

## PERMIAN CEPHALOPODS FROM TANCHIASHAN, HUNAN

CHAO KING-KOO

*Institute of Palaeontology, Academia Sinica*

(with 4 text-figures and I-VII Plates.)

The present paper deals with the material of fossil cephalopods largely collected by Mr. Y. C. Hsü and the writer in the spring of 1944, from the Tanchiashan Coal-field in the Hsiangtan district, Central Hunan. It also includes the specimens procured by Prof. C. Y. Hsieh in 1937 and described by the writer in 1940 in a paper entitled "Upper Palaeozoic Cephalopods from Central Hunan". These two collections were secured at two nearby localities in the western part of the coal field, situated about two and half kilometers south-west of Changlingpu.

The fossils are preserved in the clay shales with abundant iron nodules, and are composed almost exclusively of cephalopods. Among the hundreds of specimens there are only three small pelecypods of the *Carbonicola* group associated with the cephalopods. The cephalopod faunule contains both numerous nautiloids and ammonoids; all of which are well preserved. It is interesting to note that the nautiloids are rich in generic varieties; whereas the ammonoids are abundant in individuals.

The geology of the region has been worked out by many geologists. Hsieh gave in 1937 the following somewhat simplified table of the main divisions of strata in descending order:

1. Upper Siliceous bed with "*Gastrioceras*", *Chonetes* and *Productus*, 200 m.
2. Upper shale series, 20 m.
3. Coal series with *Gigantopteris* and *Sphenophyllum*, 80 m.
4. Middle siliceous bed, 180 m.
5. Lower shale series with cephalopods, 60 m.
6. Lower siliceous bed, 135 m.
7. Black shale and thin-bedded, crystalline limestone with corals and brachiopods, thickness unknown.

The coal series (bed 3) containing *Gigantopteris* and *Sphenophyllum* can undoubtedly be correlated with the Loping coal series of Kiangsi. Everywhere in South China the *Gigantopteris* coal series lies upon the Yangsin limestone or

its equivalents with a remarkable disconformity. It would be logical to consider that the beds (4-7) below the disconformity represent the older Yangsinian. The lower shale series (bed 5), from which the present fossils were derived and its overlying siliceous bed (bed 4) are members of the higher part of the Yangsinian. These two horizons (beds 4 and 5) probably are the representatives of the Kufeng shale of Lower Yangtze valley or the Maokou limestone of Southwestern China.

The material contains 24 species of nautiloid grouped into 18 genera and 4 species of ammonoid in 3 genera. Most of them are new forms. This is the richest cephalopod faunule hitherto known in the Permian of China.

A few words should be said on the paleo-ecology of the fossils. It is known that the cephalopods are subordinate forms among the invertebrate fossils in the Upper Palaeozoic rocks in this country. The discovery of rich cephalopod faunule in this region is therefore of special interest. The physical condition in this region during the early Permian must have been particularly favourable for the preservation of this kind of organisms. The rock in which the fossils were embedded, is ocherous clay shale rich in marcasite nodules. All the fossils are also mineralized with excessive iron substances on the shells. It is reasonable to conceive that the iron content is of secondary origin. The ferruginous character of the rock as is indicated by the ocherous color, suggests that the sediment was accumulated in a water body cloudy in nature and rich in iron content. This kind of physical environment seems to be teast favourable for most living organisms. The absence of other groups of fossils in the collection strongly supports such a conclusion. The small number of pelecypod may be native dwellers, for their valves are still in contact. The cephalopods might have been transported to this region from the neighboring open sea waters. This is inferred from the fact that these shells have greater buoyance and most of the nautiloids are broken specimens, especially the loosely coiled forms. The above conclusion is drawn from the observations in the limited area and in a few sections; a detailed geological and palaeontological investigation in the area is eagerly awaited.

The following species are described in the present paper:

1. *Pseudorthoceras* sp.
2. *Cycloceras hsiangtanense* sp. nov.
3. *Tienoceras lenticulare* gen. et sp. nov.

4. *Stearoceras* sp. A.
5. *Stearoceras* sp. B.
6. *Endolobus obsoletus* sp. nov.
7. *Endolobus hsiangtanensis* sp. nov.
8. *Domatoceras* aff. *fredericki* Kruglov.
9. *Stenopoceras orientale* Chao
10. *Tainoceras hunanense* Kayser
11. *Tainoceras changlingpuense* sp. nov.
12. *Hunanoceras globosum* gen. et sp. nov.
13. *Aulametacoceras binodosum* sp. nov.
14. *Temnocheilus multituberculatus* var. *latinodosus* var. nov.
15. *Foordiceras* sp.
16. *Tanchiashanites marginalis* gen. et sp. nov.
17. *Liroceras sinense* (Chao)
18. *Liroceras orientale* sp. nov.
19. *Livoceras* sp.
20. Gen. et sp. Undet.
21. *Ephippioceras involutum* sp. nov.
22. *Ephippioceras hunanense* sp. nov.
23. *Solenochilus auriculus* sp. nov.
24. *Periptoceras hsüyüchiani* sp. nov.
25. *Imitoceras multiseptatum* Chao
26. *Pseudohalorites subglobosus* Yabe
27. *P. celestris* Yabe
28. *P. celestris* var. *densistriatus* var. nov.
29. *Yinoceras lenticulare* gen. et sp. nov.

### Description of Species

#### NAUTILOIDEA

#### Genus *Pseudorthoceras* Girty 1911

#### *Pseudorthoceras* sp.

(Pl. I, Fig. 2)

This is represented by three fragments. The best one upon which the following description is made, is an internal mold, 19 mm long, consisting of 8 camerae. The cross section of the shell is circular in outline, the diameter of the lower end is 7.8 mm across the center. The upper end is 9.8 mm. The height of camera is 2.5 mm. The second specimen shows that the siphuncle is very

small, centrid in position, each septum bears a short septal neck, about one-fourth of the height.

### Genus *Cycloceras* M'Coy, 1844

#### *Cycloceras hsiangtanense* Chao sp. nov.

(Pl. I, Fig. 3)

The generic name *Cycloceras* was first proposed by M'Coy in 1844, and three species were referred to it, without designation of its genotype. In 1915, Bassler listed *Orthoceras annulare* Fleming, the first species described by M'Coy, as the genotype, which was accepted by Foerste in 1932 and rediagnosed to include those forms with "Annulated conchs, with transverse striae, but without vertical markings of any kind". Early in 1924, Foerste selected *Orthoceras rugosum* Flem. as the genotype of *Cycloceras*, and proposed a new generic name, *Perigrammoceras* for three forms with "Orthoceracones with transverse annulations and striae, but without vertical striae or ribs", taking *Orthoceras laevigatum*, the second species described by M'Coy, as the genotype. As has been pointed out by Miller, Dunbar and Condra in 1933, these two genera only differ materially one from the other in the shape of annulations, they therefore listed *Perigrammoceras* as a synonym of *Cycloceras*.

In the Hunan collection there is one fragmentary specimen, 14 mm long, consisting of 5 camerae. It bears three annulations, which are sharp-edged, about 5 mm apart, and is essentially perpendicular to the long axis. The circular-suture lines are slightly oblique to the long axis of the conch. The siphuncle is small and is located near the dorsal side.

The present specimen resembles closely *Cycloceras annulare* (Fleming) and *C. undatum* (Roemer non Fleming) in the shape of annulations and in the thickness of camerae, but differs from these species in having the more distant and much sharper ridges. From the Bituani Beds of Middle Permian in Timor, Haniel described in 1951 a species "*Orthoceras*" *naubesiense* which is closely related to the present species, differing only in having the much thicker camerae and in the centrid position of the siphuncle. "*Orthoceras*" *sinuosum* Mansuy from Chou Tang in Yunnan is a much smaller specimen, which is too imperfectly known and can hardly be comparable with the Hunan example. The two forms "*Orthoceras*" *cyclophorium* and "*Orthoceras*" *oblique-annulatum* of Salt

Range are also annulated forms. The grooves in the former species is much deeper than those of the present specimen. The latter form is quite different from our species as implied by its specific name.

**Genus *Tienoceras* Chao gen. nov.**

**Genotype: *Tienoceras lenticulare* Chao gen. et sp. nov.**

(Pl. 1, Fig. 1)

In the material there is a single fragmentary representative, which is morphologically quite like that of the Ordovician genus *Gonioceras*, being lenticular in cross section with the suture lines curving backward on the central part and arching upward on the wings of the ventral and dorsal sides. Two angular lobes are located on the lateral edges. The adoption of the new generic name *Tienoceras* is to place on record the enthusiasm and careful work of Dr. C. C. Tien, to whose labours we are indebted for the valuable knowledge of Palaeontology and stratigraphy of Hunan province. The characteristics of the genotype is briefly given as follows:

The specimen at the writer's hand consists of 5 camerae, and measures about 22 mm in length. The conch is straight, lenticular in cross section. The medial portions of the ventral and dorsal sides are more or less flat, or slightly depressed. Two rather shallow but distinct longitudinal depressions or grooves are marked on the lateral medial parts on each side of the conch. The lower end measures 21.5 mm wide, 11.5 mm thick; whereas the upper end measures 25.5 mm wide, 12.8 mm thick. That is, the lateral expansion of the conch is 4 mm in 20 mm distance, and the thickness is only slightly increased. Camerae on the preserved part vary from 3 to 4 mm in thickness. Suture lines curve backward in the medial zone of the ventral and dorsal sides, then arch upward in the lateral medial zones of the ventral and dorsal sides, and finally bend backward rather rapidly across the lateral edges, forming sharp, lateral lobes. Surface smooth. Siphuncle small, subcentrid in position, structure unknown.

**Genus *Stearoceras* Hyatt 1893**

(= *Permonutilus* Kruglov parti)

In the collection there are three fragmentary examples, which bear striking

resemblance to the forms figured by Kruglov under his new genus *Permonutilus* from the Permian of Volga basin. As has been pointed out by Miller and Youngquist (1949, p.49, 120) the genotype of the mentioned genus, *Nautilus cornatus* Golovkinsky, is congeneric with the type species of *Acanthonutilus*, *A. bispinosus* Foord. They suppressed the genus *Permonutilus* in favor of *Acanthonutilus*, which has priority. The other forms, namely, *P. pinegaensis*, *P. kargovokensis* and *P. sp.* were referred to *Stearoceras*. Following these two authors the three fragments are tentatively included in *Stearoceras*. Two species can be distinguished.

#### ***Stearoceras* sp. A**

(Pl. I, figs. 9-14)

Two fragments are referred to this species. The shells are rather thick, evolute and perforate, expanding rapidly. The whorls are strongly depressed ventro-dorsally and are much wider than high with subtrapezoidal cross section. The venter is wide and flattened. The dorsal part is slightly impressed by the inner volution. The sides are narrowly rounded or with a flattened zone in the outer part of the last whorl. The camerae are moderately thick, varying from 3.5-4.5 mm. The siphuncle is small and centroventral in position. The suture lines are essentially straight across the broad venter.

#### ***Stearoceras* sp. B**

(Pl. II, figs. 9-11)

The form is represented by a unique fragment. The shape is essentially like that of the preceding, differing from it in the greater thickness of camerae (6 mm).

### **Genus *Endolobus* Meek and Worthen 1865**

#### ***Endolobus obsoletus* Chao sp. nov.**

(Pl. I, Figs. 5-8)

The shell is discoid, evolute and perforate with a wide umbilicus. It consists of only two and half volutions. The whorl increases rather regularly in height and

width and is more or less depressed ventro-dorsally, giving a sub-elliptical cross section. The venter is broad, regularly arched. The dorsal side is very slightly impressed by the penultimate volution. The lateral sides are strongly arched with the maximum width at the middle part. Faint, low and elongated nodes or ridges seem to exist on the penultimate volution, but the surface is smooth for the most part of the outer volution, or marked only with fine lines of growth. The ridges are more conspicuous in the fragmentary specimen (Pl. I, fig. 7). The inner volution is quadratic in section with flat sides and well rounded umbilical shoulders. The body chamber is not preserved in the specimen. The suture line is almost straight across the broad venter. Only a very shallow, broad, gently backward curving lateral lobe is present on the dorso-lateral part of the volution. The siphuncle is small and subcentrid in position.

Remarks: This species is closely related to *Nautilus (Tenucheilus) atuberculatus* Tzwetaev in some respects, it differs from the latter species in the elliptical section of the whorl. The test of our species is smooth throughout.

