. Plectronoceratidae KOBAYASHI 1935.
- II. Ellesmereoceratidae KOBAYASHI, 1934.
- III. Endoceratidae HYATT, 1884.

Section 1. *Endoceras* HALL, *Vaginoceras* HYATT, *Cameroceras* CONRAD, *Kotoceras* KOBAYASHI,²⁾ *Paravaginoceras* KOBAYASHI.

1) R. Endo. (1932), Op. cit., pp. 64-65, Pl. 32, figs. 8-10.

2) It is unfortunate that *Kotoceras* KOBAYASHI, 1934, is duplicated by YABE's *Kotoceras*, 1927, (Sci. Rept. Tohoku Imp. Univ. Vol. XI, No. 1. 1927, p. 44), but still more unfortunate is it that SHIMIZU and OBATA have proposed *Subvaginoceras* 1935, for my *Kotoceras* by this duplication, (Chikyu, the Globe, Vol. XXIV, No. 2, 1935). This proposal is, however, nullified by the reason that *Kotoceras* Yabe is nom. nudum., and *Kotoceras* KOBAYASHI is a valid name.

Table showing the phylogenetical relation of the primitive nautiloids.

Evolutional Trends

- 1) Cross section of the shell. (laterally compressed→subcircular→dorso-ventrally depressed.)
- 2) Length of the shell. (longiconic→breviconic.)
- 3) Coiling of the shell (orthoconic→cyrtoconic→gyroceraconic→nautiliconic.)
- 4) Camera-height (short→broad.)
- 5) Septal character.
 1. (holochoanoidal→ellipochoanoidal.)
 2. (orthochoantic→cyrtochoanitic.)
- 6) Siphuncular structure, (diaphragm→endosheathes and endosiphuncle.)
- 7) Surface ornamentation.

Note:—The *Wolungoceratidae* might be located close to the *Troedossoneillidae*.

Section II. *Cyclendoceras* GRABAU & SHIMER, *Kawasakiceras* KOBAYASHI.

Section III. *Cyrtoarginoceras* KOBAYASHI.

Section IV. *Nanno* CLARK, *Sueccoceras* HOLM, *Proterocameroceras* RUEDEMANN, *Penhsioceras* ENDO.

IV. *Wolungoceratidae* KOBAYASHI. (nov.) Endoceroids with a

subcentral siphuncle, or the Orthoceratidae with a holochaoanitic siphuncle. Endosheathes present in the later form.

Wolungoceras KOBAYASHI, *Chisiloceras* GORTANI.

- V. Baltoceratidae KOBAYASHI, (nov.) Endoceroids with an orthochoanitic, marginal or submarginal siphuncle.

Baltoceras HOLM.

- VI. Troedssonellidae KOBAYASHI, (nov.) (See page 45)

Troedssonella KOBAYASHI, (nov.)

- VII. Piloceratidae MILLER, 1889.

Piloceras SALTER.

- VIII. Cyrtendoceratidae HYATT, 1896.

Cyrtendoceras RÉMÉLÉ.

- IX. Manchuroceratidae KOBAYASHI, (nov.) Breviconic endoceroids with a ventral elevation in the siphuncle.

Manchuroceras OZAKI em. KOBAYASHI.

- X. Chihlioceratidae GRABAU, 1922.

Chihlioceras GRABAU, *Coreanoceras* KOBAYASHI.

6. *Acknowledgement*:—During my stay in North America I was able to examine a number of *Piloceras* in the United States National Museum at Washington, D. C., in the New York State Museum at Albany, N. Y., in the Victoria Memorial Museum at Ottawa, and in other places for comparison with Asiatic piloceroids; and had an opportunity to discuss with Dr. AUG. F. FOERSTE on this group of cephalopods. In Italy I could see the types of *Chisiloceras* in the Geological Institute, R. University of Florence. Since I returned, Prof H. YABE of the Geological Institute, Tohoku Imperial University at Sendai bestowed upon me the privilege of revising OZAKI's specimen. My sincere thanks are due to Dr. R. S. BASSLER, Dr. RUD. RUEDEMANN, Dr. E. M. KINDLE, Dr. AUG. F. FOERSTE, Prof. G. DAINELLI and Prof. H. YABE.

(摘 要)

マンチュロセラスの再研究とエンドセロイドの分類に就いて

小 林 貞 一

1) 尾崎金右衛門氏のマンチュロセラスの記載を英譯し、2) 其の原品に對する余の觀察を記す。先づ其のセプタのホロコアニティクなることを證し、體管の腹側に腹側隆起が存

在し、之を endosiphoblade の貫通すること、3) endosiphuncle が endosiphontube と endosiphuncular segments とよりなり、内臓は前者を限りとし、後者は生物の生長に伴ひ後方に残されたる沈澱物の充填部にして、生物は endosiphuncle を通じて外界と通じゐたるものに非ざること、及び尾崎氏の管状窩は endosheath を構成せる stereoplasm の再結晶に依つて生じたる二次的構造なることを述ぶ。

4) 東亞の所謂 *Piloceras* を眞の *Piloceras* と比較し、其の識別六項目を數へ、東亞の *Piloceras* を屬として *Piloceras* s. str. より分離し、之に對して、尾崎氏の屬名を採用し、其の基本型として *Piloceras wolungense* KOBAYASHI を選び、屬の記載を訂正す。

5) ハイヤットの分類を難じ、新たなる立場より系統分類を立て、附表(第49頁)の如き系統を提案する。

本論文を通じて提唱されたる新科、新屬、新種は次の如し。

Manchuroceras OZAKI em. KOBAYASHI

Manchuroceras endoi KOBAYASHI

Troedssonella KOBAYASHI

Protoecycloceratidae KOBAYASHI

Manchuroceratidae KOBAYASHI

Wolungoceratidae KOBAYASHI

Baltoceratidae KOBAYASHI

Troedssonellidae KOBAYASHI

Explanation of Plate 20(III).

Manchuroceras wolungense (KOBAYASHI.)

Figure 1. Lateral view of the siphuncle.

Figures 2-3. Polished cross sections slightly oblique to the axis of the Siphuncle. The two sections are apart 6 to 8 mm. from each other.

Figure. 4. Polished longitudinal section.

All magnified one and half times.

Figure 5. Polished longitudinal section of the endosiphuncle; X4; untouched.

Explanation of Plate 21(IV).

Manchuroceras wolungense (KOBAYASHI).

Polished longitudinal section of the endosiphuncle retouched by the author, X 14.

The specimen kept in the Geol. Inst., Tohoku Imp. Univ. Sendai, Japan.