CONTRIBUTION TO THE FAUNA OF THE KWEICHOU FORMATION OF CENTRAL CHINA.

By A. W. Grabau

(With four text-figures)

Introduction

The Kweichou formation was named by Willis and Blackwelder from the outcrops along the Yangtze at Kweichou and on the Taning-ho They, however, included in their formation, the sandstones and limestones which overlie the Wushan limestone and the coal-bearing shales next succeeding, which had previously been noted by Pumpelly and von Richthofen, and from which these earlier investigators had obtained plant remains which were described by Newberry and by Schenk as of Jurassic age. More recently, David White has shown that these are better referred to the Rhætic. The limestones underlying have furnished marine fossils which Girty described as suggestive of Permian age. The Rhætic plant-bearing and coal series has recently been named the Hsiangchi series by Prof. J. S. Lee of the National University, who restricts the name Kweichou series to the overlying grayish sandy shales from the base of which, at Kweichou in Hupeh, Mr. Y. T. Chao has collected the fauna herein described. This is clearly the same formation as that previously described by von Richthofen from the Szechuan border of the Yangtze and from which Frech has described a Wealden fauna obtained near Kweichou-fu and elsewhere in Szechuan. The species described by Frech are:

1. *Unio cremeri* Frech
2. *Unio johan-böhmi* Frech
3. *Cyrena (Miodon) cf. kiliani* Frech

The species obtained by Mr. Chao at Kweitchou in Hupeh, are the following:—

1. *Unio cremeri* Frech
2. *Unio chaoi* Grabau (sp. nov.)
3. *Unio (Lampsilis) johan-böhmi* Frech
4. *Mycetopus mengyinensis* Grabau

5. *Cyrena kweichouensis* Grabau (sp. nov.)
6. *Cyrena hupehensis* Grabau (sp. nov.)

Of these 6 species nos. 3 and 4 have also been obtained from the Mêngyin formation of Shantung, as described in a preceding paper in this Bulletin. This formation is essentially equivalent to the Kweichou formation (as restricted) on the Yangtze, and like that is a Lower Cretaceous continental formation, essentially of the Wealden type of western Europe. On the Yangtze the series has a thickness, according to Professor Lee, of about 2,200 meters.

Description on the Species

Unio cremeri Frech

1911. *Unio cremeri* Frech. In Richthofen China, Vol. V, p. 223, pl. 31, fig. 1 a, b.

This species, originally described by Frech from outcrops of the same formation in Szechuan, is represented by 4 individuals in the collection from the Ichang gorge. None of them is complete but all four show the umbonal portion and the characteristic ornamentation. The largest specimen in our collection has both valves in contact but somewhat crushed and with the posterior end broken away. It is slightly larger than that figured by Frech, but because of crushing does not preserve the thickened non-pustulose anterior portion in the same degree as that shown in Frech's figure. The umbones are strongly incurved, with a deep and strong anterior subumbonal depression, while the anterior end was markedly nasute. The young stages are much more subcircular than the adult, in which the shell is elongate.

The pustules are confined to the younger stages of growth, occupying about $\frac{2}{3}$ of the shell, the last third being essentially free from them or, when the pustules occur, they are few and scattered. In the pustulose stage, the pustules disappear in the anterior portion of the shell, which is only characterized by coarse growth-lines. They extend however, nearly to the hinge margin posteriorly, though they become weaker. Their most pronounced development is in the median portion of the shell where they are crowded, varying from subcircular to elongate, with the long diameter parallel

to the direction of the growth-lines, and from 2 to 3 times the transverse diameter. In this specimen they are less regularly arranged in concentric lines, more numerous and more crowded than in the specimen figured by Frech. The longest pustule observed is 6 mm., with a transversed diameter of a little over 2 mm. All the pustules are bluntly rounded, none of them being sharp.