***Endolobus hsiangtanensis* Chao sp. nov.**

(Pl. I, Fig. 4)

This species is represented by a small, discoidal, evolute and perforate shell, consisting of one and half volutions. The whorl is much wider than high, increasing rather rapidly. The umbilicus is rather wide and open, about one-third of the diameter. The whorl section is sub-trapezoidal in the inner volution, and becomes sub-elliptical in the outer portion of the conch. A distinct ridge exists on the mid-lateral part on each side of the inner volution, forming the maximum thickness of the conch. It disappears towards the outer portion of the volution, where the lateral side is well rounded. The venter is very broad and regularly arched. The dorso-lateral side is very smooth, sloping downward towards the umbilicus, where it bends downward abruptly to form a rounded, rather shallow shoulder. The dorsal part is slightly impressed by the preceding whorl. The perforation is rather large.

The body chamber is not preserved. The test is completely worn away, exposing all of the suture lines. The surface ornamentation is thus unknown. The septa are well spaced. The height of the camerae varies from 2.6 mm in the penultimate volution to 3.3 mm in the outermost part of the last whorl.

The suture line consists of a very broad, shallow ventral lobe, a rather distinct, broad saddle on the mid-lateral part across the lateral ridge, a shallow, lateral lobe on the dorso-lateral part and a small, rather distinct saddle on the umbilical part and a small, rather distinct saddle on the umbilical shoulder, with the apex on the shoulder. The siphuncle is rather large and centrodorsan in position, probably orthochoanitic.

### Genus *Domatoceras* Hyatt 1891

#### *Domatoceras* aff. *fredericksi* Kruglov

(Pl. II, Figs. 1-4)

1928 *Domatoceras fredericksi* Kruglov. Upper Carbon, and Artinskian Nautilidae of the Urals, p. 186 Pl. XIV, figs. 1-6.

In the collection under studying we have a complete representative of this species, which is moderately large, composed of two and half volutions. Form discoid, evolute, rather thick with a wide and deep umbilicus, which is about two-thirds of the diameter. The dimensions are given below:

D. 58 mm. T. 27 mm. H. 26 mm. U. 20 mm.

Whorl increases rather rapidly and is quadratic in section, with the height and the width equal. Venter broad, regularly rounded in the inner volution. A faint, wide and shallow depression exists on the outer vertical portion. Lateral sides rounded in the inner volution, becoming flattened towards the outer one with the maximum thickness on the umbilical edge. Shoulder rounded. Wall inclined steeply. Dorsal slightly incised by the preceding volution. Surface marked with fine, sigmoid lines of growth. Camerae moderate thick, 6 mm. Each side of the external suture line with a broad, shallow ventral lobe, a rather high, distinct saddle on the ventro-lateral angle, and a rather distinct, broad lateral lobe on the flat side. Siphuncle small, dorso-centrid in position.

Remarks: The specimen is very closely related to *Domatoceras fredericksi* Kruglov in the general shape, whorl section and the suture line. It only differs from the mentioned species in having a little smaller umbilicus. The rate of expansion of the whorl of our specimens is not so rapid as is shown in Kruglov's specimen. In some respects it resembles *Nautilus (Domatoceras) hunicus* Diener and *Domatoceras arthaberri* Haniel, but it can be easily distinguished from them in having the whorl section much wider than high, whereas in the mentioned

species the proportion is reversed.

**Genus *Stenopoceras* Hyatt 1893**

***Stenopoceras orientale* Chao**

(Pl. II, Figs. 1-4)

1940 *Stenopoceras? orientale* Chao. Upper Palaeozoic Cephalopods from Central Hunan, *Journ. Pal.* 14(1), 70, pl. 9, figs. 5-7.

In his previous paper, the writer described and figured a specimen under the name *Stenopoceras? orientale* characterized by its high and much compressed whorl and the nature of the suture line. The present specimens show very clearly the characteristics of the species, particularly the acute venter of the last volution. The diagnosis is here reprinted with some slight alternations due to the study of a larger amount of material.

Shell moderately large, discoid, perforate, consisting of two volutions. Umbilicus rather small, about one-fifth of the diameter. Whorls increasing rapidly, slightly compressed laterally in the inner volution and strongly compressed in the outer one. Whorl section elliptical in the young stages, becoming triangular in the adult, much higher than wide. Venter rounded with three faint, low spiral ridges in the inner one and half volutions, becoming, gradually acute towards the outer portion of the last volution, and finally forming a sharp keel in the region of body chamber. Lateral sides broadly arched in the inner volutions, becoming flat or slightly swollen towards the outer portion of the last volution. Maximum thickness lies in the medial portion of the lateral sides in the inner volution, migrating gradually towards the umbilical shoulder as the lateral compression becoming strong in the outer volution. Umbilical shoulder rounded; dorsal side slightly impressed by the preceding whorl. Body chamber very long and large, about half in length of the last volution. Camerae moderately thick, increasing regularly. Surface smooth.

The mature suture line consists of a high, sharply pointed ventral saddle; two low, very broad, lateral lobes, inclining backward; two lateral, low, broad saddles on the umbilical walls and a very shallow, rather broad lobe in the dorsal impressed zone.

Siphuncle small, dorso-centrid in position, probably orthochoanitic in structure.

Remarks; The present species is characterized by the rather wide umbilicus and by the rounded venter in the young stages, becoming acute in the outer volution. None of the numerous American forms of this genus recently given by Miller and Younquist (1949 *Mem.* 41, *Geol. Soc. America* p. 70-80) is closely comparable with the present species.

**Genus *Tainoceras* Hyatt 1883**

***Tainoceras hunanense* sp. nov.**

(Pl. III, Figs. 1-4)

The collection under study contains four fragmentary specimens of this species. Three of them are composed of about half of the outer volution and part of the inner one. All of them are well preserved showing the general character of the species, which enables the writer to give the following description.

Shell moderately large, discoid, rather thick, consisting of two and half volutions. Umbilicus large, rather deep. Whorls expand slowly and regularly, slightly compressed ventro-dorsally, giving a trapezoid section in the inner volution, and becoming roughly circular in the outer portion of the last volution. Venter broad, regularly arched, marked with two rows of prominent nodes in pairs being narrowed slowly towards the umbilical shoulder and disappear abruptly on the ventral side. The number of these nodes is about half of those on the venter. Lateral sides smooth in the inner volution, becoming distantly ribbed in the outer by elongation of the ventrolateral nodes. Umbilical shoulder angular in the inner volutions, becoming rounded towards the outer portion of the last whorl. Wall steep and high. Dorsal side flat or slightly impressed by the preceding penultimate volution in the medial zone. Surface smooth or marked with exceedingly fine lines of growth. Aperture rounded.

Suture line like that of other species of the genus, being composed of a broad, shallow ventral lobe, two broad shallow lateral lobes; two low, wide saddles on the ventrolateral angles; two faint, wide saddles on the umbilical walls and a narrow, shallow dorsal lobe in the impressed zone.

Siphuncle small, and sub-centrid in position, probably orthochoanitic in structure.

Remarks: the inner volution is only partly preserved. As judged from the

smooth character of the lateral sides, the venter of the inner volutions probably also bears no nodes. The nodes begin to appear on the last half of the penultimate volution.

The present species is closely allied to *Tainoceras quadrangulatum* (McChesney), the genotype of the genus, but differs from it in having the lateral sides much narrower and inclining slowly towards the umbilicus. *Tainoceras orientalis* Kayser from the Loping district, resembles in many respects the present species, but the nodes in that species beside the medial groove, are arranged in an alternative manner, instead of in pairs as that in the Hunan form, which enables us to distinguish them very easily.

***Tainoceras changlingpuense* Chao sp. nov.**

(Pl. III, Figs. 5-8)

Shell thick, discoid, consisting of two volutions only. Umbilicus rather small and deep, about one-third of the diameter. Whorls expand rapidly, compressed ventro-dorsally, giving a rectangular cross section. Venter broad, marked with two rows of distinct, isolated nodes, arranged in pairs and is separated by a rather wide, median groove, occupying about one-third of the width. Ventro-lateral angle marked with sharp, angular edge, smooth in the inner volution. Nodes begin to appear towards the outer portion of the last whorl, and forming the greatest thickness of the conch. Lateral sides narrow and flattened, inclining slowly towards the umbilicus, smooth in the inner volution and becoming ribbed in the outer volution. The ribs make their appearance near the umbilical shoulder, widening gradually outward and terminating suddenly on the ventro-lateral angle, forming the nodes of that region. Umbilical shoulder angular in the inner volution, becoming rounded towards the outer portion of the conch. Umbilical wall high and steep. Dorsal slightly impressed by the preceding volution. Aperture not preserved.

Suture line with a broad, rather shallow ventral lobe; a rather low but distinct saddle on the ventro-lateral angle and a narrow, shallow dorsal lobe in the impressed zone on half side of the conch.

Siphuncle small, centrid in position.

Remarks: Of this species we have only a few fragmentary specimens. It can be easily distinguished from any other forms of the genus by its much

smaller umbilicus, more involute characters and narrow lateral sides. It resembles in some respects *Tainoceras noettingi* Frech on the surface sculpture, but the narrow lateral sides and the rapid expanding of the conch enable us to distinguish them very easily one from another. *Tainoceras orientalis* (Kayser) bears similar nodes on the venter, but in that species they are linked one another by low, faint ribs; whereas in the present species they are isolated.

**Genus *Hunanoceras* Chao Gen. nov.**

**Genotype: *Hunanoceras globosum* Chao gen. et sp. nov.**

In the collection under studying there are several well preserved specimens bearing two rows of nodes on the venter. At first, the writer intended to refer them to the genus *Tainoceras*. A closer examination shows that they are quite different from any forms of that genus. They are globose forms much compressed ventro-dorsally with the umbilicus rather wide and deep. The most characteristic feature is the absence of a delimited flat zone on the lateral sides, where a distinct, sharp longitudinal ridge is present, forming the maximum thickness of the conch, instead of flat zone as most species of *Tainoceras* possesses. For these reasons, a new generic name *Hunanoceras* is here proposed. It can be briefly diagnosed as follows:

Shell very thick, globose, perforate, consisting of one and half volutions. Umbilicus rather wide and deep. Whorls expand rapidly, much depressed ventro-dorsally. Venter very broad, marked with two rows of nodes. There is no flat lateral zone, where is occupied by sharp ridges forming the maximum thickness of the conch. Dorsal part much impressed by the preceding volution. Umbilical wall high and steep. Suture line almost straight, with only shallow lobes on the ventral and ventro-lateral parts separated by saddles on the node region and on the spiral ridges. Siphuncle small, dorsocentrid in position, probably orthochoanitic in structure.

Aperture low and wide with a wide hyponomic sinus.

Whether *Tainoceras duttoni* Hyatt from New Mexico should be included in this genus or not can not be ascertained. The whorl section in that species agrees fairly well with that of this genus, but the umbilical edges in that form bear two rows of nodes.

***Hunanoceras globosum* Chao gen. et sp. nov.**

(Pl. III, Figs. 9-15)

Shell very thick, globose, perforate, consisting of one and half volutions. Umbilicus rather wide, deep and open, about one-third of the diameter. Whorls much compressed ventro-dorsally, increasing rapidly and lunar in cross section. Venter broadly rounded, marked with two rows of elongated nodes, which disappear gradually towards the outer portion of the last volution, forming a broad, smooth, well rounded venter. Lateral sides not delimited; the corresponding position is marked with sharp, spiral ridges, forming the shoulder of the umbilicus and the maximum thickness of the conch. Ventro-lateral part smooth, sloping rapidly outward towards the venter. Umbilical wall high and steeply inclined. Dorsal part considerably impressed by the inner penultimate volution. Aperture low and very wide, with a broad hyponomic sinus on the venter.

Each side of the suture line consists of a shallow ventral lobe, a low saddle on the nodal region, a shallow lobe on the ventro-lateral area and an indistinct saddle on the ridge, then bending backward on the umbilical wall.

Siphuncle small sub-centrid in position, and orthochoanitic in structure.

**Genus *Aulametaceras* Miller & Unklesbay, 1942*****Aulametaceras binodosum* Chao sp. nov.**

(Pl. IV, Figs. 1-6)

The writer formerly described a single fragment under the name *Stroboceras?* sp. (*Journ. Pal.* vol. 14, No. 1, p. 69; Pl. 9, figs. 1,2), which is now confirmed to be a fragment of the present form on account of presence of spiral ridges on the venter. The following description of this species is based upon 12 specimens, among which two are complete individuals.

