

SOME LOWER PERMIAN OSTRACODS FROM WESTERN HUPEH

Y. T. Hou

Institute of Palaeontology, Academia Sinica

(With 2 plates)

Introduction

The material described in the present paper was collected from the Lower Permian Chihhsia limestone by Messrs. K. C. Yang and A. T. Mu in 1951 during their excursion in Western Hupeh. The Chihhsia limestone is underlain by the Maan Coal series containing *Lepidodendron ituense* and is succeeded by the Maokou limestone bearing *Verbeekina verbeeki*. The most characteristic fossils collected from the Chihhsia limestone are: *Hayasakaia elegantula* Yabe et Hayasaka, *Fistulipora chinensis* Yoh, *Stylidophyllum* cf. *intermedium* Huang, *Polythecalis* cf. *yangtzeensis* Huang, *Corwenia* cf. *chihhsiaensis* Yoh. The Ostracods came from two different horizons: one from the lower part and the other from the upper part of the Chihhsia formation. Both parts are composed of thin-bedded black shales with abundant Ostracods. Twenty-seven species of Ostracods are described and attributed to the following 12 different genera: *Aparchites*, *Hollinella*, *Amphissites*, *Kirkbya*, *Polytylites*, *Kellettina*, *Knightina*, *Roundyella*, *Bairdia*, *Bythocypris*, *Cavellina* and *Macrocypris*. Some of the species or even genera are characteristic to the lower part, others are confined to the upper part, while the remainder are common both in the upper and in the lower parts (See Table I).

Most of the genera stated above are common in both the Carboniferous and the Permian. They do not add a great deal of information concerning the age of the fauna, but judging from the associated fossils such as corals and fusulinids, it appears probable that all species belong to the Lower Permian.

The Ostracods occur commonly in the shaly beds especially in the shales which include rich montmorillonite minerals or high contents of organic matters. Except *Hollinella tingi* (Patte) which is also found in the yellowish brown Feihienkuan shale of Lower Triassic age, all species described in the present paper

are confined to the black organic shale. The black muds are usually deposited under stagnant condition and in shallow, nearly tide-less epicontinental sea where the environment is with poor circulation, with little or no oxygen. In 1937 T. N. Spizharsky (Т. Н. Спозжарский)^[39] stated that Ostracods are usually associated with pelecypods in shallow, stagnant basins where the sediments are fine, argillaceous and rich in organic matters. The organic matters are the main food of the *Palaemon*. After the deposition of the vegetable material which forms the coal-bearing sediments, the basin might be formed due to flooding. This may be proved by the fact that the Ostracods are usually over-crowded in the argillaceous shales of the coal

Table I

	U. part of Chihhsia ls.		L. part of Chihhsia ls	
	By 89, 88	By 203	By 76	By 222
<i>Aparchites sinensis</i> sp. nov.		X		
<i>Hollinella tingi</i> (Patte)	X		X	
<i>Hollinella pseudotingi</i> sp. nov.	X	X		
<i>Amphissites sinensis</i> sp. nov.			X	X
<i>Amphissites subcentronotus</i> sp. nov.			X	
<i>Kirkbya sinensis</i> sp. nov.			X	
<i>Kirkbya canyonformis</i> sp. nov.			X	X
<i>Polytylites simplex</i> sp. nov.			X	X
<i>Kellettina elongata</i> sp. nov.		X	X	
<i>Knightina reticulata</i> sp. nov.		X		
<i>Roundyella ocatiformis</i> sp. nov.			X	
<i>Bairdia convexa</i> sp. nov.	X	X		
<i>Bairdia subrounda</i> sp. nov.				X
<i>Bairdia hupeiensis</i> sp. nov.		X		
<i>Bairdia fusiformis</i> sp. nov.		X		X
<i>Bairdia changyangensis</i> sp. nov.		X		X
<i>Bairdia sinensis</i> sp. nov.			X	X
<i>Bairdia mui</i> sp. nov.		X		
<i>Bairdia yangi</i> sp. nov.				X
<i>Bairdia</i> sp. A.		X		
<i>Bairdia</i> sp. B.	X			
<i>Bairdia</i> sp. C.		X		
<i>Bairdia</i> sp. D.				X
<i>Bythocypris maanshanensis</i> sp. nov.	X	X	X	
<i>Macrocypris</i> sp.	X			
<i>Caellina maanshanensis</i> sp. nov.	X			X
<i>Caellina mui</i> sp. nov.	X	X	X	
Gen. et sp. indet.	X			

beds. The occurrence of abundant Ostracods in the black shales of Western Hupeh gives further evidence to Spizharksy's conclusion. His original statement is as follows: "Ostracoda жили совместно с pelecypoda в тихих, застойных, неглубоких водоемах, на дне которых, отлагался тонкий глинистый материал, переолненный полуразрушившимся органическим веществом, служившим пищей для рачков. Такие водоемы могли образоваться после окончания отложения растительного материала, послужившего началом для каменного угля, вследствие затопления болот. Об этом свидетельствует то обстоятельство, что глинистые сланцы в кровле угольного пласта обычно бывают переполнены остатками Ostracoda, выше же они встречаются значительно реже." The same conclusion that some Ostracod genera are intimately and directly related with organic matters has been further confirmed by the writer.

