

## NAUTILOID FOSSILS OF *YANGTZEELLA POLOI* BEDS FROM SHENSI AND HUPEI

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### Introduction

The specimens dealt with here were sent by the Museum of the Ministry of Geology to the writer for examination. They were collected from the *Yangtzeella poloi* beds of I-Chang, Hupeh; and Hanchung, Shensi. Sixteen species and varieties belonging to eight genera are described in this paper. They comprise the following species:

*Protocycloceras hupehense* (Shimizu and Obata)

*P. hupehense* (Shimizu and Obata) var. *remotum* Lai (var. nov.) *Protocycloceras?* sp.

*Thylacoceras yangtzeense* (Yu)

*Cochlioceras lingfengkowense* Lai (sp. nov.)

*C. yangtzeense* Chang

*Michelinoceras sinoceraforme* Lai (sp. nov.)

*Michelinoceras* cf. *yangi* Chang

*Orthoceras?* *thyrsus* Barrande

*Vaginoceras wahlenbergi* (Foord)

*V. endocylindricum* Yu

*V. mui* Chang

*Kotoceras curvatum* lai (sp. nov.)

*Endoceras leei* Yu

*Endoceras chienchangi* Lai (sp. nov.)

*Endoceras suni* Lai (sp. nov.)

Another genus *Bathmoceras* will be described in another paper by Prof. C. C. Yu and the writer.

The *Yangtzeella poloi* horizon of Llanvirn age is an important geological horizon in Central and South-western China. Different opinions have been expressed regarding its position in the classification of the Ordovician system. Some authors have assigned it to Late Lower Ordovician, while others consider it to be Early Middle Ordovician. To settle such differences needs further studies. Here it is attempted only to deal with the nautiloids in the Llanvirn horizon.

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### Description

**Family: *Protocycloceratidae* Kobayashi**

**Genus: *Protocycloceras* Hyatt 1900**

**Diagnosis**—Annulated orthocones or cyrtocones (with fine striae in annulations and the interspaces between them), with circular-elliptical section; siphuncle central or submarginal with its diameter equal to  $1/6$ — $1/3$  of the width of the conch; camerae of middle height; septal necks

straight and short; connecting ring thick; sutures straight and transverse.

**Remarks**—The genus *Protocycloceras*, with *Protocycloceras lamarchi* (Billings) as a type, was proposed by Hyatt for the annulated orthoceracones and cyrtoceracones without longitudinal ridges and with large siphuncle; and it has been placed with the *Cycloceratidae* under the sub-order *Orthochoanites*.

Ruedemann (1906) regarded it as an annulated endoceratid after he had restudied the genotype of this genus. Based upon the study of thin sections, Flower (1914) found that the wall of the siphuncle in this genus is made of very thick connecting rings and very short septal necks. In 1943 the description of this genus was amended by Flower as follows:

“Circular to depressed annulated cephalopods with simple sutures and a large submarginal siphuncle, apparently holochaonic, but made up of aneuchoanitic septal necks and complex thick rings”.

In 1936 Shimizu and Obata established the genus *Palaeocycloceras*, with *Protocycloceras deprati* Yu (non Reéd) collected from I-Chang, as a type species. His original diagnosis reads as follows:

“Orthoceraconic longicone, gradually expanding, subcircular in section, with narrow subcircular siphuncle; surface of test ornamented with prominent, round annulations and transverse striae, which run obliquely on the sides, arching on one side to form broad forward sinus.”

They indicate that *Palaeocycloceras* is different from *Protocycloceras* belonging to *Holochaonites* in having a narrower siphuncle, which is presumably *Orthochoanites*.

*Palaeocycloceras* is listed as a synonym of *Protocycloceras* by Flower (1945).

Our form occurring in the *Yangtzeella poloi* Beds of Lojoping and Lingfenkow, I-Chang, is referred to this genus. It is identical with those forms which were selected as genotype of *Palaeocycloceras* by Shimizu and Obata. The wall of the siphuncle consists of straight and short septal necks, having an inward oblique plane, and a thick connecting rings, beginning at the outside of the point of a septal neck, gradually expanding posteriorly, ending inside of the point of the preceding septal neck.

However, the siphuncle is narrower than that of *Protocycloceras lamarchi*. Teichert and Glenister (1954) stated that “the genus *Protocycloceras* is restricted to contain species with either large siphuncles or small siphuncles removed from the venter”. The width of the siphuncle of *Protocycloceras deprati* (Yu. 1930, p. 60 Text-fig. 6) is equal to 1/5 of the diameter of the conch, 1/4 of that in *P. hupehense* (Shimizu and Obata) var. *remotum*, 1/3 of that in *P. lamarchi* (Ruedemann 1906. Text-fig. 16). Apparently there is little difference among them.