Form discoid, thick, perforate with a large umbilicus, consisting of two and half volutions. Whorls increase regularly and depressed ventro-dorsally and quadratic in section. Venter wide, broadly arched and is marked with numerous longitudinal striations in the inner volution, which disappear gradually towards the outermost volution, where a medial, narrow, shallow but distinct groove is present and persists throughout towards the aperture. Lateral sides rather nar-

row, flat and slightly depressed. Ventro-lateral edges well rounded, each marked with a row of rather distinct elongated nodes. Umbilical shoulder arched rather abruptly and also marked with a row of nodes but much smaller in size. These nodes are arranged in pairs and are located on the camerae, which are about 2-4 mm thick in the outer volution. Umbilical wall rather deep, steeply inclined towards the umbilical junction. Dorsal portion slightly impressed by the preceding volution.

Aperture not preserved. Siphuncle small and sub-centrid in position.

Each side of the external suture line consists of a broad, shallow ventral lobe; a low, wide saddle with its highest apex on the ventro-lateral angle; a broad, shallow lateral lobe and a low, wide saddle on the umbilical wall with its apex at the junction of the volutions and a dorsal lobe in the impressed zone. The inner suture is formed by a distinct dorsal lobe in the impressed zone.

### Genus *Temnocheilus* M'Coy, 1844

#### *Temnocheilus multituberculatus* var. *latinodosus* Chao var. nov.

(Pl. IV, Figs. 13-15)

1879 *Nautilus multituberculatus* Waagen. Salt Range Fossils, *Paleont. Indica*, Ser. XIII 1, pt. I, p. 51, pl. VI, fig. 5.

1928 *Temnocheilus multituberculatus* (Waagen). Kruglov. Upper Carboniferous and Artinskian Nautiloids of the Urals, *Travaux du Musee Geol. Acad. des Sci. de l'Union des USSR*, Tom. III, p. 105.

1933 *Nautilus multituberculatus* Waagen. Miller, Dunbar and Condra: Nautiloid Cephalopods of the Pennsylvanian System in the Mid-Continent Region, *Nebraska Geol. Surv. Bull.* 9, p. 195.

1933 *Temnocheilus* sp. Yin. Cephalopods of the Penchi and Taiyuan series of North China, *Pal. Sinica* Ser. B, vol. 11, Fasc. 3, p. 18, pl. II, fig. 7.

The present species is represented by a single fragmentary specimen which consists of a large portion of the shell and shows well the essential characteristics. It comprises three volutions and is disci-form, with a wide and rather deep umbilicus. The approximate measurement is given below: D. 40 mm; T. 19 mm; H. 12 mm; U. 21 mm. The cross section of the whorl is trapezoidal in outline with the outer part much depressed, forming a wide, gently and evenly arched venter. The last whorl is marked by many prominent, distant, elongated nodes or ridges on the middle part of the lateral sides, which are perpendicular to the long axis of coiling. The dorsal is slightly impressed by the penultimate volu-

tion. The dorsal-lateral part slopes regularly and gently towards the umbilical suture, without distinct umbilical shoulder. The nodes or ridges disappear just a little before the umbilical suture is reached. As the specimen is fragmentary, the number of nodes in the complete volution can not be ascertained; but as is measured in the preserved part of the last whorl, which is 5 in number in 4 cm, the complete volution may comprise 11—12 ridges. The inner two volutions bear no nodes and the whorl section seems to be rather sub-tetragonal, with rounded shoulders.

The surface seems rather smooth, with faint lines of growth. The aperture is not preserved.

The suture lines, as exposed on the last volution, are straight across the venter and are perpendicular to the long axis of volution. Siphuncle small, dorso-centrid in position.

Remarks: The nearest form of the present species is *Nautilus (Tannocheilus) multituberculatus* Waagen. It differs from the mentioned species in having much smaller number of nodes, being 5 in 4 cm, instead of 8 in the same distance, as Waagen's specimen shows (pl. VI, fig. 5). *Tannocheilus* sp. Yin bears similar distant nodes on the lateral, which are comparable with the present form, but it is too fragmentary for more precise comparison. The species occurs in much lower geological horizon (Taiyuan Series). Kruglov recorded two varietal forms, *Tannocheilus multituberculatus tastubensis* and *T. multituberculatus simensis* from the Urals. They differ from the present form in having the ridges much narrower, greater in number and oblique in direction.

The nodes on the outer volution are quite like those of *N. nikitini* Tzwetaev, differing only in the absence of nodes on the inner volutions and its straight suture-lines.

### Genus *Foordiceras* Hyatt 1893

#### *Foordiceras* sp.

(Pl. IV, figs. 7-12)

Four fragmentary specimens are provisionally referred to this genus on account of the presence of distant, transverse ribs on the lateral sides. The whorl section is quadratic with distinct ventro-lateral edges and shoulder angles. The venter is broadly flattened with very gentle convexity. The flanks are also com-

pressed, marked with sharp, distant, transverse ribs. These ribs become most pronounced on the ventro-lateral edges, forming nodes, then disappear suddenly on the ventral part. The dorsal side is provided with three longitudinal ridges in one specimen 4 (Pl. IV, Fig. 9).

The suture-lines are well shown in the specimen. Each consists of four shallow broad lobes on the ventral, dorsal and lateral sides, and four distinct saddles on the ventro-lateral and shoulder edges. The siphuncle is small and centrid in position.

#### Genus *Tanchiashanites* Chao gen. nov.

Genotype: *Tanchiashanites marginalis* Chao gen. et sp. nov.

There are three specimens at the writer's hand, which though fragmentary, show fairly well the general shape of the conch. They can not be referable to any known genus. A new generic name *Tanchiashanites* is here proposed for these specimens. It resembles the Triassic genus *Pleuromutilus* in having the lateral ribs, but the venter of that form is broadly rounded; whereas the venter of our form is flat or bicarinate. Yin described and figured a specimen, *Pleuromutilus nodosostriatus* Yin, which bears elongated nodes on the lateral sides and seems to have a narrow and flat venter. All these characters suggest that Yin's species may fall in the present genus. According to Yin, his specimen is much compressed laterally, it can not be ascertained whether his specimen belongs to the present new genus. This new genus can be briefly diagnosed as follows:

Shell discoid, evolute with a rather large, shallow umbilicus. Whorls laterally compressed, roughly rectangular in section. Laterals marked with distant, sinuous ribs; venter flat or bicarinate, well delimited by two sharp edges on the ventro-lateral edges. Aperture unknown. Each side of the suture consists of a shallow ventral lobe; a low, rather distinct saddle on the bordering edge, a shallow, broad lateral lobe; a rather wide, high saddle on the umbilical wall and a rather wide, shallow dorsal lobe in the impressed zone. Siphuncle small, centroventrid in position, and probably orthochoanitic in structure.

#### *Tanchiashanites marginalis* Chao Gen. et sp. nov.

(Pl. V, Figs. 3-7)

Shell discoid, evolute, increasing slowly and regularly, strongly compressed

laterally with a moderately large, shallow umbilicus. Whorls slightly embracing, roughly rectangular in section. Venter wide, flat in the inner portion, becoming bicarinate in the outer portion, and is well delimited by two sharp ridges on the ventro-lateral angles. Lateral sides are marked with distant, sinuous ribs curving backward and projecting obliquely forward. They disappear gradually on the ventro-lateral portion, forming a smooth, rather wide peripheral margin, and continue to the umbilical junction. Dorsal slightly impressed by the preceding whorl. Umbilical shoulder rounded with rather steep, high wall. Surface marked with fine, sigmoidal lines of growth, besides the ribs. Camerae moderately high, about 4-5 in 20 mm. Aperture unknown.

Suture line comprises a very shallow, rather broad ventral lobe; a low, rather distinct saddle with the apex on the ventro-lateral edge; a shallow, broad lateral lobe on the lateral side; a rather high saddle on the umbilical wall and a rather wide shallow dorsal lobe in the impressed zone on each side of the whorl.

Siphuncle, small centro-ventrid in position and probably orthochoanitic in structure.

### Genus *Liroceras* Teichert 1940

#### *Liroceras sinense* (Chao)

(Pl. V, fig. 10)

1940 *Coloceras sinensis* Chao, Upper Paleozoic Cephalopods from Central Hunan, *Jour. Paleont.* 14, 69; Pl. 9, figs.1,2.

In the paper cited the following diagnosis was given to the species.

“The shell is globose, small, with a diameter of 16.5 mm, and strongly involute. The umbilicus is very small or nearly closed. The whorl is low, broad, and semilunar in cross section, indented by the preceding whorl about one-half of its height. The venter is broad and regularly curved. The true shell has mostly been exfoliated, exposing the closely arranged septa. Traces of the shell, however, show that the surface is probably smooth or marked by lines of growth. The amount of increase in width in the last whorl is very rapid, thus the last whorl is 15 mm thick, though the preceding one is only about 7.5 mm thick; the living chamber is not preserved.

The suture lines are closely arranged, with spaces ranging from 2 mm to 3 mm wide in the last whorl. The suture bends slightly backward on the venter,

less than one millimeter.”

***Liroceras orientale* Chao sp. nov.**

(Pl. V, Figs. 1-2)

This species is represented by three examples, one complete, well-preserved specimen and two fragmentary ones. The shell is rather small and globose in shape. Maximum diameter of the septate part of the holotype measures 23 mm across the umbilicus, which is moderately wide and deep. Whorls few, depressed ventro-dorsally, giving a reniform transverse section, deeply embracing and indented by the inner volution. The width of the whorl is about twice of the height. The venter is broadly arched, expanding rapidly and regularly. The umbilical ridges are distinct and angular. Body chamber not preserved and the length of it is unknown. Part of the test is preserved, which is perfectly smooth. The suture-lines are straight and perpendicular to the direction of coiling. They are well spaced in the outer volution. The thickness of the camerae varies from 2.5 mm in inner part of the last whorl to 4 mm in the outer part.

Remarks: The general appearance of the inner part of the *Liroceras orientale* preceding species. It differs from that form in having a much wider and deeper is similar to the umbilicus. Hayasaka has described two forms of *Liroceras* from Chekiang (1947). According to the descriptions given by that author, his species A may be related to our species, if not identical. All the known forms of congeners are different from this species.

***Liroceras* sp.**

(Pl. V, Fig. 11)

A well preserved fragment, consisting of three high camerae, is referred to this genus. The shell seems to be rather involute and spherical in shape with a deep, open umbilicus. Its venter is broadly arched. Distinct shoulder angles are in existence on the lateral parts, forming the maximum width of the shell. The surface is partly smooth.

The suture-line is straight across the whorl. The siphuncle is well shown, and is dorso-centrid in position.

**Gen. et sp. undet.**

(Pl. VI, Figs. 1-4)

The fragments of nautiloids shown in Pl. VI, figs. 1-4 is too imperfect for even generic determination, but they are evidently distinct from all other species described in the present paper. A definite generic determination can not be made until more complete material is available. The shell seems to be rather thick, moderately evolute, with an open umbilicus. The whorls are much depressed ventro-dorsally with trapezoidal cross-section, much wider than high. The venter is very broad with gentle convexity, marked with regular costation, curving slightly backward. They are mostly pronounced in the middle part of the venter. The ventro-lateral edges are angular, forming the greatest thickness of the shell, marked with nodes, which are formed by connecting two costae. The flanks slope rather rapidly toward the umbilicus, with the nodes gradually dying out. The dorsal side is moderately impressed by the penultimate volution.

The sutures are well exposed in both of these specimens. They are almost straight across the shell, forming a very shallow, broad lobe on the venter and two saddles on the peripheral edges and an incipient dorsal lobe in the impressed zone.

The siphuncle is small and subcentrid in position.

**Genus *Ehippioceras* Hyatt 1884**

In the collection there are two small examples, which were once included in the genus *Liroceras*. After some hesitation they are referred to the present genus on account of development of a ventral saddle and two lateral lobes. They are not so conspicuous as most species of their congeners. Therefore, the classification should be considered as tentative.

***Ehippioceras involutum* Chao sp. nov.**

(Pl. V, figs. 12-15)

A small but well preserved specimen representing the camerate portion of an immature individual, is referred to this genus on account of the nature of the suture line. The shell is small in size, globular in shape and nautilonic in

mode of involution. The diameter across the umbilicus is 16.5 mm. The whorls increase fairly rapidly, much wider than high and are reniform in cross-section. The venter is well rounded, curving regularly towards the umbilicus forming convexflanks without demarcation between them. The umbilicus is moderately wide and deep, with steeply inclined walls and distinct, rounded shoulders, which form the maximum thickness of the shell.