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Aparchitidae

Genus *Aparchites* Jones 1889

***Aparchites? sinensis* Hou sp. nov.**

(Pl. I, Fig. 1a-b)

The carapace of this species is fusiform, small in size, with equal ends; hinge line straight and shorter than the length of valves which are compressed toward the margins. A broad swelling is developed at the middle part of the valve. Dorsal margin strongly convex, ventral margin gently convex. Highest part at median line, thickest just in the center. Cardinal angles slightly obtusely rounded; a narrow flange is present around all the margins, except the dorsal. Valves probably equal in size. Surface smooth.

According to the external sculpture, the present species is related to the genus *Aparchites* which ranges in America from Ordovician to Devonian, whereas the specimens in China are obtained from the black shale of Lower Permian age, so it is not certain whether the Chinese specimen may belong to the same genus. A definite generic determination cannot be made until more complete

material is available.

Occurrence: From the black shale of the upper part of Chihhsia Ls., L. Permian; at Maanshan of Changyang district, Hupei province (Cat. No. 7176-7177).

Hollinellidae

Genus *Hollinella* Coryell 1928

Hollinella tingi (Patte)

Beyrichia ttingi Patte: Pal. Sinica, Ser. B., vol. 15, fasc. 2, pl. I, fig. 7, 1935.

(Pl. I, Fig. 2a-b)

Carapace sub-ovate to semi-circular, length 1.36 mm, height 0.88 mm. Anterior end slightly rounded, posterior obliquely dorsally truncate and more rounded into the ventral margin below. Cardinal spines obsolete. Sulcus rather narrow and long behind the center of hinge line. Anterior node large and sharp rising above the surface and is located near the middle of the valve, sloping towards the anterior and constricted at the base. Posterior node small, raised above the posterior surface of the valve. Ridge beneath the sulcus prominent. Convexity of the valve not great. Frill fairly wide, beginning at about three-fourth in the way down to the anterior margin continuing downward and backward, and following the edge of the valve closely at the postero-ventral angle. The frill widens at the postero-ventral angle and then narrows suddenly, dying out before it reaches the hinge line. Surface distinctly punctate.

Relationship: This species was found by Dr. V. K. Ting and Y. L. Wang early in 1929 from Chien-See^[9] district of Kweichow province in the yellowish shale lying below the Yulungshan limestone of L. Triassic. In 1930 Dr. Y. T. Chao and T. K. Huang obtained the same species in the Feishienkuan shale from Tungtze district of Kweichow; and the specimens were determined in 1932 by Prof. E. Patte as *Beyrichia tingi*. In 1948 the same species was also collected by S. F. Sheng in the black shale of Tingchiashan Formation corresponding to the Kufeng Formation of Permian from Chekiang. The specimens studied in the present paper are obtained from the black shale beds of Chihhsia formation of Lower Permian by Messrs. K. C. Yang and A. C. Mu at different localities of Maanshan of Changyang district, Western Hopei.

As described above, the sculpture on the surface is clear, there is a median sulcus, a large anterior node reaching the dorsal margin, and a small node at

the posterior half. A ridge is produced below the two nodes, sometimes the ridge is reduced to node-like. Two forms of this species are differentiated, one of them is the productive female which has wide frill all along the margin, except at the anterior; the other form is the male without frill. The surface of *Beyrichia* is marked by a small, isolated median node with a long and large posterior node. The chief difference between *Beyrichia* and *Hollinella* is that the former has a large ovate broad pouch at the postero-ventral portion (as oriented by Ulrich and Bassler) of the female individuals. It is obvious that this pouch is not a sequence of alteration of nodes. Patte states that the sex of his specimen was decidedly due to the change of nodes. His explanation seems to be not quite sufficient. His original description reads as follows: "Sur l'échantillon le plus tuberculé, on distingue un gros tubercule tangent à la linge cardinale et s'étendant, en longueur jusqu'au premier quart antérieur, ce tubercule se continue par une crête arrondie qui, en s'incurvant, suit le bord jusqu'à l'angle antérieur; un étranglement sépare nettement la crête du tubercule; dans la concavité formée par cet ensemble, se voit une chaîne rectiligne de petits tubercules presque confondus; son axe atteint obliquement la charnière; enfin un tout tubercule se voit dans l'angle postérieur.

Sur d'autres échantillons, la chaîne de tubercules se réduit à 1 ou 2 tubercules, le tubercule restant peut rester bien individualisé ou se souder à la crête marginale....."