Another specimen, the umbonal portion of a right valve, shows the beak strongly incurved with a pronounced anterior depression and a strongly developed broad non-pustulose shell area below it which, however, is not elevated as in Frech's type but flattened. The pustules of the central area are smaller and sharper than in the specimen previously described and were apparently largely confined to the young shell.

The other specimens show the pustules even more restricted, and widely scattered in the later stages of growth. The shell is thick, especially in the umbonal region the fragment of the right valve above noted, having a shell-thickness of 11 mm. It is composed of numerous parallel layers of shell substance.

Formation and Locality: In the argillaceous sanbstones of the Kweichou formation of the Yangtze gorge, above Ichang. Hupeh. Coll. Y. T. Chao, 4 specimen. The original type described by Frech came from the same horizon 5 li above Fuchow, province of Szechuan. The age is Lower Cretaceous or Wealden.

Unios with this type of shell ornamentation are not uncommon in modern Chinese waters, the most noteworthy being *U. leai* Gray var. *truncatula* Neum. which lives in the Grand Canal and Lake Tai-hu, province of Kiangsu. Other varieties and other species were described and figured by Heude, and the form seems to be common in Central China. None of them however, show the strong incurvature of the beak and the pronounced impression below it which characterize this species and give it the character of a *Quadrula,* to which subgenus it may be referable. The surface characters are probably independently developed in different genetic series.

Unio chaoi Grabau (sp. nov.)

(Figs. 1a-e)

Shell small, short for the genus, appearing sometimes subrotund and strongly inflated in the umbonal region. The ratio of height to length varies somewhat markedly so as to permit the recognition of two types, one shorter with a ratio of 1:1.13 to 1:1.4, and a longer in which the ratio ranges from 1:1.33 to 1:1.40. A young form (f of the table) shows an intermediate ratio 1:1.26. The beaks lie about two-fifths the length of the shell from the anterior end, but are not very prominent; they are only moderately depressed below the level of the umbonal region. There is only a slight excavation in front of the beak, this being less pronounced than the depression behind the beaks.

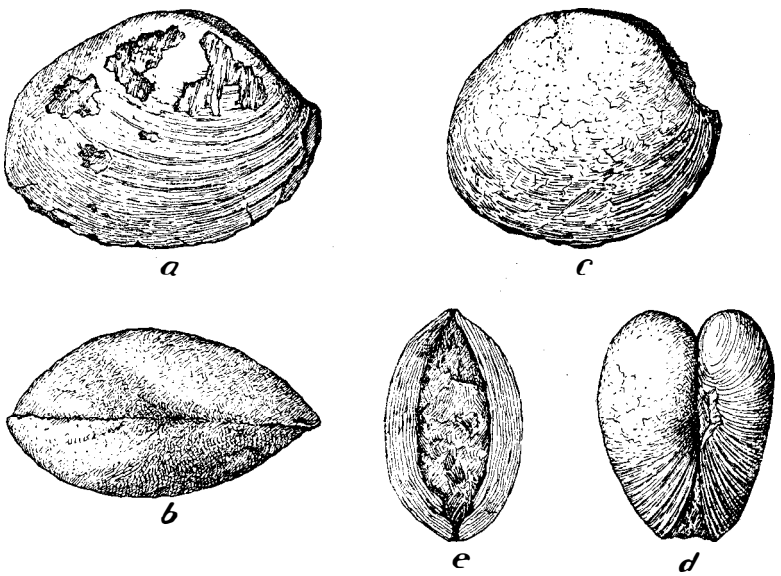

Fig. 1. *Unio chaoi* Grabau nat. size. *a*, long form showing right side; *b*, dorsal view of same; *c*, short form, right side; *d*, anterior view of the two valves; *e*, median longitudinal section showing thickness of shell and laminate character. Kweichou formation, near Kweichou, Hupeh.

Anterior end rounded, sometimes slightly nasute, curving into the ventral border, which is gently arcuate, never becoming quite straight; posteriorly the ventral border curves upward more abruptly into the subangular posterior end. This varies somewhat in the different individuals being more

rounded in the shorter and more sharply angulated in the longer individuals, with the angulation always obtuse. A faint rounded umbonal ridge extends from this angle to the umbonal region but is never very prominent. The shell surface above it is sometimes nearly flat and in rare cases slightly concave.