The specimen is an internal mold, hence the nature of the test is entirely unknown. The siphuncle is not shown in the specimen.

The suture-lines in the inner whorls are essentially straight across the venter. Towards the outer part of the shell, they become flexuous, forming a low, very broad ventral saddle on the venter and large part of the ventro-lateral sides. Besides, these appear two shallow lobes near the umbilical edges. They seem to be straight on the walls.

Remarks: A.K. Miller has described a specimen from the Leonard formation of Texas under the generic name *Stearoceras* with question mark, which bears close similarity both in form and in suture line with the present specimen (1949, p. 68, Pl. 6, figs. 1,2). The difference between them as far as the writer can judge, is that the ventral saddle in the Hunan example is more conspicuous. The venter of the Texas form seems to be less depressed and more evolute in coiling.

### *Ephippioceras hunanense* Chao sp. nov.

(Pl. V, Figs. 8-9)

Of this species the writer has only one representative with the body chamber not preserved. Shell subglobose, perforate, expanding very rapidly, composed of two volutions, slightly depressed ventro-dorsally, giving a lunar section in the inner whorl, becoming thicker towards the outer one. Umbilicus large and deep. Venter broadly rounded; lateral sides provided with rather distinct ridges forming the maximum thickness of the shell and the shoulder of the umbilicus. Surrounding the ridge on the outer lateral sides is a depressed zone forming a faint, shallow groove in the outer portion of the outer whorl. Wall high, steeply inclined towards the umbilicus. Dorsal side rather deeply incised by the preceding whorl.

Aperture unknown. Test completely exfoliated. Camerae moderately thick.

Suture line essentially straight in the inner volution and is perpendicular to the long axis of coiling. A broad, shallow but distinct saddle appears on the venter towards the outer portion of the last whorl, and two shallow lateral lobes are formed in the depressed zone surrounding the umbilical ridges.

Siphuncle small, dorso-centrid in position.

This species bears close similarity to the preceding form both in the whorl shape and suture-line. Differences exist only in the more evolute character of the shell and in the presence of depressed zones on the lateral sides.

### **Genus *Solenochilus* Meek and Worthen 1870**

#### ***Solenochilus? auriculus* Chao sp. nov.**

(Text-figure 1, Pl. V, figs. 16-17)

This is represented by a single, well-preserved internal mold. The shape of the conch is quite like that of the genotype, *Solenochilus springer* (White and St. John) but much smaller. Since the siphuncle is not well shown, the inclusion of it in the present genus is tentative.

The shell consists of only the camerate part, the body chamber being not preserved. The whorls are few, expanding very rapidly, much wider than high. The whorl-section is reniform in outline. The venter is narrow and well arched in the inner volution, becoming broad and more or less flattened as the shell growing onward. The dorsal side is slightly impressed by the inner volution. Two remarkable ears are developed on the lateral sides of the outer volution, each bearing two sharp ridges and two depressed grooves.

The test is partly preserved, showing the surface of the shell, which is perfectly smooth.

The septa are well spaced and the camerae are moderate in height. The suture-lines are almost straight across the broad venter.

### **Genus *Periptoceras* Hyatt 1893**

#### ***Periptoceras hsüyüchiani* Chao sp. nov.**

(Pl. VI, Figs. 5-6)

Shell rather small, robust, strongly involute. Umbilicus very small or nearly closed. Whorls few, expanding rapidly, semi-circular in cross section. Venter

broadly rounded; lateral sides slightly compressed laterally in the early volutions, but becoming rounded in the outer one. Dorsal indented by the preceding whorl and completely embracing it. Aperture not preserved. Surface smooth. Camerae moderately thick, measuring about 3-5 mm on the outer portion of the last volution, and increasing regularly.

Suture line roughly transverse to the long axis of the conch, with a broad, low saddle across the venter, and reclines backward on the lateral sides.

Siphuncle small, centrid in position

Remarks: The present species is closely allied to the young specimen of *Periptoceras wanneri* (Han.) (1915, Pl. II, fig. 1a,b.) but differs from it in having a perfectly rounded venter, instead of a slightly flattened one possessed by the mentioned species. Moreover, the sutureline of that species is straight across the venter, which is quite different from that of the present species. This species is named in honor of Mr. Y.C. Hsü who was accompanied by the writer in collecting the fossils.

## AMMONOIDEA

### Genus *Imitoceras* Schindewolf 1923

#### *Imitoceras multiseptatum* Chao

(Text-figure 2; Pl. VI, figs. 9-12.)

1940 *Imitoceras multiseptatum* Chao Upper Palaeozoic Cephalopods from Central Hunan. *Journ. Palaeont.* 14, (1), 70, pl. 9, figs. 8-10.

Although much materials have been procured in our collection little knowledge of this species is added.

The original description of the species, which was given by the writer in a previous paper, will be quoted here.

"The shell is medium in size, moderately compressed, strongly involute or nearly closed. The umbilicus is very small or closed. The whorl section is twice as high as wide and deeply indented by the preceding whorl. The venter is smooth and rounded; the flanks being slightly compressed laterally. The shell has been worn away, so that the surface sculpture is unknown. The living chamber is very long, about two-thirds of the last whorl in length."

"The septa are crowded especially in the outer part of the last whorl. In some median sized individuals, the number of septa is more than twenty, and the

largest example amounts to 35 or more in the last volution. The pattern of the suture-line is quite like that of most species of this genus. It consists of a ventral lobe, a pair of lateral lobes, and two pairs of lateral saddles of unequal magnitude. The ventral lobe is long, narrow, and bottle-shaped. The lateral lobe is deep and sharply pointed backward. The first lateral saddle is high, narrow, rounded and tongue-shaped; whereas the second is broad, with the dorsal side steeper. The end of the lateral lobe approaches the ventral side of the preceding lobe, instead of pointing posteriorly to the middle. The internal suture is composed of corresponding but more crowded lobes and saddles." (see figure 2 in the Chinese text, page 16.)

Remarks; The large forms of this genus have been thought by most authors to be confined to the Upper Devonian and Lower Carboniferous, whereas the small ones are of Carboniferous and Permian species. Plummer and Scott included in the small species to their genus *Neogoniatites*, Miller and Owen gave a more specification in 1939 saying "it is worthy to note that all of the Pennsylvanian and Permian forms known that have simple sutures like those of the genotype of *Imitoceras* are less than 15 mm in diameter, whereas most of the Lower Mississippian and Upper Devonian forms attain a much larger size" (*Journ. Palaeont.* 13(2), p.146-147). This conclusion was also accepted by the writer in 1940. It appears now clear that this conclusion does not hold true at least for the Chinese form.

#### Genus *Pseudohalorites* Yabe 1928

1928 *Pseudohalorites* Yabe. Some Interesting Fossils from South China, *Japan Journ. Geol. and Geography*, 6. (1-2), 19, pl. III, figs. 1-3.

1940 *Hunanites* Chao. Upper Paleozoic Cephalopods from Central [Hunan, *Journ. Paleont.*, 14 (1), 71, pl. 10.

The genus is re-diagnosed as follows:

Conch ammonitonic, subglobose or laterally compressed, strongly involute, deeply embracing and deeply indented by the inner whorls. Whorls low, semicircular in cross section. Umbilicus very narrow or closed; venter regularly curved with a broad hyponomic sinus at the aperture and sometimes with a pair of lateral ears. Body chamber very long, about three-fourths of one complete volution.

Surface marked with numerous ribs and grooves, which are flexuous, curving

backward gently on the ventral part and forward on laterals. The ribs are dichotomous or increasing by intercalation. All of them cross the venter without interruption. In the mature stage the shell is smooth near the aperture, or slightly thickened near the umbilical border.

Suture-line ceratitic; composed of eight lobes and the same number of saddles. Ventral lobe long, slender and serrated, external saddle high and broad, lateral lobe slightly wider than the ventral one, bearing few serrations at its base, lateral saddle slightly shorter and broader than the external one. Umbilical lobe wide and simple. The internal lateral lobes, saddles as well as the dorsal are much narrower and shorter than the external ones.

Remarks: In his previous paper the writer described two species under the generic name *Humanites*, namely *H. hsieli* and *H. siangtanensis*. He is much obliged to the late Mr. T. Y. Hsü, who told the writer that these two forms had been described and figured early in 1928 by Yabe as *Pseudohalorites subglobosus* and *P. celestris* respectively. The generic name *Humanites* is thus a synonym of *Pseudohalorites*. According to the rule of priority the name *Humanites* should be discarded.

While erecting the generic name Yabe obviously compared it with the Triassic genera *yovanites* and *Halorites*, and dated this genus as Triassic or Permian. Both Yabe and Chao had once erroneously considered it to be of Lower Carboniferous. It is now well justified from the field evidence and fossil assemblage that it occurs in upper part of the Yangsinian group, or the Kufeng formation of Lower Yangtze Valley, which is Middle Permian in age.

As to the phylogenic relation, Yabe and Chao independently arrived at the same conclusion, that this genus is an offshoot of *Imitoceras* (*Aganides*), Schindewolf is of opinion (1940 *Paleont. Zentrablatt*, 15(5), p. 237) that this genus is possibly a link form between *Imitoceras* and *Prothalassoceras*. Ontogenetic study of some young individuals of the genotype shows that the serration of the lobes is merely a modification of simple type of lobes.

The ventral lobe is never so deeply incised or divided by a medial saddle, which leads the writer to believe that this genus is a direct offshoot of *Imitoceras*. The serration of the lobes indicates that this genus belongs undoubtedly to the family Thalassoceratidae.

***Pseudohalorites subglobosus* Yabe**

(Text-figure 3; PL. VI, figs. 13-14; PL. VII figs. 1-4.)

1928 *Pseudohalorites subglobosus* Yabe, *Japan. Journ. Geol. and Geogra.* 6 (1-2), 19, Pl. VI, Figs. 1-2.

1940 *Hunanites hsihtsi* Chao, *Journ. Paleont.*, 14 (1), 71, Pl. 10, figs. 1-9.

In mature specimens the size of this species varies from 26-40 mm across the umbilicus.

Shell strongly involute, subglobose in shape but slightly compressed laterally. Whorls rather low, broad and helmet-shaped in transverse section, completely embracing and deeply indented by the inner volutions. Umbilicus very small but fairly well defined. Venter broad and regularly arched. Aperture low with a wide hyponomic sinus, as is indicated by the backward bending ribs on the ventral part. Body chamber long, attaining three-fourths of one complete volution.

Surface ornamented with numerous flexuous ribs and grooves in the mature stage, curving backward on the venter and forward on the laterals. They can easily be differentiated into three stages. In the nepionic stage at the diameter 10.5 mm, there are 6-7 single grooves or constrictions in one volution at regular distances of about 5 mm. In the neanic stage at the diameter 15-17 mm, two secondary grooves begin to appear in front of the primary ones, resulting in the ribs between them. At the same time these grooves with the intervening ribs occur at shorter intervals than they are in the nepionic stage. The character of this stage can be observed on the penultimate whorl in some of adult specimens. The ribs and grooves increase successively in this way and finally all the separating smooth areas give way to regularly ribbed sculpture on the shell surface in the adult or ephebic stage. Consequently, the ribs fall into two categories, the longer and the shorter ones, and each longer one is in alternation with 1-3 shorter ones. It should be added that the ribs and grooves usually become faint or disappear towards the umbilical shoulder in the adult specimens. The primary ribs in the neanic and early ephebic stages are more prominent on the umbilical shoulder, then quickly die out toward the umbilical wall.

The suture-line is fairly well exhibited in most specimens without any special preparation. It is ceratitic, consisting of 8 saddles and 8 lobes, including the ventral and dorsal lobes. The ventral lobe is rather long, slender with 3-5 ser-

rations at the posterior end. In the latter case the inner two are slightly longer. The external saddle is high and spatulate in shape with the steep side near the ventral side. The lateral lobe is equal or longer but wider than the ventral, with 4-7 serrations at its base. The lateral saddle is comparatively lower but broader than the external one. The second lateral lobe meets the umbilical suture, forming a part of the umbilical lobe. The three internal lobes are much shorter and crowded than the external ones. (see figure 3 in the Chinese text, page 18)

### *Pseudohalorites celestris* Yabe

(Pl. VII, Figs. 5-11)

1928 *Pseudohalorites celestris* Yabe, *Japan. Jour. Geol. & Geogr.* 6 (1-2), 21, Pl. VI, Fig. 3.

1940 *Hunanites siangtanensis* Chao, *Journ. Paleont.*, 14 (1), 72, Pl. 10, Figs. 10-16.