"Ces différences peuvent tenir au sexe."

The geological distribution: *Beyrichia* ranges from Ordovician to Permian, and is restricted to the Palaeozoic. Patte's description is "Le genre *Beyrichia* est connu du Silurien et du Dévonien, peut-être du Cambrien et du Carbonifère. Tous les *Beyrichidae* sont paléozoïques." The genus is found in great abundance from the Ordovician to Devonian rocks and rarely in the Permian.

According to the present discovery, it is improbable that the genus *Beyrichia* occurs also in the Triassic. The writer is of the opinion that the form described by Patte from Kweichow should be possibly referred to the genus *Hollinella* rather than to *Beyrichia*.

This species is very closely related to *H. gibbosa* but differs from it in having a narrow and long sulcus. Furthermore, the cardinal spine of the present species is absent; and the anterior node is sharpened, sloping more abruptly to-

ward the dorsal anterior. The surface is distinctly punctate.

Occurrence: This species is obtained from the black shale beds of Chihhsia limestone of L. Permian, at the locality Maanshan of Changyang District, W. Hupei. (Cat. No. 7178-7179).

***Hollinella pseudotingi* Hou sp. nov.**

(Pl. I, Fig. 3a-b)

Carapace subovate to subelliptical in lateral view, length about twice the height, anterior end slightly acute, posterior truncate and becoming rounded into the ventral margin below. The greatest length lies at the mid-height. Anterior cardinal extremity sharpened at about a right angle; posterior cardinal margin slightly obtusely angulated. Anterior ridge forming a broad swelling near the hinge line, and occupying a part of the anterior of the valve; posterior ridge narrow, located slightly below the dorsal margin near the posterior marginal ridge; median node elliptical, situated behind the median sulcus, parallel to the posterior ridge; the ventral ridge is broadly rounded, merging into the anterior and posterior ridges. A long and deep sulcular depression is located at about the center of the valve; the anterior depression is even, broad, and triangular in form, bending backward towards the lower end of the anterior ridge; a narrow and shallow posterior depression is present between the median node and the posterior ridge. The anterior and posterior marginal ridges are apparent but the later is wider than the former, sometimes the latter is especially swollen at the postero-ventral margin. The other characters of this species are similar to those of *H. tingi* (Patte).

Relationships: This species differs from *H. tingi* (Patte) in having: (1) the flattened anterior depression; (2) both anterior and posterior marginal ridges; (3) bulbous, broad anterior ridge and the narrow posterior ridge; (4) median node parallel to the posterior ridge.

Occurrence: This species is obtained from the upper part of Chihhsia limestone, L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7180-7181).

Kirkbyidae

Genus *Amphissites* Girty 1910 emend Cooper 1941

***Amphissites sinensis* Hou sp. nov.**

(Pl. I, Fig. 4)

Carapace subelliptical or subovate in side view, strongly convex and thick;

hinge straight, slightly impressed between the shoulders, and shorter than the greatest length. Ends evenly rounded, cardinal angles blunt. Dorsal margin bends slightly upward at the posterior extremity, ventral profile flat in the middle, rounded toward the ends. Carapace highest at the posterior end, thickest above the middle. The posterior node is obsolete while the anterior one is present, looking like a rounded node at the shoulder, gradually blending along the ventral into the contours of the valve until just behind the pit, it becomes indistinguishable. The median node is ovate, its length measured at about 0.9 mm, height 0.1 mm, and is situated at the middle near dorsal. A kirkbyan pit or muscle spot is deep and rounded, and is large being about as long as two to three reticulation pits; it is sub-centrally located just below and to the posterior of the median node. Surface ornamented with polygonal reticulation. The separate valves are imperfect in the collections, and the hingement of both valves is not observed.

Relationships: This species is closely related to the Pennsylvanian species *A. rotundus* Geis, *A. pinguis* (Ulrich and Bassler) and *A. geneae* Roth., *A. rotundus*, however, has fine reticulation and coalescent swelling in the place of two nodes; *A. pinguis* has a low median node, and a large kirkbyan pit is located to the front at the place of the latter; *A. geneae* is thinner, instead of strongly convex.

Occurrence: This specimen is collected from the black shale bed of the lower part of Chihshia limestone; at Maanshan of Changyang district, Hupei province (Cat. No. 7182).

***Amphissites subcentronotus* Hou sp. nov.**

(Pl. I, Fig. 5)

Carapace sub-oblong or subquadrate in side view; cardinal angles almost equal to ninety degrees. Ends rounded, more or less smooth in the ventral outline. Hing-line straight and slightly shorter than the greatest length. Submarginal ridge (inner flange) narrow, apparently continuous around the ventral side from angle to angle, but the carinae on it is indistinct; the outer flange border is inconspicuous in the imperfect valve. The anterior and posterior nodes are obsolete. Only a well developed, rounded, protruding median node is situated at the middle and near the dorsal, and slopes gradually toward the margin. A sub-circular kirkbyan pit or muscle spot is located just below and slightly oblique to the front

of the median node. No surface pattern is visible, except the faint reticulation and the inner flange.