The present writer agrees with Flower in treating a *Palaeocycloceras* as a synonym of *Protocycloceras*. But the siphuncle, which is generally central or excentral in our form, is quite different from the North American form.

### ***Protocycloceras hupehense* (Shimizu and Obata)**

(Pl. I, Figs. 1—2, 3, 4a—b, 5; Pl. II, Figs. 1a—c, 2; Pl. III, fig. 1; Pl. IV, Fig. 1; Pl. V, Fig. 4a—c, Text-fig. 1.)

**Diagnosis**—Shell straight, very gradually expanding, with circular or elliptical section. The siphuncle, 1/5—1/6 the width of the conch, is subcentral or central. The septal necks are short and grow toward the interior of the siphuncle. The connecting ring is slightly thick. Five or six camerae occupy a distance equal to the diameter of the shell, and the concavity of the septa reaches a distance equal to the depth of one or two camerae.

The sutures are straight and transverse. The oblique annulations are well-marked out, 4—5

in the diameter of the shell, cutting the sutures at an angle of  $18^\circ$ . The annulations and the interspaces between them are again covered with fine striae, which are parallel to annulations.

**Remarks**—This species is represented by internal molds. Owing to the poor preservation of the internal structure, Prof. Yu, basing upon the surface character of the mold, has placed these forms under the species *Protocycloceras deprati*.

In 1936 Shimizu and Obata established the genus *Palaeocycloceras*, with *P. hupehense* (= *Protocycloceras deprati* Yu, non Reed) as a type species, of which the internal structure is also uncertain. Under the same name it has been included a specimen, which was described and collected by Mr. Chang (1957) from the *Yangtzeella poloi* Beds at Chang-yang, Hupeh. The septal necks are of orthochoanitic, but the structure of connecting rings was not given by Chang.

**Horizon and Locality**—From the *Yangtzeella poloi* Beds of Ling-Feng-Kow and Lojoping near I-Chang, Hupeh. Cat. No. 1001—1006, 1023.

### ***Protocycloceras hupehense* (Shimizu and Obata) var. *remotum***

**Lai (sp. nov.)**

(Pl. I, Fig. 6; Pl. III, Figs. 2a—b)

**Diagnosis**—Shell small and straight, with rather large and subcentral siphuncle. The septal necks are only  $1/8$  of one camera in length. Septa are widely separated and not deeply concaved. The surface of the shell is marked by transverse annulations,  $3\frac{1}{2}$  in a space of the diameter of the shell.

**Remarks**—This form is close to *Protocycloceras hupehense*, from which it may be slightly distinguished by the transverse annulations, widely separated septa and larger size of the siphuncle. According to the external character, the present specimen may be compared with *Michelinoceras yangi* Chang, but the structure of annulations is absent in the latter.

**Horizon and Locality**—From the *Yangtzeella poloi* Beds of Lojoping, I-Chang, Hupeh. Cat. No. 1007 (Holotype.)

### ***Protocycloceras* ? sp.**

(Pl. III, Fig. 3; Text-fig. 2)

**Remarks**—The specimen is not well preserved, and external character is unknown. Although it is similar to *Protocycloceras* in the structure of the siphuncle, generic determination of this form is somewhat doubtful.

This form is distinct from any of the preceding ones in its endogastric shell and other characters.

The only species which is identical with the present specimen is *Protocycloceras cki-kunense* Kobayashi, but Kobayashi's species is characterized by high camerae and with few angular ridges.

**Horizon and Locality**—Same as the preceding species. Cat. No. 1008.

## **Family: Thylacoceratidae Teichert and Glenister 1954**

### **Genus: *Thylacoceras* Teichert and Glenister 1952**

#### ***Thylacoceras yangtzeense* (Yu)**

(Pl. II, Figs. 3a—d; Text-fig. 3)

**Diagnosis**—The shell is straight or slightly curved, with elliptical cross section. Its tapering

is rather rapid. The siphuncle is small, circular, and submarginal. The sutures have "U" shaped ventral lobes. The camerae are of middle height.

**Remarks**—Professor Yu (1930) attributed that forms, with "U" shaped lobes, to the genus *Orthoceras*. Based upon the character of the ventral lobes, *Thylacoceras* was established in 1952 by Teichert and Glenister.

The present form may be compared with *Thylacoceras yangtzeense*. But our specimen has a straight shell, narrower camerae, and shallow dorsal lobes and broad lateral saddles. Nevertheless, this difference may be considered a minor point and does not serve as a distinct specific character.

The Australian species, *T. kimberleyense* and *T. teretilobatum*, described by Teichert and Glenister (1954), have slowly expanded shell, more narrow camerae and subholochoanitic siphuncle. They differ from the Chinese specimens, which are all represented by internal moulds without any trace of the internal structures. But according to the external character, both belong to the same genus.