The form of this species is essentially like that of the preceding, but is more compressed laterally and consequently the whorls are higher. The aperture is provided with one pair of broadly rounded ears on the ventro-lateral regions and a distinct, broad hyponomic sinus is located between them on the ventral part.

The surface is sculptured with numerous flexuous ribs, like those on the foregoing species, curving backward on the ventral portion and slightly forward on the laterals. These ribs can be grouped into two categories namely: the primaries, which become more prominent as short, strong transverse ridges or elongated nodes on the inner portion of the lateral sides, and the secondaries, which seldom reach the shoulder. They usually occur alternatively, though two secondaries lying between the primaries are not uncommon. Sometimes they seem to be bifurcate. At mature stage the aperture is contracted and sometimes followed by expansion. This results in two smooth, depressed regions on the lateral parts and thickened rims near the aperture.

The manner of increase of ribs in this species is not like that in the preceding form. The shell of some small individuals, which represent the young forms of this species, is perfectly smooth. Faint regular ribs begin to appear near the aperture in the latter stage.

The suture-line is elementarily like that of the preceding form, differing only in the shape of the lateral lobe, which is more pointed in the lower end and open wider upward.

***Pseudohalorites celestris* var. *densistriatus* Chao var. nov.**

(Pl. VII, Figs. 12-14)

In the collection of Prof. Y. C. Hsieh the writer has noticed one example of *P. celestris* with fine plications (1940, PL. 10, fig. 16). A study of additional specimens in the present collection confirms the persistence of this character, and a new varietal name is here proposed.

The shell is quite similar to that of the typical form, but is much smaller and more compressed laterally. The ribs are much finer and sharper. The lateral ears and the hyponomic sinus are also far more pronounced. The body chamber is about one complete volution. The shape of the suture line is similar to that of the typical form.

**Genus *Yinoceras* gen. nov.**

**Genotype: *Yinoceras lenticulare* Chao gen. et sp. nov.**

Involute, lenticular ammonites with acute venter. Surface ornamented with radial plications, projecting obliquely forward. Suture-line ceratitic, consisting of a small divided ventral lobe, one pair of wide, short lateral lobes and two long, straight auxiliary series in the external line. The external and the lateral saddles between the lobes and the auxiliary series is very low. Internal suture-line with one dorsal lobe, and two internal laterals. The lateral saddle, like the external one, is also wide and low.

The generic name is given in honor of Dr. T. H. Yin, who has given valuable contributions on the Upper Paleozoic fossil cephalopods of China.

Remarks: The establishment of this genus is based upon a unique small example, which is related to but quite different from *Epithalassoceras* Miller and Furnish from Mexico (1940, Geol. Soc. America, Special Paper 26, p. 105-107). In the mentioned genus the shape of the shell is subglobose with well rounded venter; whereas that of the present form is lenticular with narrowly arched or acute venter. Moreover, the surface sculpture of this genus is distinctly plicated. The last but the most important distinguishing feature between them is the presence of a much lower and narrower ventral lobe in the suture-line, although in both forms it is divided by a low medial saddle. The long and straight-

auxiliary series is also peculiar to this genus. *Thalassoceras*, *Prothalassoceras* and *Eothalassoceras* are all smooth, subglobose forms. Each possesses a wide ventral lobe, completely divided by a high, medial saddle. The difference between them is the degree of serration in the ventral branches and the lateral lobe. They are undoubtedly relatives of this genus, but not so closely allied to it, as compared with *Epithalassoceras*. The present genus is included in the family Thalassoceratidae on account of the general resemblance of the suture-lines and the same number of sutural elements.

***Yinoceras lenticulare* Chao gen. et sp. nov.**

(Text-figure 4; Pl. VI, Figs. 7-8)

The unique specimen of this species is represented by the septate part, the body chamber being not preserved. The shell is rather small, involute and lenticular in shape. The diameter of the shell measures 16.5 mm across the umbilicus, which is very small or almost closed. The whorls are high as compared with the size of the shell, increasing rather rapidly and strongly compressed laterally. The outer whorl embraces the inner penultimate one completely and is deeply indented by it about one third of its height. The venter is narrowly arched in the inner volutions, tending to become acute in the outer one. The lateral sides are gently convex with the maximum thickness at the inner half of the flanks. The umbilical shoulder is broadly rounded with gently sloping walls towards the center. Length of body chamber unknown.

The surface is provided with low transverse ribs and shallow grooves, projecting obliquely forward on the lateral sides and slightly backward towards the ventral part. They commence at the umbilical shoulder, widening outward. Whether they are continuous or interrupted on the venter can not be ascertained. The plications increase in number by bifurcation in the outer part of the lateral sides. A hyponomic sinus seems to be present on the aperture, as is indicated by the backward bending of the plications towards the outer periphery.

The suture-line is ceratitic, (see figure 4 in the Chinese text, page 20) consisting of a small, divided ventral lobe, one pair of wide, short lateral lobes and two long, straight auxiliary in the external part. The ventral lobe is divided by a medial saddle into two narrow branches, which are serrated

in the lower part. The lateral lobe is distinctly serrated with the outer side notched considerably upward. The auxiliary series is rather long and straight with regular denticulations. The outer saddle as well as the lateral one are very low and much narrower than the lateral lobe. Their tops are well rounded and entire. The internal suture consists of a narrow, long dorsal lobe and two shorter laterals. The internal saddles are high and narrow. The laterals are wide and low.

## 圖 版 說 明

圖內標本除說明者外, 均為著者及徐煜堅二人採自湖南湘潭縣長嶺舖西南五里路旁同一地點。標本存中國科學院古生物研究所內, 劉雪筠照相。

## 圖 版 I

- 圖 1. *Tienoceras lenticulare* Gen. et sp. nov.  
側面及橫斷面, 放大  $\times 1.5$  倍, 屬型, 登記號 7111.
- 圖 2. *Pseudorthoceras* sp.  
側面及橫斷面, 放大 1.5 倍, 登記號 7109.
- 圖 3. *Cycloceras hsiangtanense* sp. nov.  
側面表示節環, 橫斷面, 放大 2 倍, 登記號 7110.
- 圖 4. *Endolobus hsiangtanensis* sp. nov.  
側面表示稜紋, 放大 2 倍, 正型, 登記號 7117.
- 圖 5—8. *Endolobus obsoletus* sp. nov.  
5—6. 側面及正面, 放大 1.5 倍, 正型, 登記號 7115.  
7—8. 側面及橫斷面, 放大 1.5 倍, 副型, 登記號 7116.
- 圖 9—14. *Stearoceras* sp. A.  
9—11. 腹面, 背面及側面, 放大 1.5 倍, 綜合型, 登記號 7112.  
12—14. 腹面, 側面及背面, 放大 1.5 倍, 綜合型, 登記號 7113.

## Explanation of Plate

## Pl. I.

All specimens illustrated on the plate were collected by the author and Mr. Y. C. Hsü at a locality about 2.5 km. southwest of Changlingpu, Hsiangtan district, Hunan, except those stated. All the figured specimens are kept in the Institute of Palaeontology, Academia Sinica.

- Fig. 1. *Tienoceras lenticulare* Gen. et sp. nov.  
Lateral view and cross-section.  $\times 1.5$ . Genotype Cat. No. 7111.
- Fig. 2. *Pseudorthoceras* sp.  
Lateral view and cross-section.  $\times 1.5$ . Cat. No. 7109.
- Fig. 3. *Cycloceras hsiangtanense* sp. nov.  
Lateral view and cross-section. Holotype.  $\times 2$ . Cat. No. 7110.
- Fig. 4. *Endolobus hsiangtanensis* sp. nov.  
Lateral view showing the spiral ridge. Holotype.  $\times 2$ . Cat. No. 7117.
- Figs. 5—8. *Endolobus obsoletus* sp. nov.  
5—6. Lateral and frontal views. Holotype.  $\times 1.5$ . Cat. No. 7115  
7—8. Lateral and cross-section of a smaller specimen. Paratype.  $\times 1.5$ . Cat. No. 7116.
- Figs. 9—14. *Stearoceras* sp. A.  
9—11. Ventral, dorsal and lateral views.  $\times 1.5$ . Cat. No. 7112.  
12—14. Ventral, lateral and dorsal views. Cat. No. 7113.

## 圖 版 II

- 圖 1—4. *Domatoceras* aff. *frederickst* Kruglov,

1—2. 側面及正面, 原大。登記號 7118.

3—4. 側面及橫斷面, 原大。登記號 7119.

圖 5—8. *Stenopoceras orientale* Chao

5—6. 側面及正面, 原大。正型, 登記號 7098.  
產地: 湘潭長嶺舖南南西五里, 謝家榮採集.

7—8. 側面及正面, 原大。副型登記號 7114.

圖 9—11. *Stearoceras* sp. B.

腹面, 背面及側面表示氣室的高度, 放大 1.5。登記號 7114.

#### Plate II.

All specimens illustrated on the plate were collected by the author and Mr. Y. C. Hsü at a locality about 2.5 km. southwest of Changlingpu, Hsiangtan district, Hunan, except those otherwise stated.

Figs. 1—4. *Domatoceras* aff. *fredericki* Kruglov.

1—2. Lateral and frontal views. Nat. size. Cat. No. 7118.

3—4. Lateral and cross-section. Nat. size. Cat. No. 7119.

Figs. 5—8. *Stenopoceras orientale* Chao.

5—6. Lateral and frontal views of the holotype. Nat. size, Cat. No. 7098.

Locality: 2.5 km. SSW of Changlingpu. collected by C. Y. Hsieh.

7—8. Lateral and frontal views of the paratype. Nat. size, Cat. No. 7120.

Figs. 9—11. *Stearoceras* sp. B.

Ventral, dorsal and lateral views showing the thick camerae.  $\times 1.5$ , Cat. No. 7114.

#### 圖 版 III

圖 1—4. *Tainoceras hunanense* sp. nov.

1—2. 綜合型之一的側面及腹面, 放大 1.5 倍, 登記號 7121.

3—4. 綜合型另一標本的側面及腹面, 放大 1.5 倍, 登記號 7122.

圖 5—8. *Tainoceras changlingpuense* sp. nov.

5. 一塊破碎標本的腹面, 放大 1.5 倍, 登記號 7124.

6—8. 正型標本的側面, 正面及腹面, 放大 1.5 倍, 登記號 7123.

圖 9—15. *Hunanoceras globosum* gen. et sp. nov.

9—10. 副型標本的側面及正面, 放大 1.5 倍, 登記號 7126.

11—12. 另一副型的側面及正面, 放大 1.5 倍, 登記號 7127.

13—15. 正型標本的側面, 腹面及正面, 放大 1.5 倍, 登記號 7125.

#### Plate III.

Figs. 1—4. *Tainoceras hunanense* sp. nov.

1—2. Lateral and ventral views of a syntype.  $\times 1.5$ . Cat. No. 7121.

3—4. Lateral and ventral views of another syntype.  $\times 1.5$ . Cat. No. 7122.

Figs. 5—8. *Tainoceras changlingpuense* sp. nov.

5. Ventral view of a fragment.  $\times 1.5$ . Cat. No. 7124.

6—8. Lateral, frontal and ventral views of the holotype.  $\times 1.5$ . Cat. No. 7123.

Figs. 9—15. *Hunanoceras globosum* gen. et sp. nov.

9—10. Lateral and frontal views of a paratype.  $\times 1.5$ . Cat. No. 7126.

- 11—12. Lateral and frontal views of another paratype.  $\times 1.5$  Cat. No. 7127.  
 13—15. Lateral, ventral and frontal views of the holotype.  $\times 1.5$ . Cat No. 7125.