Relationships: *A. subcentronotus* resembles most closely *A. centronotus* from which it may be readily differentiated by having the clear ridge-like anterior and posterior nodes in that species.

Occurrence: From the black shale of the lower part of Chihhsia limestone, L. Permian; at the Maanshan of Changyang district, Hupei province (Cat. No. 7183).

Genus *Kirkbya* Jones 1859

***Kirkbya sinensis* Hou sp. nov.**

(Pl I, Fig. 6a-b)

Carapace angles sharpened, approximately perpendicular. Hinge-like straight or slightly depressed, hingement unknown. Free edge of the left valve bordered by a raised ridge or outer carina. The inside of this ridge is a thicker and broader prominent inner ridge. Between the flange ridges is a furrow extending also to the cardinal angles, but it is much wider at the ventral than at the ends and dies out at the cardinal angles. The central node is elliptical, well developed, located near the dorsal and united with the anterior and posterior ridges. There is a rather steeply inclined plane on the dorsal and a gently sloping plane on the ventral. The anterior ridge is more convex than the posterior one raising above on the hinge line. Surface marked by indistinct reticulations. Pit depressed, oval and small.

Relationships: This species is closely related to *K. wymani* Kellett, differing in its longer size, broader and thicker inner flange edge, more sharpened anterior ridge, and non-concentric line on the lower half of the valve.

Occurrence: From the black shale of the lower part of Chihhsia limestone, L. Permian, at Maanshan of Changyang district, Hupei province. (Cat. No. 7184-7185).

***Kirkbya canyonformis* Hou sp. nov.**

(Pl. I, Fig. 7a-b)

Carapace small, suboblong to sub-rectangular in side view, length 0.88 mm, height 0.41 mm; greatest thickness in the middle to anterior of the valve, where a thick ridge formed by the anterior and central nodes is located; the anterior node is elongated, swelled and slightly elevated above the hinge-line; the central node is small and sharp, situated at the middle near dorsal. The hinge-line is

impressed below the shoulder. Inner flange rounded, having a banded border surrounding it in perpendicular direction. This border is wider at the ventral and dies out at the cardinal angles. The extremity angles are equal to about 90° and the anterior one is more acute. Surface with indistinct reticulation; an ovate, deep pit is located just below the central node. Owing to the imperfect state of preservation of separate valves, the outer margin and hingement are unknown.

Relationships: This species resembles *K. canyonensis* Harlton and *K. dorsoconvexa* Geis, but differs from the former in having only two nodes and rounded inner flange; it differs from the latter in having the central node and the maximum thickness at the middle to the anterior of the valve.

Occurrence: From the black shale of the lower part of Chihhsia limestone; at Maanshan of Changyang district, Hupei province. (Cat. No. 7186-7187).

Genus *Polytylites* Cooper 1941

Polytylites simplex Hou sp. nov.

(Pl. I, Fig. 8a-b)

Carapace small, suboblong to sub-quadrate in outline, length 0.66 mm, height 0.37 mm; moderately convex, highest at posterior end; central node prominent; anterior and posterior shoulder nodes long and high more or less parallel to the margins of both ends, rising well above the hinge line; its other end being connected just below the central node and forming a ventral ridge. The inner flange margin is absent, except in the anterior portion where it is present inconspicuous.

A small, distinct and shallow pit is present below the central node. Surface ornamented by faint coarse reticulations.

Relationships: This species may be distinguished from *F. geniculatus* Cooper by having the long shoulder nodes and its connection with the central node; the inner flange margin is obsolete, except it is present inconspicuously in the anterior portion of this species.

Occurrence: From the black shale of the lower part of Chihhsia limestone, L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7188-7189)

Genus *Kellettina* Swartz 1936

Kellettina elongata Hou sp. nov.

(Pl. I, Fig. 9a-b)

Ventral edge subparallel to the hinge, post-cardinal angle more or less smaller

than a right angle; antero-cardinal angle often quite acute. Hinge line straight or slightly depressed. Two large nodes are well developed and vertically elongated, extending well down to the center of the valve and parallel each other; sharper anterior node extending perceptibly above the hinge line. The narrow, prominent flange is apparent at the anterior and posterior ends, but the free edge of the valve is indistinct.

Relationships: *K. elongata* differs from *K. robusta* Kellett in the greater length of the valve, in the sharper anterior node and in the anterior and posterior margins paralleling to each other.

Occurrence: Collected from the black shale of the upper and lower parts of Chihhsia limestone, L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7190-7191).

Genus *Knightina* Kellett 1933

Knightina reticulata Hou sp. nov.