Greatest thickness of the shell about one third the height below the umbonal region, the convexity below this being very gentle, except when flattened or depressed by compression. Surface marked only by lines of growth, which near the front may be somewhat lamellose, and in some cases rather pronounced wrinkles may develop. When exfoliated the shell appears to be finely striated radially.

Measurements:

	a	b (Fig. 1c,d)	c (Fig. 1a,b)	d	e	f
Length	37.8	35.8	41.5	45.0	40.0	29.5
Height	32.5	31.5	31.5	32.0	26.0	23.5
Greatest thickness	19.5	23.5	22.0	19.5	26 5	17.0
Beak to front	17.0	13.5	16.0	19.0	17.5	13.5
Ratio, Height to Length	1:1.13	1:1.14	1:1.33	1:1.40	1:1.54	1:1.26

In section the shell is seen to be composed of a number of strong and nearly uniform lamellæ, some of which show a fine prismatic structure. In a specimen about 30 mm. in length there are 9 such layers, aggregating a total thickness of shell-substance of 4.5 mm. in the thickest part. The thickness of the entire shell is about 18 mm. (Fig 1e).

This shell resembles somewhat *Unio brachyopisthus* White[1] of the Laramie of the western United States, but is larger and more elongated, while the beaks are more central than in the American form. Of modern Chinese forms *Unio superstes* Neum.[2], and *Unio heres* Neum.[3], from

1. 3d Ann. Rept. U. S. G. S. Pl. 16, figs. 7, 8, p. 433.
2. Neumayer M., in Wissenschaftliche Ergebnisse der Reise des Grafen Bela Szechenyi. Vol II, pl. I, fig. 3, p. 643.
3. Ibid. pl. I, fig. 6, p. 644.

Talifu Lake are not unlike our form, but in both the beaks are more anterior. The former is also more elongate than our form but has the umbonal ridge and the posterior angulation which characterize the present species. These features are less marked in *U. heres* which is of about the size of our species, though less inflated and with more anterior beaks.

Horizon and Locality:— In the Kweichou beds of the Ichang gorge of the Yangtze, near Kweichou, Hupeh. Associated with *U. cremeri,* etc. 15 specimens. The species is named after Mr. Y. T. Chao one of the active and enthusiastic young palæontologists of the Survey, who collected these fossils.

Unio (Lampsilis) johan-böhmi Frech.

1911. *Unio Joh-Böhmi* Frech; in Richthofen China, Vol. V, p. 223, pl. 31, figs. 3 a-c 4.

1924. *Unio (Lampsilis) johan-böhmi* Grabau; Cretaceous Fossils from Shantung; this bulletin p. 149, fig. 2.

This elongated *Unio* previously described by Frech from the Kweichou formation of Szechuan and identified in the Mêngyin formation of Shantung, is represented by several poorly preserved specimens in the collection of Kweichou fossils made by Mr. Chao at Kweichou, Hupeh. These show some variation both in size and in the position of the beak, but I shall for the present refer them all to the above species, since the material is not in a sufficiently good state of preservation to permit any other proceeding. The shell is preserved in these specimens, and is generally of moderate thickness showing, where fractured, a distinct lamellose character. The surface however is exfoliated and corroded so that the growth-lines are more or less obscured, and the shell is rough.