## 圖 版 IV

- 圖 1—6. *Aulametaceras binodosum* sp. nov.  
 1—2. 副型標本的側面及橫斷面，放大 1.5 倍，登記號 7129。  
 3—4. 正型標本的正面及側面，放大 1.5 倍，登記號 7128。  
 5—6. 一個幼年期殼的正面及側面，放大 1.5 倍，登記號 7130。  
 圖 7—12. *Foordiceras* sp.  
 7—8. 兩塊破碎標本的側面，放大 1.5 倍，登記號 7158—9。  
 9—10. 另一塊破碎標本的背面，顯示背部的縱紋及側面上的橫肋，放大 1.5 倍，登記號 7160。  
 11—12. 一塊小標本的側面及橫斷面，登記號 7161。  
 圖 13—15. *Temnocheilus multituberculatus* var. *latinodosus* var. nov.  
 正型標本的側面，腹部橫斷面，放大 1.5 倍，登記號 7157。

## Plate IV.

- Figs. 1—6. *Aulametaceras binodosum* sp. nov.  
 1—2. Lateral view and section of the paratype.  $\times 1.5$ . Cat. No. 7129.  
 3—4. Frontal and lateral views of the holotype.  $\times 1.5$  Cat. No. 7128.  
 5—6. Frontal and lateral views of a young specimen.  $\times 1.5$ . Cat. No. 7130.  
 Figs. 7—12. *Foordiceras* sp.  
 7—8. Lateral views of two fragments.  $\times 1.5$ . Cat. No. 7158—9.  
 9—10. Dorsal and lateral views of another fragment showing the spiral ridges on the dorsal part.  $\times 1.5$ . Cat. No. 7160.  
 11—12. Lateral and cross-section of a small fragment.  $\times 1.5$  Cat. No. 7161.  
 Figs. 13—15. *Temnocheilus multituberculatus* var. *latinodosus* var. nov. Lateral ventral views and section of the holotype.  $\times 1.5$ . Cat. No. 7157.

## 圖 版 V

- 圖 1—2. *Liroceras orientale* sp. nov.  
 側面及正面，放大 1.5 倍，正型，登記號 7133。  
 圖 3—7. *Tanchiashanites marginalis* Gen. et sp. nov.  
 3—4. 一塊小標本的側面及腹面。放大 1.5 倍，登記號 7138。  
 5. 另一塊標本的側面表示縫合線，放大 1.5 倍，登記號 7137。  
 6—7. 側面及腹面，放大 1.5 倍，屬型，登記號 7136。  
 圖 8—9. *Ephippioceras hunanense* sp. nov.  
 側面及正面，放大 1.5 倍。正型，登記號 7141。  
 圖 10. *Liroceras sinense* (Chao)  
 側面，放大 1.5 倍，登記號 7132。  
 圖 11. *Liroceras* sp.  
 正面表示輪環切面及體管位置，放大 1.5 倍，登記號 7131。  
 圖 12—15. *Ephippioceras involutum* sp. nov.

12—13. 一塊破碎標本的側面及橫斷面, 放大 1.5 倍, 登記號 7140

14—15. 正型的正面及側面, 放大 1.5 倍, 登記號 7139.

圖 16—17. *Solenochilus? auriculus* sp. nov.

正型的正面及側面, 放大 1.5 倍, 登記號 7142.

#### Plate V.

Figs. 1—2. *Liroceras orientale* sp. nov.

Lateral and frontal views of the holotype.  $\times 1.5$ . Cat. No. 7133.

Figs. 3—7. *Tanchashanites marginalis* Gen. et sp. nov.

3—4. Lateral and ventral views of a small fragment.  $\times 1.5$ . Cat. No. 7138.

5 Lateral view of another fragment showing the septa.  $\times 1.5$ . Cat. No. 7137.

6—7. Lateral and ventral views of the holotype.  $\times 1.5$ . Cat. No. 7136.

Figs. 8—9. *Ephippioceras huananense* sp. nov.

Lateral and frontal views of the genotype.  $\times 1.5$ . Cat. No. 7141.

Figs. 10. *Liroceras stense* (Chao)

Lateral view.  $\times 1.5$ . Cat. No. 7132.

Fig. 11. *Liroceras* sp.

Frontal view showing the whorl-section and the position of siphuncle.  $\times 1.5$ . Cat. No. 7131.

Figs. 12—15. *Ephippioceras involutum* sp. nov.

12—13. Lateral and cross-section of a small fragment.  $\times 1.5$ . Cat. No. 7140.

14—15. Frontal and lateral views of the holotype.  $\times 1.5$ . Cat. No. 7139.

Figs. 16—17. *Solenochilus? auriculus* sp. nov.

Frontal and lateral views of the holotype,  $\times 1.5$ . Cat. No. 7142.

#### 圖 版 VI

圖 1—4. Gen. et sp. undet.

1—2. 腹面及側面表示橫肋情形, 放大 1.5 倍, 登記號 7134.

3—4. 另一標本的側面及腹面, 放大 1.5 倍, 登記號 7135.

圖 5—6. *Periptoceras hsiyüchiani* sp. nov.

側面及正面表示縫合線及切面。正型, 放大 1.5 倍, 登記號 7143.

圖 7—8. *Yinoceras lentilare* Gen. et sp. nov.

屬型的側面及正面, 放大 2 倍, 登記號 7156.

圖 9—12. *Imitoceras multiseptatum* Chao.

9—10. 一塊小標本的側面及正面, 放大 2 倍, 登記號 7145.

11—12. 另一塊大標本的側面及正面, 放大 2 倍, 登記號 7144.

圖 13—14. *Pseudohalorites subglobosus* Yabe

13 一塊幼年期標本的側面, 表示單橫溝紋, 放大 1.5 倍, 登記號 7148.

14 一塊大些標本的側面表示橫肋生長情形, 放大 1.5 倍, 登記號 7149.

#### Plate VI.

Figs. 1—4. Gen. et sp. undet.

1—2. Ventral and lateral views showing the ribs.  $\times 1.5$ . Cat. No. 7134.

- 3—4. Lateral and ventral views of another specimen,  $\times 1.5$ . Cat. No. 7135.
- Figs 5—6. *Periptoceras hsüüchiant* sp. nov.  
Lateral and frontal views of the holotype showing the suture-lines and whorl section.  $\times 1.5$ . Cat. No. 7143.
- Figs. 7—8. *Yinoceras lenticulare* Gen. et sp. nov.  
Lateral and frontal views of the genotype.  $\times 2$ . Cat. No. 7156.
- Figs. 9—12. *Imitoceras multiseptatum* Chao.  
9—10. Lateral and frontal views of a small specimen.  $\times 2$ . Cat. No. 7145.  
11—12. Lateral and frontal views of a large specimen.  $\times 2$ . Cat. No. 7144.
- Figs. 13—14. *Pseudohalorites subglobosus* Yabe.  
13. Lateral view of a young specimen showing the simple constructions.  $\times 1.5$ . Cat. No. 7148.  
14. Lateral view of another small specimen showing the transverse ribs.  $\times 1.5$ . Cat. No. 7149.

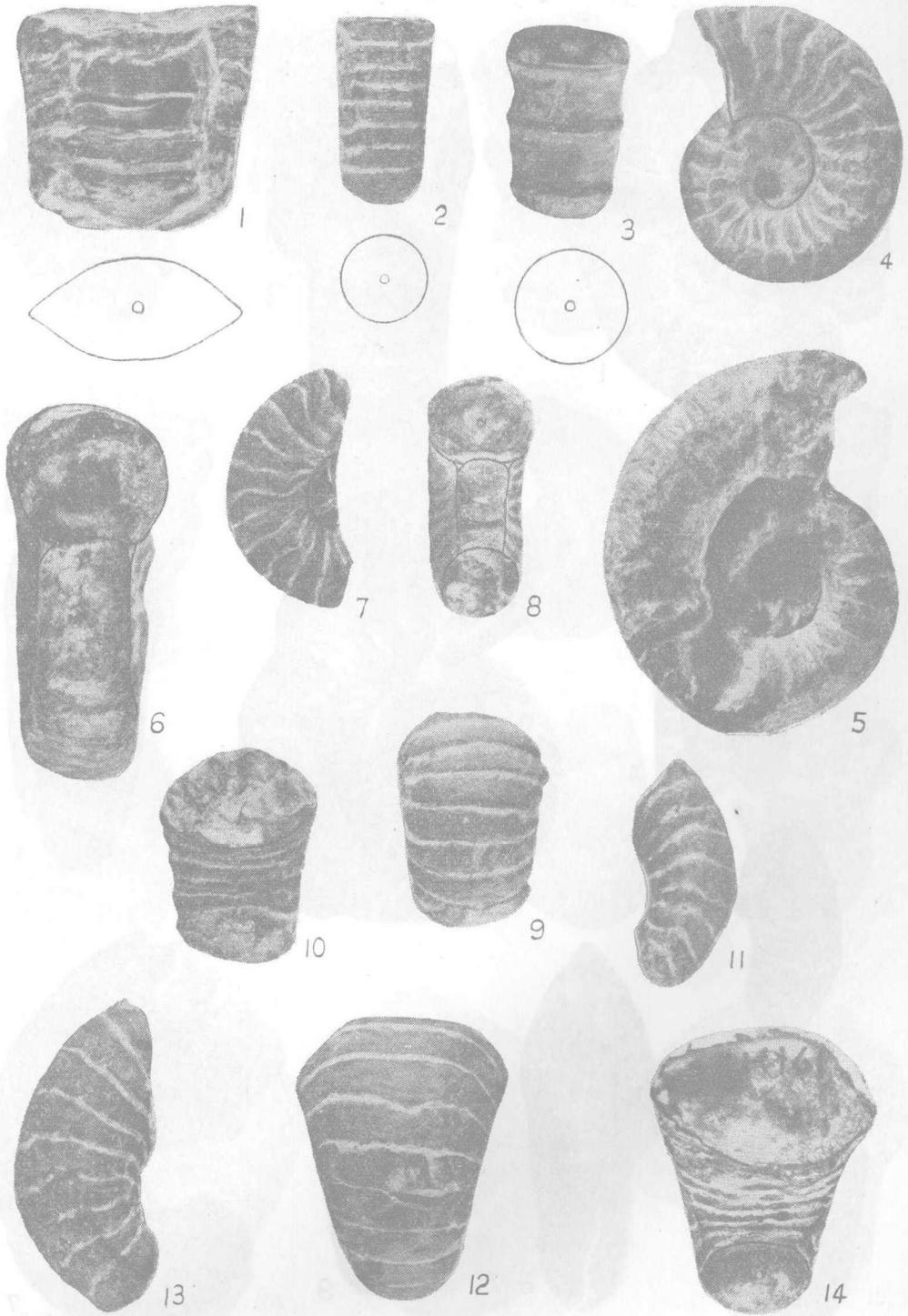
## 圖 版 VII

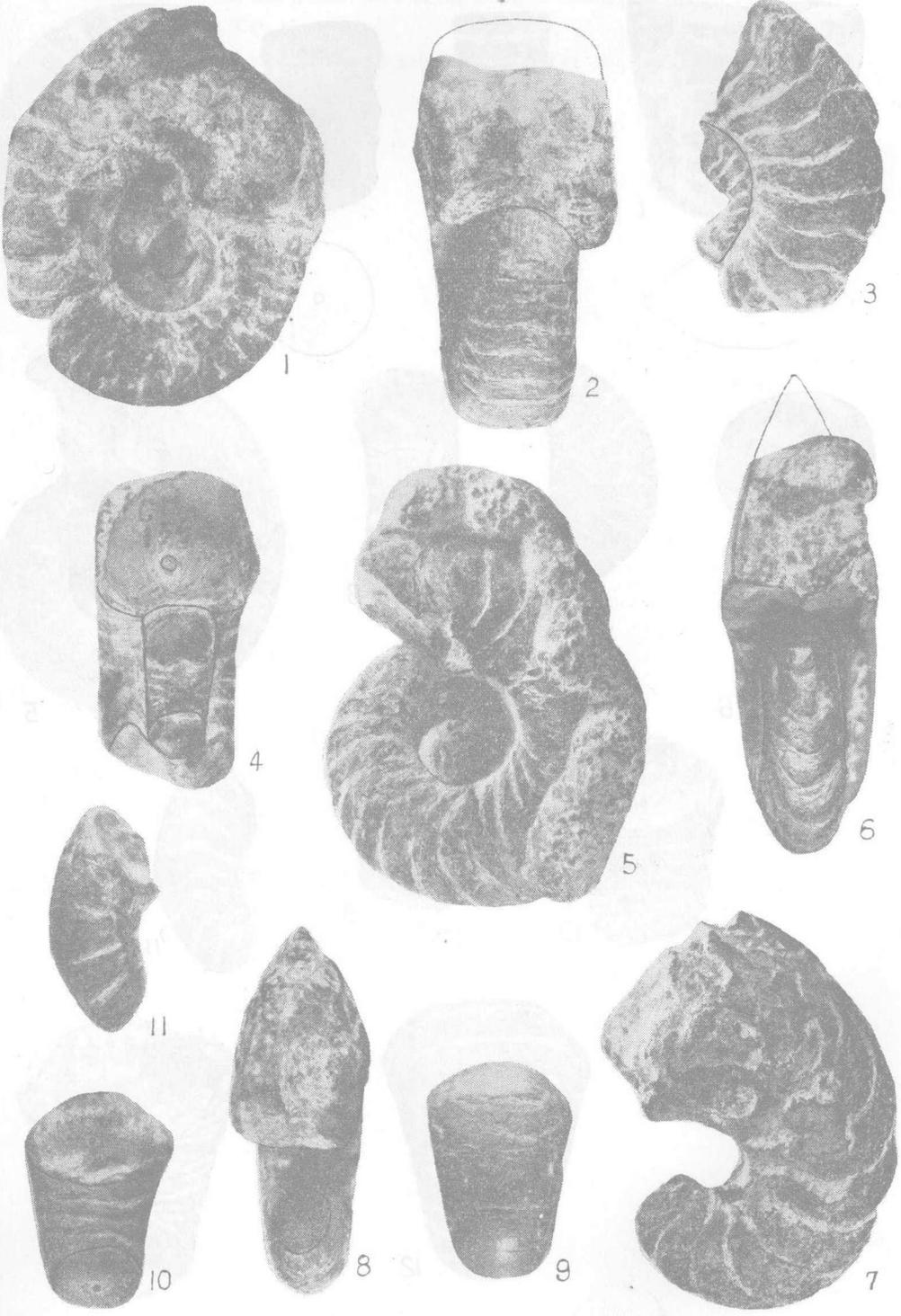
- 圖 1—4. *Pseudohalorites subglobosus* Yabe.  
1—2. 成年期的側面及正面表示切面及線紋，放大 1.5 倍，登記號 7146。  
3—4. 另一標本的側面及正面，放大 1.5 倍，登記號 7147。
- 圖 5—11. *Pseudohalorites celestris* Yabe.  
5—6. 一個幼年期殼的側面及正面，表示光滑的表面，放大 2 倍，登記號 7107。  
7—8. 另一個幼年期殼的側面及正面，放大 2 倍，登記號 7150。  
9—10. 一個成年期殼的側面及正面，放大 2 倍，登記號 7105。  
11. 一個小些的標本的側面，放大 2 倍，登記號 7151。  
產地：湖南湘潭長嶺鋪南南西五里，謝家榮採集。
- 圖 12—14. *Pseudohalorites celestris* var. *densistriatus* var. nov.  
12—13. 正型的側面及正面表示側垂及腹灣，放大 2 倍，登記號 7152。  
14. 另一標本的側面，放大 2 倍，登記號 7153。