(Pl. I, Fig. 10)

Carapace elongated, subtriangular in outline; in side view the anterior end is narrowly rounded and the anterior-ventral outline is more rounded than the postero-ventral margin with the highest part of the valve near the middle. The anterior margin is short, and perpendicular to the dorsal; the posterior margin curves obliquely outward to the cardinal extremity, making a cardinal angle of less than ninety degrees. Hinge line long, forming the greatest length of the valve, and slightly depressed below the shoulders. The antero-dorsal shoulder is quite distinct, strongly convex, rising above the hinge line with very deep anterior side, the posterior one is flat, and moderately convex; the central ridge is formed by elevation of these two shoulder-lobes. This specimen upon which the species is found is only represented by ill-preserved, separate valve; the inner flange is apparent only at the ventral and posterior margins, the outer flange is obsolete. Pit fairly small, deep and rounded, well-defined. Reticulation prominent, clear, and polygonal in form.

Relationships: This species can be easily distinguished from *K. bassleri* by its greatest height at the middle and by its very oblique posterior margin.

Occurrence: From the black shale of the upper part of Chihhsia limestone, L. Permian; at Maanshan of Chanyang district, Hupeh province. (Cat. No. 7192).

Genus *Roundyella* Bradfield 1935***Roundyella ovatiformis* Hou sp. nov.**

(Pl. I, Fig. 11)

Carapace small and sub-oblong or rectangular in shape with rounded, almost semi-circular and equal ends. Cardinal angles almost equally obtuse; ventral margin nearly parallel to the dorsal margin. There is a narrow smooth margin passing completely around the valves. No sulci, nodes or flanges are developed. The surface of the valves except on the margins is indistinctly reticulated or almost smooth, being either undeveloped or exfoliated. A circular kirkbyan pit or muscle spot impressed below the surface is located at the center of the valve. Spinelets absent. The surface is quite flattened.

Relationships: No other Permian forms are comparable with the present species. It bears some resemblance to *R. simplicissicus* (Knight) and *R. bellatula* Bradfield of Pennsylvanian of Missouri and Oklahoma of America but it can be distinguished from them by the small size, the uniform convexity of the valve and the absence of spinelets.

Occurrence: From the black shale of the lower part of Chihhsia limestone, L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7193.

Bairdiidae**Genus *Bairdia* McCoy 1844*****Bairdia convexa* Hou sp. nov.**

(Pl. I, Fig. 12 a-b)

Carapace rather large, short and thick; dorsal margin strongly arched; anterior beak broad and rather blunt, rising slightly above the mid-height of the valve. posterior beak bluntly acuminate and slightly below the mid-height of the valve; greatest height and greatest thickness at the middle; ventral margin slightly concave in the middle, and arched at the antero-ventral margin. This species is represented by several separate valves, one of which (7194) is compressed at the anterior half of the valve; the muscle scar in the other specimen (7195) is located slightly to the front of the middle. The overlap is unknown.

Measurement of the figured specimen:

Length 1.36 mm, Height 0.92 mm. (7194)

Length 1.50 mm, Height 1.00 mm. (7195)

Occurrence: From the black shale of the upper part of Chihhsia limestone,

L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7194-7195).

***Bairdia subrounda* Hou sp. nov.**

(Pl. I, Fig. 13 a-c)

Carapace small in size, subovate or subelliptical in side view, fusiform in dorsal or ventral view, length 0.75 mm, height equal to thickness 0.44 mm. Anterior beak broad and high; posterior beak low and pointed; ventral margin long, and slightly depressed in the middle. It curves abruptly toward the anterior end, forming a rounded and conspicuous antero-ventral angle; the other end of the margin is gentle toward the posterior; the postero-ventral angle is flattened and inconspicuous. Hinge line arched, slightly but apparently overlapping the larger valve (left valve). It is not conspicuous in the lateral view, because of the pronounced dorsal inflation of the valves, and rising slightly above the hinge line, which is slightly depressed below the latter. Ventral overlap fainter than that of the dorsal owing to the development of the thin and sharpened ventral margin.

Occurrence: From the black shale of the lower part of Chihhsia limestone, L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7196).

***Bairdia hupeiensis* Hou sp. nov.**

(Pl. I, Fig. 14)

Carapace subrhomboidal, protuberant centrally, length 1.63 mm, height 0.68 mm. Dorsal margin prominently convex at the middle, and sloping gradually down-ward each extremity; ventral margin slightly convex at the portion from middle to anterior, and the other part of the ventral margin slightly sinuate. Both extremities very angulate, but the posterior one very low. The greatest height and thickness are located at the central part of shell. The unique specimen, upon which this species is based, is an internal cast; the muscle scar is conspicuous near the middle of the valve and circular in shape. The diameter of the muscle field is 0.27 mm, and the arrangement of the scars is shown on plate 1, figure 14.