A medium-sized specimen agrees essentially with the figures published by Frech, but the anterior end is somewhat crushed and corroded thus giving the appearance of a more anterior beak than is actually the case. The length is about 55 mm. but was originally probably nearly 60 mm. when the anterior end was perfect. The greatest height is 32 mm., this being near the center of the shell and behind the beak. The thickness is 14 mm. but this is

less than the original, the valves being somewhat crushed. A young stage of this shell, outlined by the rather obscure growth-lines, has a length of 34 mm. with the beaks which are rather strongly corroded about 6.5 or 7 mm. from the front, i.e., about one fifth the length of the shell. The height at this stage was about 12.5 mm. If the original length of the shell was 60 mm. the beak was about 12 mm. from the front, i.e., $\frac{1}{5}$th the length of the shell; but it may have been something less, say perhaps $\frac{1}{6}$th the length of the shell. This agrees essentially with the position which it holds in Frech's types.

This shell is proportionally somewhat higher than Frech's types and the Mêngyin specimens, but this may be due, in part at least, to the crushing which has correspondingly reduced the thickness. The basal margin is, however, gently arcuate as is the case in one of the specimens figured by Frech, lacking the concavity seen in the basal margin of the others. In this respect it corresponds to most of the internal molds from the Mêngyin formation.

A second specimen more strongly crushed vertically has a length of about 60 mm. with the beak 10 to 11 mm. from the front or between $\frac{1}{6}$th and $\frac{1}{5}$th the length of the shell. There is a small but distinct excavation beneath the beak in front, and the dorsal excavation behind it is also rather strongly marked. Teeth not determinable.

A third specimen is much larger than the others and may belong to a different species, though the shell is not well enough preserved for precise determination. The fragment at first sight suggests *Unio menkii,* but the shell is too long, and the beaks too near the anterior end for reference to this form. The original length was apparently about 90 mm. with the beak about 15 mm. from the front or $\frac{1}{6}$th the length of the shell. The greatest height is behind the umbo and is about 40 mm. There is a faint excavation below the beaks in front, and from this point to the ventral margin the anterior margin is regularly rounded as in the typical forms. The ventral margin is gently arcuate, without concavity; characters of posterior end not fully determinable, but apparently as in the Mêngyin shells.

This is the largest individual of this species so far obtained and probably represents a full-grown shell.

Horizon and Locality:— In the Kweichou sandy shales at Kweichou, Hupeh, Coll. Y. T. Chao.

Mycetopus mengyinensis Grbaau

(Fig. 2.)

1924. *Mycetopus mengyinensis* Grabau; Cretaceous Fossils from Shantung; this Bulletin, p. 153, text-figs. 4 & 5.

This shell previously described by me from the Mêngyin beds of Shantung, is represented in the collection from Kweichou by a single small specimen, which, however, preserves most of the shell. The length of the shell is only 11.5 mm. while the beak lies 2.3 mm. or one-fifth the length of the shell from the front. The height at the umbones is about 5 mm. while near the posterior end of the hinge-line it is 5.5 mm. The hinge-line is straight for about 6 mm. behind the beak after which the shell margin slopes obliquely downward to the rounded posterior end. A faint but definite umbonal ridge extends from the beak to the junction of the dorsal posterior slope with the rounded posterior ventral end; the postero-dorsal portion thus outlined, and which is bounded behind by the oblique sloping shell edge, is gently concave. The ventral border is straight, without concavity, and the anterior, somewhat nasute, end is narrowly rounded. A slight excavation occurs below the beaks.

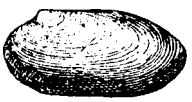

Fig. 2.
Mycetopus mengyinensis Gr. Small left valve preserving shell × 2, Kweichou.

The shell surface is smooth except for fine subregular lines of growth. The thickness of the shell substance is slight. Though smaller than the Mêngyin specimens this shell undoubtedly belongs to the same species.

Horizon and Locality:— In the finer sbales of the Kweichou formation, Kweichou, Hupeh. Coll. Y. T. Chao. 1 specimen.

Genus *Cyrena* Lam.

Cyrena kweichouensis Grabau (sp. nov.)