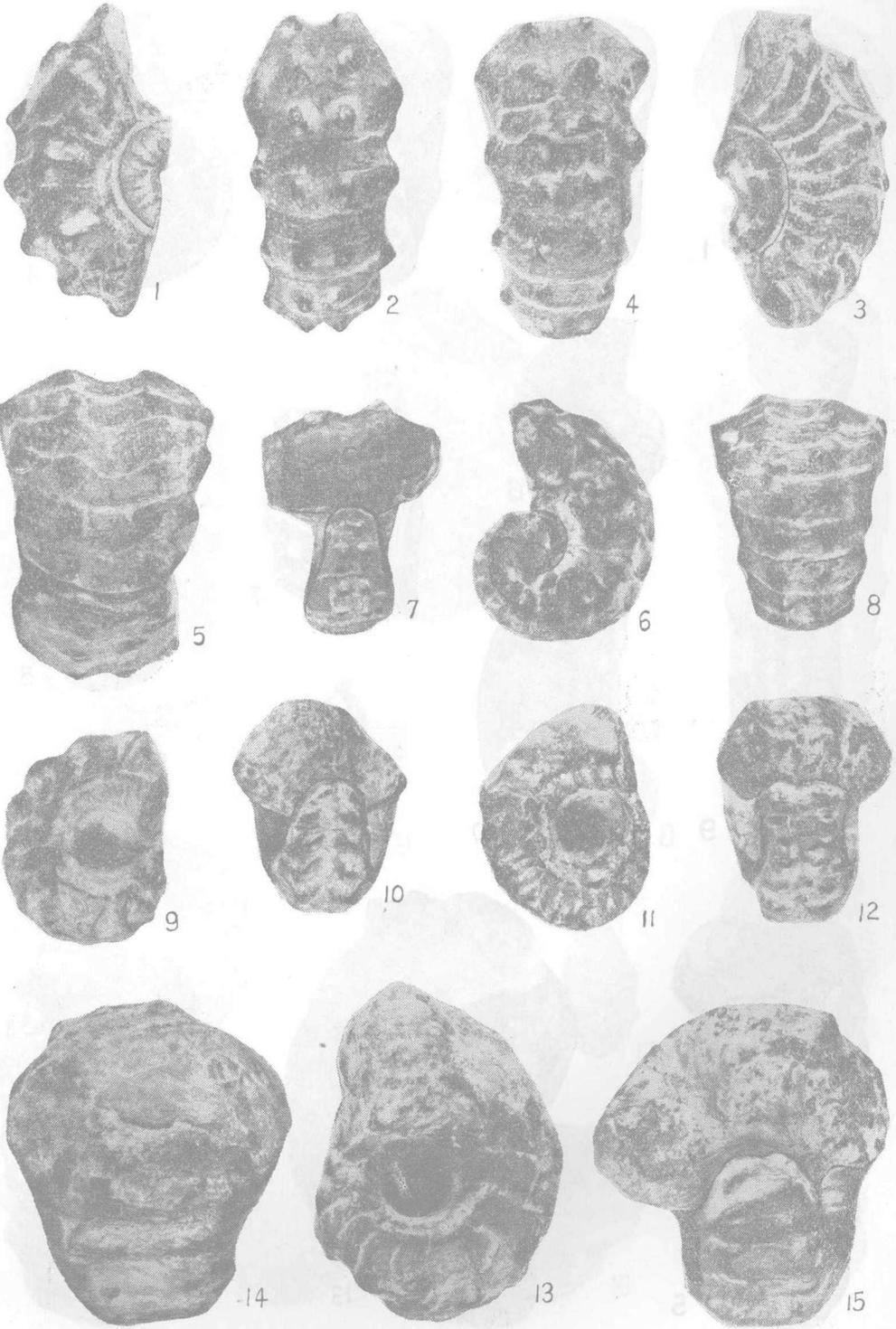
## Plate VII.

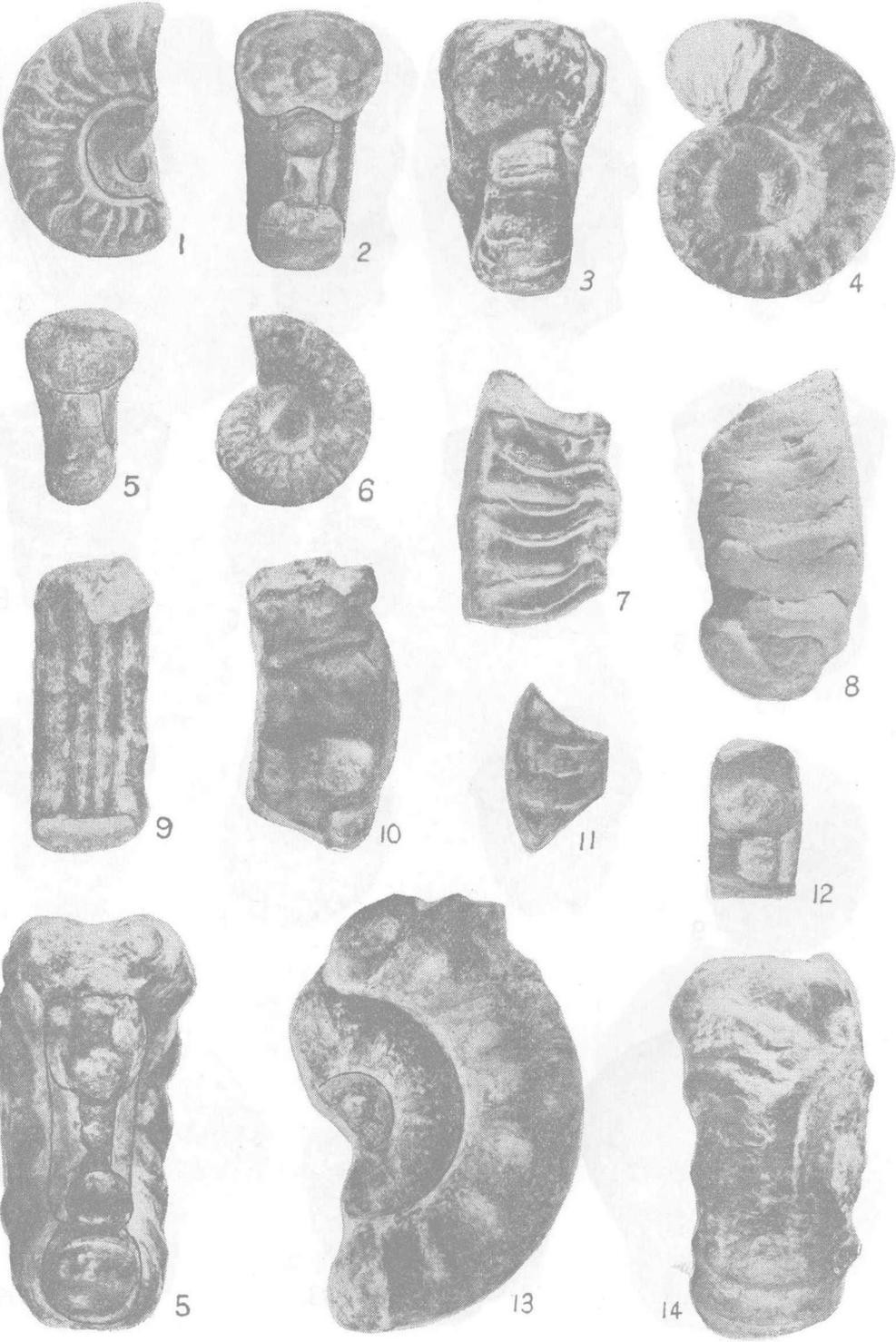
- Figs. 1—4. *Pseudohalorites subglobosus* Yabe.  
1—2. Lateral and frontal views of a mature specimen.  $\times 1.5$ . Cat. No. 7146.  
3—4. Lateral and frontal views of another specimen.  $\times 1.5$ . Cat. No. 7147.
- Figs. 5—11. *Pseudohalorites celestris* Yabe.  
5—6. Lateral and frontal views of a young specimen showing the smooth shell.  $\times 2$ . Cat. No. 7107.  
7—8. Lateral and frontal views of another young specimen showing the appearance of the ribs.  $\times 2$ . Cat. No. 7150.  
9—10. Lateral and frontal views of a mature specimen.  $\times 2$ . Cat. No. 7105.  
11. Lateral view of a smaller specimen.  $\times 2$ . Cat. No. 7151.  
Locality: 2.5 Km. SSW of Changlingpu Collected by C. Y. Hsieh.
- Figs. 12—14. *Pseudohalorites celestris* var. *densistriatus* var. nov.