Relationship: The description of the species is far from complete. It is ascribed to the genus *Bairdia* in view of the characters of the carapace. The marked difference between this form and *Bairdia rhomboidea* Kirkby is the sharpened, angulate anterior, though the muscle scar may be compared with that of the latter species.

Occurrence: From the black shale of the upper part of Chihhsia limestone,

L. Permian; at Maanshan of Changyang district, Hupei province. (Cat. No. 7197).

***Bairdia fusiformis* Hou sp. nov.**

(Pl. II, Fig. 1a-d)

This species is represented by only separate valves, carapace rather large and triangular in lateral view. Dorsal margin broadly and strongly convex in the middle, gradually sloping toward the extremities; ventral margin nearly straight or slightly convex in the middle. Anterior beak more or less rounded than the posterior one and slightly above the mid-height of the valve; posterior beak acuminate and slightly below the anterior beak. The greatest height in the central, and the greatest thickness in the middle of ventral portion Muscle field distinct, but the scar is inconspicuous on the Hingement is unknown.

Occurrence: From the black shale of the upper and lower parts of Chihshia limestone, L. Permian; at the Maanshan of Changyang district, Hupei province. (Cat. No. 7202-7204).

***Bairdia changyangensis* Hou sp. nov.**

(Pl. II, Fig. 2a-b)

Carapace elongate-oval or subrhomboidal in lateral view; highest part near the center; ends thin, greatest thickness at the middle of the valves; length 1.7 mm and height 0.87 mm; the length is twice the height. Dorsal margin sloping backward, antero-dorsal slope straight, and nearly equal to the postero-dorsal slope which is rather deep, slightly concave, turning outward near the posterior extremity; beak long, thin, bluntly rounded. Ventral margin slightly concave in the middle, more convex at the antero-ventral and slightly convex at the postero-ventral. Anterior extremity slightly above the median line, broadly rounded; the posterior one narrow, sharp and below the median line. The left valve overlaps the right one is along the free margins and it widens on the dorsal margin and antero-dorsal slope which is very narrow throughout. The posterior end and postero-ventral are inconspicuous. Line of commissure at the dorsal margin straight for about two-fifths the length of the shell, rising anteriorly, the highest point of the commissure being well shown from anterior to center.

Relationships: This form can be distinguished from *B. longirostris* by the more sloped line of commissure, by the concave and convex ventral margin and the narrow overlap.

Occurrence: From the black shale of the upper and lower parts of Chi-

hsia limestone, L. Permian; at Maanshan, Changyang district, Hupei province, (Cal. No. 7205-7206).

***Bairdia sinensis* Hou sp. nov.**

(Pl. II, Fig. 3a-c)

Carapace small, somewhat elongate or rhombic in lateral view; length 0.82 mm, height 0.37 mm. Dorsum broadly arched, with long, nearly straight antero-dorsal slope and short, slightly convex postero-dorsal slope; dorsal curvature inconspicuous. The center of ventral is slightly concave, the antero- and postero-ventral are nearly straight or gently convex, and are nearly parallel to the antero- and postero-dorsal. Anterior end thin, bluntly pointed, a little above the median line of the shell; posterior beak crushed, but the outline of it seems to be equal to the anterior beak by joining the line of both dorsal and ventral margins. The muscle scar of this specimen, merely a right valve, is distinct; it consists of some ovate secondary scars surrounding the circular medial scar. Another two specimens obtained from different localities are morphologically related to this species; all of them are ill-preserved; hingement unknown.

Relationships: *B. sinensis* resembles in lateral view *B. verwiebei* Kellett and *B. peracuta* Warthin, but differs from them in having long, nearly straight antero-dorsal and short, slightly convex postero-dorsal. The muscle scar pattern of *B. sinensis* shown on the specimen is very similar to that of *B. pompilioides* Harlton, but some scars are indistinct.

Occurrence: In the black shale of the lower part of Chihhsia limestone; at the locality of Maanshan, Changyang district. (Cat. No. 7207-7208).

***Bairdia mui* Hou sp. nov.**

(Pl. II, Fig. 4a-d)

Carapace sub-ovate in lateral view and sub-fusiform to sub-elliptical in dorsal view, length 1.16 mm, height 0.61 mm, thickness 0.51 mm. Dorsal margin flatly, broadly rounded, antero-dorsal margin either nearly straight or slightly concave, postero-dorsal slope long and curving out-turned near the end. The ventral margin is gently curved to nearly flat medially, curving upwards more sharply toward the ends. The short, bluntly rounded, anterior beak is located above the line of mid-height, the posterior beak is typically rather narrow, and drawn out well down toward the ventral line. The overlap of the left valve is thick and continuous along the free margins, especially at the ventral. Owing to the inflation of the

two valves the overlapped area of the dorsal margin is conspicuously impressed. Greatest thickness at the center, highest near the middle and slightly toward the anterior. Surface smooth, rather strongly convex.