**Horizon and Locality**—Obtained from the *Yangtzeella poloi* Beds near Ling-Feng-Kow, I-Chang, Hupeh. Cat. No. 1014.

### Genus: *Cochlioceras* Eichwald 1860

#### *Cochlioceras lingfengkowense* Lai (sp. nov.)

(Pl. I, Fig. 7; Pl. II, Figs. 5a—b; Text-fig. 4)

**Diagnosis**—Shell straight, cyclindrical; marginal siphuncle moderately large; septal necks extending less than 1/3 the height of the camera; connecting ring almost tubular; camerae shallow; septa little concave; sutures with shallow and broad ventral saddles.

**Remarks**—In the position and structure of the siphuncle, this new species is similar to *Cochlioceras sinense* Chang, but is distinguished from one another by the following characters:

1. The ratio of the diameter of the siphuncle to that of the shell in the former is 7:18, but in the latter is 5:18.

2. The sutures in *Cochlioceras sinense* differ from those in the present form in having very low ventral lobe and shallow lateral saddle.

3. Septal necks of the former are much shorter than the latter.

**Horizon and Locality**—Same as the preceding species. Cat. No. 1013 (Holotype).

#### *Cochlioceras yangtzeense* Chang

(Pl. II, Fig. 4; Text-fig. 5)

**Remarks**—This form bears some resemblance to *Hemichoanella canningi* Teichert and Glenister in the general aspect of the septa, but differs in the feature of sutures and camerae; the sutures of the latter are with deep and narrow ventral lobes and have very closely set septa. The specimens of I-Chang are identical with those collected by Chang from Chang-Yang in the essential characters, but differ slightly from the Chang-Yang specimen in having longer septal necks.

**Horizon and Locality**—This species occurs in *Yangtzeella poloi* beds of Lojoping, I-Chang, Hupeh. Cat. No. 1012.

**Genus: *Michelinoceras* Foerste 1932*****Michelinoceras sinoceraforme* Lai (sp. nov.)**

(Pl. IV, Fig. 2; Text-fig. 6)

**Diagnosis**—Shell orthoceracone, with subelliptical section; camerae very deep; septal necks, with tubular connection rings, being greater than  $1/3$  the height of the camera.

**Remarks**—This new species resembles *Orthoceras elongatum* Yu in the shape of camerae, but differs from the latter in its longer septal necks. It may be also compared with *Michelinoceras michelini* (Barrande), collected from the Middle Silurian Rocks. Both are distinguished by the following differences:

1. The cross section of the shell is circular in the latter, but subelliptical in the former.
2. The septal necks are much shorter in the Barrande's species.

**Horizon and Locality**—*Yangtzeella poloi* Beds of Liangshan, Hanchung, southern Shensi. Cat. No. 1010.

***Michelinoceras* cf. *yangi* Chang.**

(Pl. II, Fig. 6; Text-fig. 7)

**Remarks**—Our specimen is identified with by Chang's species but differs from the holotype of *Michelinoceras yangi* in the character of the very short septal necks and in having siphonal and cameral deposits.

**Horizon and Locality**—*Yangtzeella poloi* beds of Ling-Feng-Kow, I-Chang, Hupeh, Cat. No. 1009.

***Orthoceras* ? *thyrsus* Barrande**

(Pl. II, Figs. 7a—c)

**Remarks**—The specimens photographed here are identified to *Orthoceras thyrsus* Barrande, owing to the essential characters common to both forms. The only difference is with regards to the septal necks. The length of septal necks in Barrande's specimen is equal to  $1/5$  the camera, while in our specimen about  $1/11$ . The siphuncle of this species is submarginal, differing from that of *Orthoceras*, in which it is central. Generic designation of this species is however questionable.

**Horizon and Locality**—From the *Yangtzeella poloi* beds of Ling-Feng-Kow, I-Chang, Hupeh, Cat. No. 1011.

**Family: *Endoceratidae* Hyatt 1884****Genus: *Vaginoceras* Hyatt 1884*****Vaginoceras wahlenbergi* (Foord)**

(Pl. V, Figs. 1a—b; Text-fig. 8)

**Remarks**—The specimen photographed here is identified to Foord's species in accordance with the same general characters, except that it tapers at the rate of 1:20.

**Horizon and Locality**—*Yangtzeella poloi* beds of Lojoping, I-Chang, Hupeh, Cat. No. 1015.

***Vaginoceras endocylindricum* Yu**

(Pl. III, Figs. 6a—b; Text-fig. 9)

**Diagnosis**—Slender orthoceracone, with closely arranged septa, circular section and slow rate of growth (as 1 to 9); siphuncle large, one fourth the width of the conch, marginal in position, circular in cross section; Length of the septal necks about that of two camerae combined; connecting ring absent; septa slightly concave; endoconch very deep, endosiphuncle situated at the siphonal central position.