(Fig. 3)

Shell thin, of medium size, not inflated, elongate, with the beak about one-fourth the length of the shell from the anterior end. Umbo

not prominent, the shell margins on either side sloping away so as to form an angle of about 110°. Anterior margin faintly excavated beneath the umbo, straight for about half the height of the shell below the beak, then curving regularly into the ventral margin which in gently convex. The posterior end appears to be more sharply rounded, but this is due to the fact that the curvature continues further dorsally passing into the much more obliquely sloping and nearly straight dorsal or hinge margin, which in the type specimen is 7 mm. long (total length of shell 13 mm.). A posterior lateral tooth is indicated by a depression parallel to the hinge margin. Greatest convexity of the shell near the middle from which point the shell curves nearly equally to the umbonal and ventral margins, somewhat more abruptly to the front and more gently to the posterior end. Surface of shell marked only by faint lines of growth.

Fig. 3.
Cyrena kweichouensis Gr. left valve. × 2. Kweichou

Measurements of two shells gave the following proportions:

	1	2
	Type (fig. 3)	
Length	13.0 mm	9.5 mm.
Height	8.5 mm	7.0 mm.
Beak to anterior end	3.0 mm	2.3 mm.

This shell resembles the one figured by Frech as *Cyrena* sp. (Richthofen V, pl. 31, fig. 7) from the Wealden of Oberkirchen, Germany and which he states is intermediate between *C. caudata* A. Roemer, and *C. majuscula* A. Roemer. That shell however, if the figure is of natural size (Frech forgets to mention this detail) is nearly three times as large as our form, having a length of 32 mm. and a height of 22. The form figured by Frech as *Cyrena* cf. *kiliani* n. sp. from this formation at Kweichou-fu, Yun-yan-hsien, Szechuan, if of natural size, is likewise nearly three times as large as our form and also has less elevated umbones which are situated much further back than in our species.

Horizon and Locality:— In the sandy shales of the Kweichou formation at Kweichou on the Yangtze, province of Hupeh. Coll. Y. T. Chao. It is apparently a common form though usually much crushed.

Cyrena hupehensis Grabau (sp. nov.)
(Fig. 4)

Shell of medium size, moderately convex, elongated with the beaks in the anterior third. Umbones not prominent, a very faint excavation occurs beneath the beaks, below which the shell margin is straight and slopes diagonally forward, passing into the round anterior end. Ventral margin rounded, on a larger radius than the front; posterior margin more sharply rounded below, obliquely sub-truncate in the upper part. Hinge-line straight for about half the length of the shell behind the beak, or about one-third of the entire length of the shell.

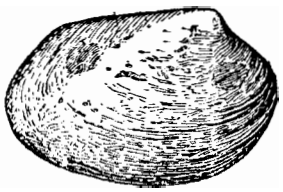

Fig. 4
Cyrena hupehensis Grabau. right valve; showing muscular scars. × 2. Kweichou.

A very faint umbonal ridge extends from the beak to the posterior ventral margin, the posterior dorsal region thus outlined being less strongly convex than the rest of the shell, being sometimes even flattened, but not concave.

Greatest convexity of the valve behind the beaks and somewhat dorsad of the median longitudinal line. The central part of the shell is gently arched but near the ends the curvation of the shell becomes rather abrupt. Dorsoventrally the curvature of the shell is rather regular.

Surface marked by fine growth lines, which in the anterior-ventral region are supplemented by wrinkles.

Hinge structure unknown. Muscular impressions dorsad of the median longitudinal line, very faintly marked on the internal mold.

Measurements:— A typical left valve measures length 17 mm., greatest height 11 mm., beak 4.5 mm. behind front end.

Horizon and Locality:— Rather common in the calcareous layers of the Kweichou formation of Kweichou on the Yangtze, in Hupeh province. Y. T. Chao, Coll.

BULLETIN

OF

THE GEOLOGICAL SURVEY OF CHINA

NUMBER 5. PART 2. DECEMBER, 1923.

CONTENTS

PEKING
THE GEOLOGICAL SURVEY OF CHINA
MINISTRY OF AGRICULTURE AND COMMERCE

THE COMMERCIAL PRESS, PEKING BRANCH WORKS
1928.