Relationships: This form differs from *B. citriformis* Knight in its thicker overlap along the ventral, in the more nearly straight dorsal outline and in the relatively longer valves.

Occurrence: From the black shale of the upper part of Chihhsia limestone; at the Maanshan, Changyang district. (Cat. No. 7209).

***Bairdia yangi* Hou sp. nov.**

(Pl. II, Fig. 5a-d)

Carapace sub-ovate in side view; moderately convex, length 0.92 mm, height 0.51 mm. Dorsum rounded, forming extremely regular antero- and postero-dorsal slopes inclining toward the ends; venter nearly straight or slightly concave in the middle and more or less curved to meet the ends. Anterior beak high, and short; posterior beak pointed, long and very low. The greatest thickness is slightly below the center and in front of the middle of the valve. The muscle area is located just at the greatest thickness of the shell, but arrangement of scars is inconspicuous on the internal cast.

Relationships: *B. yangi* might be confused with *B. mui* and *B. brevis* Jones and Kirkby but the former does not possess the strongly convex valve of the latter two species. *B. yangi* has a rounded dorsum instead of the highly arched one as in *B. brevis* and has a angulated beak in place of the bluntly rounded one as in *B. mui*.

Occurrence: From the black shale of the lower part of Chihhsia limestone; at the locality of Maanshan, Changyang district. (Cat. No. 7210-7211).

***Bairdia* sp. A.**

(Pl. II, Fig. 6a-b)

Carapace small, sub-fusiform or subrhomboidal in lateral view, length 0.92 mm, height 0.54 mm. Surface moderately convex; dorsal border roundly arched; antero- and postero-dorsal slope slightly convex, but the former is shorter than the latter, the dorsal curve is non-apparent; ventral border straight to gently convex, rounding up smoothly to posterior and anterior ends which are nearly equal to one another; the posterior beak pointed and is lower than the anterior. Greatest height and thickness at the center of the valve. The muscle field is circular,

indistinct and is situated at slightly below the center.

Occurrence: In the black shale of the upper part of Chihhsia limestone; Maanshan, Changyang district. (Cat. No. 7212).

***Bairdia* sp. B.**

(Pl. II, Fig. 7a-b)

Carapace elongated, length 1.19 mm, height 0.58 mm, moderately convex, but compressed anteriorly and posteriorly. Dorsal margin rounded and evenly convex, curving without angularity from the anterior margin to the termination near the posterior beak; antero-dorsal nearly straight and shorter than the postero-dorsal which curves slightly outward near the beak. Ventral margin has a slight sinuosity at the middle and is broadly and roundly convexed curving up gradually to join the flattened anterior margin and gently to posterior beak; posterior extremity pointed, well below the mid-line, maximum height and thickness central. Though this specimen is morphologically related to the species *B. hupeiensis* in outline, the muscle scar of the internal cast is quite faint, therefore it is very difficult to observe the relations between them; the hingement and overlap are undeterminable. It is probably a new species.

Occurrence: From the black shale of the upper part of Chihhsia limestone; at Maanshan of Changyang district. (Cat. No. 7213).

***Bairdia* sp. C.**

(Pl. II, Fig. 8)

Carapace elongated subfusiform in side view, the length twice the height which is 1.36 mm. Dorsal margin straight with both slopes conspicuously concave in the margin near the extremities. Ventral margin straight or faintly incurved at the middle, but bending upward along the antero- and postero-ventral angles to the ends. Anterior and posterior extremities narrow, sharp and nearly equal to one another, but the former is slightly higher than the latter. Surface smooth, strongly convex at the middle, sloping gently and gradually to the margins; it seems to be compressed at both sides of the greatest convexity.

Occurrence: From the black shale of the upper part of Chihhsia limestone; at Maanshan of Changyang district. (Cat. No. 7214).

***Bairdia* sp. D.**

(Pl. I, Fig. 15).

Carapace sub-elliptical in side view, length 1.36 mm, height 0.68 mm.

Dorsal margin broadly rounded, antero- and postero-dorsal slope either nearly straight or more slightly concave; the curvature of the posterior dorsal is distinct and forming an obtused angle. Ventral margin flattened, or more or less rounded at the postero-ventral. Anterior beak high, rising above the mid-height of the valve and rounding broadly into the convex postero-ventral margin; posterior beak well below the mid-height of the valve and narrow, more acuminate. The overlap of the left valve seems to surround the right one along the free margins, but it is inconspicuous, owing to the ill-preserved state of the specimen. The muscle field is located at about the center of the valve, the arrangement of the scars is not clear. Surface strongly convex, the greatest height and thickness lie at the middle of the shell.

Occurrence: From the black shale of the lower part of Chihhsia limestone; at Maanshan of Changyang district. (Cat. No. 7198).