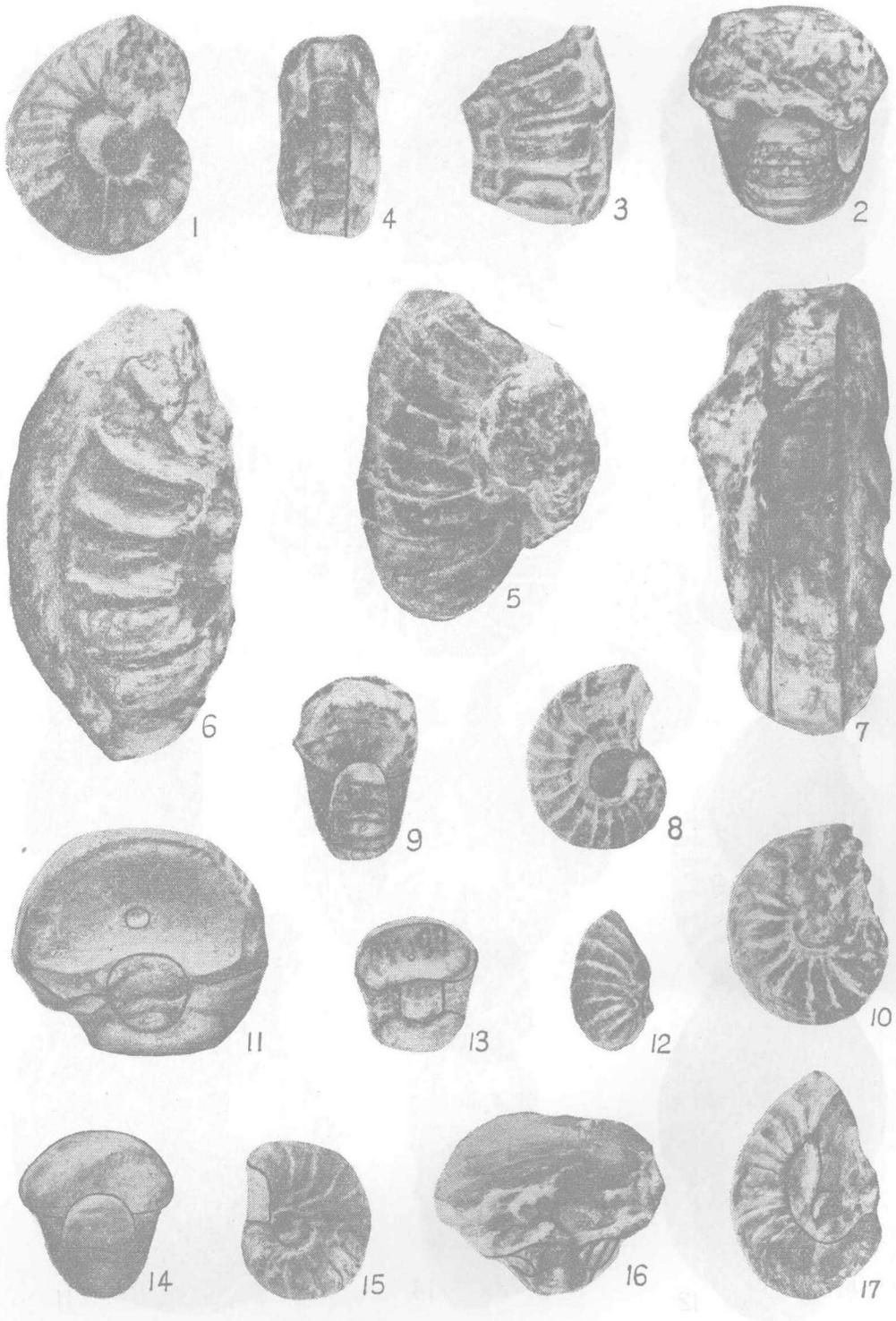
- 
- 12—13. Lateral and frontal views of the holotype showing the lateral ear and sinus.  
× 2. Cat. No. 7152.
14. Lateral view of another individual. × 2. Cat. No. 7153.

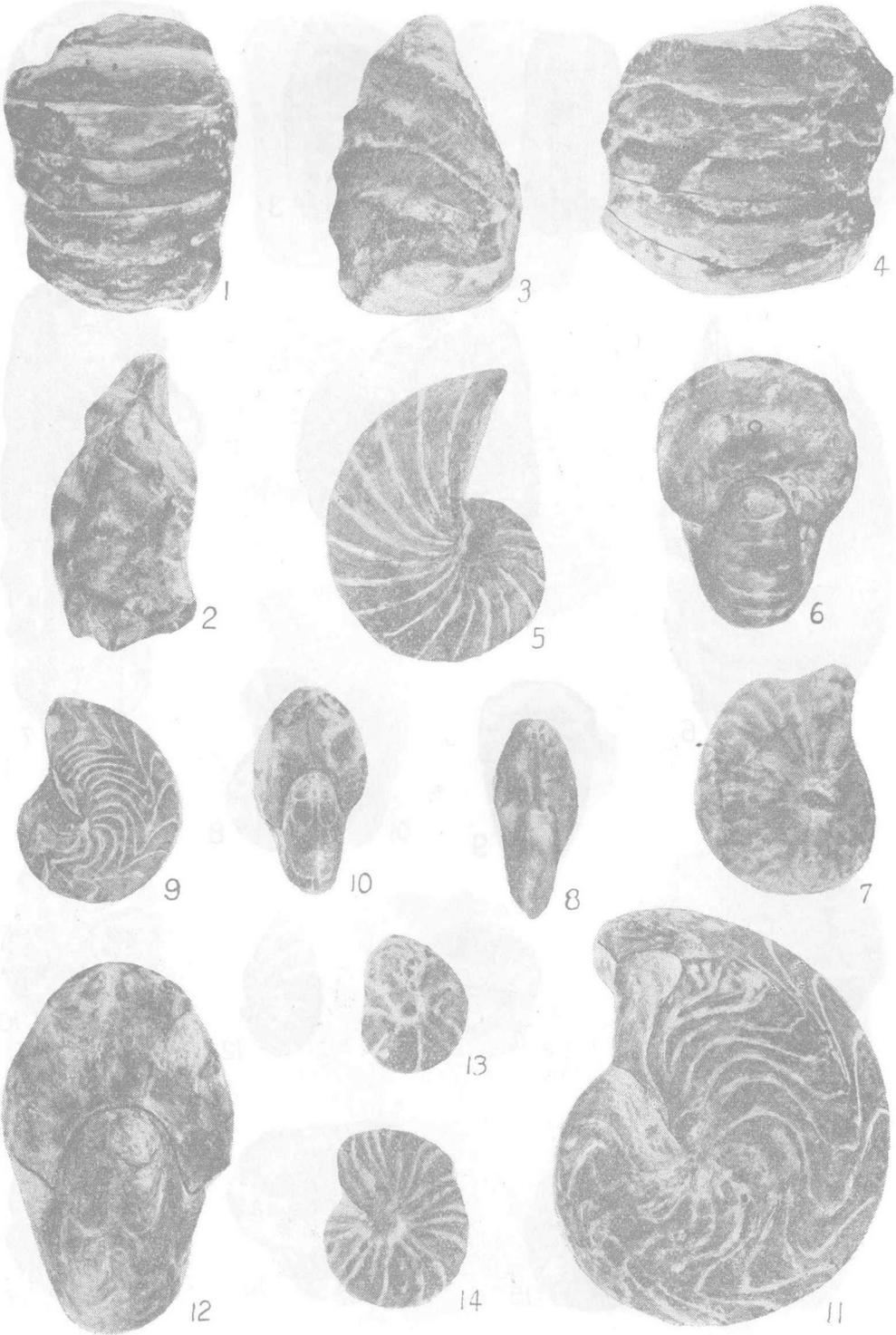


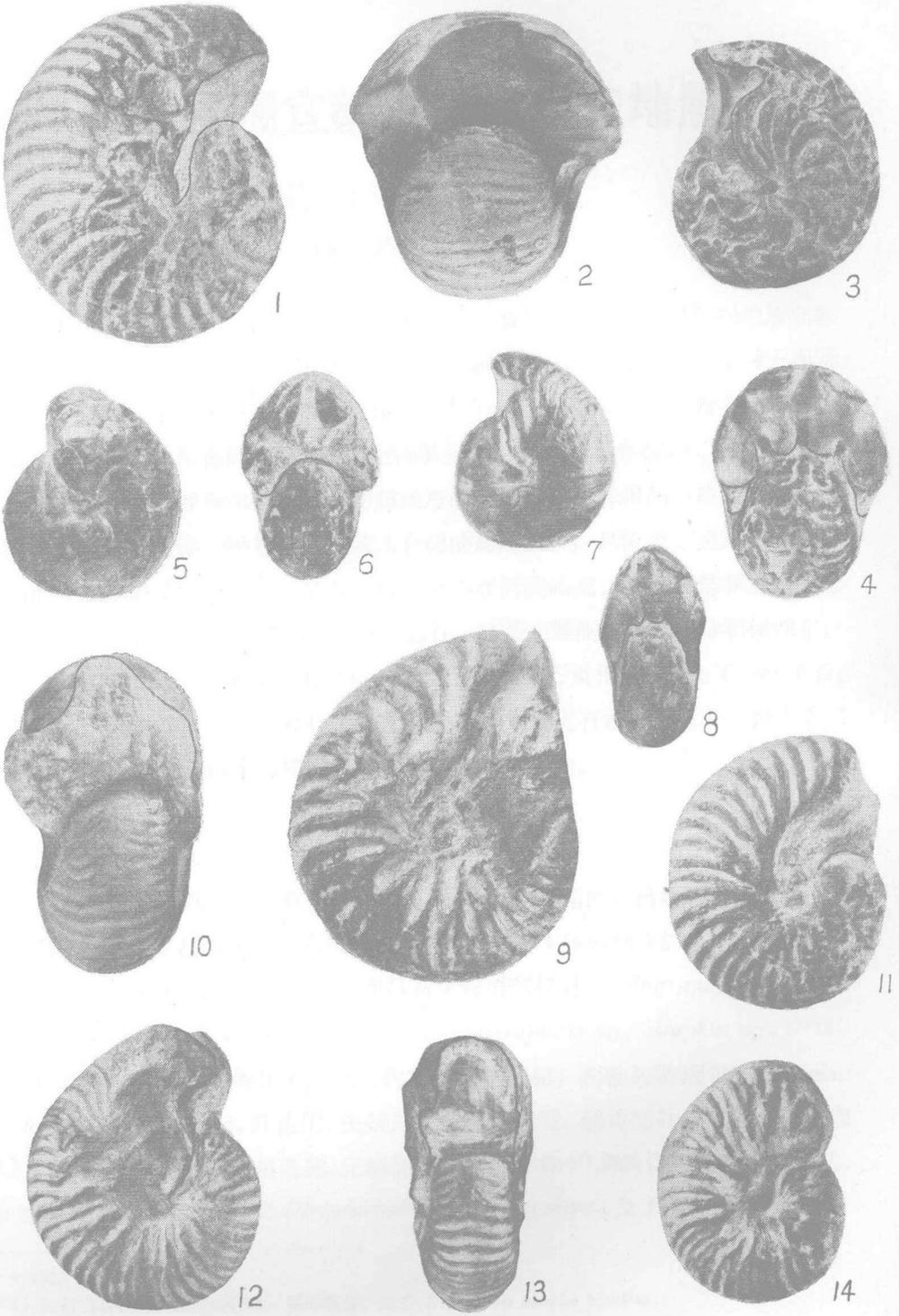












107); 但是與它又很不相同, *Epithalassoceras* 的形狀是橢圓, 具有圓形的腹部, 表面光滑, 而這一屬是扁形具有稜狀的腹部, 表面飾以放射狀的橫肋紋, 最重要的是這一屬的縫合線具有一個短而小的腹葉和長而直的肋系。 *Thalassoceras*, *Prothalassoceras* 以及 *Epithalassoceras* 都是橢圓形的, 表面光滑的屬, 每一屬都有一個很寬而長的腹葉, 並被一高而寬的中央鞍所分裂, 它們之間的區別只是腹枝葉和側葉上的齒在程度上的不同。它們無疑與這一屬有關係, 但不如與 *Epithalassoceras* 更密切。因縫合線的相似, 這一屬也歸入 *Thalassoceratinae* 一科中。

### 種名 *Yinoceras lenticulare* Chao 新屬新種.

(插圖 4; 圖版 VI, 7—8)

代表這一種惟一的標本只是它的氣室部分, 住室部分未見保存, 殼體相當小, 內旋呈扁餅狀。直徑為 16.5 毫米, 中間的臍很小幾近閉合。輪環很高, 增長很快, 兩側有強烈壓縮現象。外旋輪完全包圍內旋輪, 並為其侵陷很深, 約為環高的三分之一。內部旋輪的腹部很窄而圓, 到外輪環上變為稜形。側面扁平而微凸, 最大厚度位於側面中線以內。臍緣彎度很小, 壁向中心漸漸傾斜。

表面有不甚明顯的橫肋紋, 在兩側向前斜, 到近腹部時略向後彎曲, 表示有一腹缺存在, 至於這些橫肋紋是否通過腹部, 尚不敢斷定, 因為腹部保存不好, 多少有些破壞。

縫合線呈菊面石型, 外部由一小的分裂的腹葉, 一對寬而短的側葉, 和兩條長而直的輔助線系組成。腹葉被一中央鞍分割為二窄枝, 下部呈齒狀, 側葉的齒很顯著, 並且外面一邊上的齒向上侵蝕遠比內面一邊的高。輔助線系很長而直, 具有很規則的齒。外鞍和側鞍都很低矮, 比側葉也窄的多, 頂部很圓而完整。內縫合線由一個窄而長的背葉及兩個稍短的側葉組成。中間的內鞍很窄而高, 側鞍較寬而矮。



插圖 4 *Yinoceras lenticulare* Gen. et sp. nov. 的縫合線放大 6 倍

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### 附 頭 足 類 名 詞 對 照 表

Adventious lobe or saddle	偶生葉或鞍	Ammoniticone	菊石殼
Air chamber	氣室	Anaptychus	雙瓣口蓋