**Remarks**—The present species resembles *Vaginoceras multiplectoseptum* Yu in general outline, but differs from the former in the nearly approximate septal distance, smaller siphuncle and other characters. Except the endoconch and endosiphuncle which are not preserved, the structure and the position of the siphuncle of our form belongs to *Vaginoceras endocylindricum* Yu.

**Horizon and Locality**—Same as the preceding species. Cat. No. 1016.

***Vaginoceras mui* Chang**

(Pl. II, Figs. 9a—b, 8, Pl. III, Fig. 4, 5; Text-fig. 10)

**Remarks**—The present specimen, collected from I-Chang, differs slightly from those described by Chang from Chang-yang, in having a slightly curved conch in the oximal end, and longer septal necks, and wider siphuncle than the other form (Pl. III, Fig. 3). Nevertheless, this difference may be of individual variation. The surface of the endoconch is undulatory and this feature, which is also represented in Chang's Plate (Pl. III, Fig. 2b), is considered to be characteristic of this species.

**Horizon and Locality**—*Yangtzeella poloi* beds of Ling-Feng-Kow, I-Chang, Hupeh. Cat. No. 1017, 1018.

**Genus: *Kotoceras* Kobayashi 1934*****Kotoceras curvatum* Lai (sp. nov.)**

(Pl. II, Figs. 10a—b, Pl. IV, Fig. 3; Text-fig. 11)

**Diagnosis**—Shell slightly endogastric, with a large and marginal siphuncle; its diameter equals to one half the width of the conch; camerae crowded; the length of the septal necks is equal to the height of one and a half camerae; endoconch deep; its apex situated close to the dorsal wall of the siphuncle.

**Remarks**—In the shape of the conch, the new species may be compared with *Cameroeras curvatum* Ruedemann in which the camerae are very crowded and the apex of the endoconch is situated at the centre of siphuncle, while in our specimen camerae are much wider and the apex of the endoconch is close to the dorsal wall.

In the position of the endoconch and the size of the siphuncle, the new species is similar to *Kotoceras typicum* Kobayashi, but differs from the latter in having a curved shell and broad camerae and other characters.

**Horizon and Locality**—*Yangtzeella poloi* Beds of Ling-Feng-Kow, I-Chang, Hupeh, Cat. No. 1019 (Holotype).

**Genus: *Endoceras* Hall 1847*****Endoceras leei* Yu**

(Pl. II, Figs. 11a—b; Pl. V, Fig. 2; Text-fig. 12)

**Remarks**—Our specimen is identified with *Endoceras leei* Yu from Chang-Yang-Hsien. It differs from the latter only in having a smaller shell and more rapid tapering.

**Horizon and Locality**—Same as the preceding species. Cat. No. 1022.

***Endoceras chienchangi* Lai (sp. nov.)**

(pl. III, Figs. 7a—b; Pl. IV, Fig. 4, Pl. V, Fig. 3; Text-fig. 13)

**Diagnosis**—Orthoceracone, with circular section and closely arranged septa; septa slightly concave; marginal siphuncle very large, occupying one half the width of the conch, and in contact with the outer wall; sutures with rather deep ventral lobes, one siphonal saddle opposite the siphuncle, and with very low lateral saddles and dorsal lobes; septal necks extending a little longer than the septal distance; connecting ring rather thick, forming a structure of eyelet in its anterior end

**Remarks**—This new species is characterized by the feature of the sutures and differs from any species of that genus. It may be compared only with *Endoceras montrealense* Billings, but is distinguished from one another by the following differences:

1. In *E. montrealense*, the apex of the siphonal saddle of the ventral lobe is arched, but in *E. chienchangi*, it is nearly flat.

2. In regard to the distance of the septa, however, there is a close resemblance between them. The concavity of the septa is equal to two camerae in Billings's species, but less than one camera in our new species.

3. Our shell has much larger siphuncle.

**Horizon and Locality**—Same as the preceding species. Cat. No. 1021 (Holotype).

***Endoceras suni* Lai (sp. nov.)**

(Pl. IV, Fig. 5; Text-fig. 14)

**Diagnosis**—Cylindrical orthoceracone, with very gradually expanding and moderately deep camerae; Siphuncle very wide, one half the width of the conch, situated at the central in neanic stage, but marginal in ephebic stage, and decreased in size; septal necks extended for nearly one camera's length; Endosheaths relatively few; Endoconch deep, apical angle about 25°.

**Remarks**—The present form resembles *Endoceras leei* Yu in outline, but differs from the latter in having a larger apical angle of the endoconch and marginal siphuncle in ephebic stage.

It is also similar to *Endoceras proteiforme*, but distinguished from the latter, in having a larger marginal siphuncle and numerous endosheaths.

**Horizon and Locality**—From the *Yangtzeella poloi* Beds near Lojoping, I-Chang, Hupeh. Cat. No. 1020 (Holotype).