Genus *Bythocypris* Brady 1880

***Bythocypris maanshanensis* Hou sp. nov.**

(Pl. I, Fig. 16a-d)

Carapace elongate or sub-elliptical in outline; the greatest height from anterior to center; length 1.4 mm, height 0.7 mm; valves moderately convex, dorsal margin nearly straight in the middle curving abruptly downward at the postero-dorsal, posterior end lower and narrower than the anterior; ventral margin slightly depressed and nearly straight in the postero-ventral, the other end bending upward to meet the anterior margin in a broad curve and making an obtuse, rounded antero-ventral angle. The left valve overlaps the right one all around. The overlap being more prominent on the dorsal and ventral margin. Surface smooth. The muscle spot appears to be present on the middle and slightly slopes toward the lower portion.

Relationships: This species differs from *B. procera* Coryell and Billings in the large size, in the more prominent overlap of the dorsal and ventral instead of anterior, and in the nearly straight dorsal margin in place of a broadly arched one as shown in the mentioned species.

Occurrence: From the black shale of the upper and lower parts of Chihhsia limestone; at Maanshan, Changyang district. (Cat. No. 7199-7201).

Genus *Macrocypris* Brady 1867***Macrocypris* sp.**

(Pl. II, Fig. 9a-b)

Carapace elongate in lateral view, length 2 mm and height 0.65 mm, highest at middle; the height being one-third of the length. Surface apparently smooth, moderately convex. Dorsal margin gently arched. Ventral margin straight or very slightly sinuate at the middle part. Anterior end rounded and posterior tapering to an acute postero-ventral angle. The right valve overlaps the left along the dorsal margin; but in the crushed specimen, the overlap is only apparent at the anterior dorsal portion. Other characters of this specimen are unknown.

Occurrence: Only one separate valve is found from black shale of the upper part of Chihhsia limestone; at Maanshan, Changyang district. (Cat. No. 7215).

Cytherellidae**Genus *Cavellina* Coryell 1928*****Cavellina maanshanensis* Hou sp. nov.**

(Pl. II, Fig. 10a-b)

Carapace wedge-shaped in dorsal view, sub-ovate to sub-quadrated in side view, dorsal margin sub-parallel with the ventral, posterior end nearly equal to the anterior, greatest height at the middle; subovate in posterior view. The greatest thickness lies below the middle. The details of hingement are not clear in the material studied.

Surface of valve smooth, moderately convex, ventral portion more convex than dorsal, a very shallow, undefined, scarcely discernible depression at about the middle of the dorsal half, and sometimes two short, small sulci at both sides of the ventral convex portion.

The measurements of the right valve of a female are: length 0.61 mm, height 0.29 mm.

Relationships: This species is very close to *C. paraquesita* Swartz, but it can be distinguished from the latter in having dorsal margin nearly parallel to the ventral, in the clearer dorsal-median depression and in the nearly equal thickness of both ends.

Occurrence: Collected from the black shale of the upper and lower part of Chihhsia limestone; at Maanshan, Changyang district. (Cat. No. 7216-7217)

***Cavellina mui* Hou sp. nov.**

(Pl. II, Fig. 11a-b)

Carapace elongate, elliptical in side view, dorsal margin gently arched, ventral slightly sinuate; anterior end slightly obliquely truncated, with extremity bending slightly downward; posterior margin rounded with regular curvature on the dorsal and ventral. Dorsal view elongate-subelliptical, anterior end more or less sharp, posterior bluntly rounded, sides gently convex. Greatest height and thickness median; the length about twice and half the height of the shell. There is a shallow furrow perpendicular to the shell length at a line one-fourth of the shell from the posterior end. Another slight depression is seen at about one-fourth of the shell length from the anterior end. Surface is marked with a wave ornamentation.

Relationships: This species is very close to *C. maanshanensis*, but it is longer, the depression is weaker, the greatest thickness is at the middle, it is a narrow elongate elliptical form in dorsal view. It represents undoubtedly a distinct species.

Occurrence: From the black shale of upper and lower part of Chihhsia limestone; Maanshan. Changyang district (Cat. No. 7218-7219).

Gen. et sp. indet.

(Pl. II, Fig. 12a-d)

These two specimens are procured in the black shale of the upper part of Chihhsia limestone. They are only ill-preserved, separate valves. In one specimen (7220) the length is 0.78 mm and the height is 0.41 mm; but in the another specimen (7221) the length is 1.09 mm, and height is 0.51 mm. Carapace sub-rectangular, hinge-line straight and forming the greatest length of the valve; dorsal margin with undulations, middle part of the margin impressed, antero- and postero-dorsal margins slightly convex; ventral more regularly rounded, it curved gently toward the ends, with a depression under the cardinal extremities; ventral angles rounded.

Cardinal angles nearly equal, quite acute. Surface smooth, strongly convex, with a distinct swelling at the middle, sloping gently to all margins. Muscle scar or pit not quite conspicuous below the middle swelling. The free margins of the valve are surrounded by the broad, radially striated frill.