ON AN ENIGMATIC PTEROPOD-LIKE FOSSIL FROM THE LOWER CAMBRIAN OF SOUTHERN SHANSI, *BICONULITES GRABAUI*, NOV. GEN., NOV. SP.

by

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I. GEOLOGY OF THE SITE

The Lower Cambrian fossils here described were first found, insufficiently preserved, by Licent and Teilhard in 1926 at Kêntingshih (圪丁石), just along the border of the high limestone range, 50 lis N. of Chishanhsien (S. Shansi).[1] Later, in 1929, much better specimens were collected in the same locality, but at a different level, by Teilhard and Young[2] and the geology of the site was restudied.

The geological section, near Kêntingshih, is as follows:—

1. Cambro-Ordovician massive limestone, forming the mountain range.
2. Red shales, interbedded with several thin layers of fossiliferous "upper limestone"..5 meters.
3. Red shales..20 m.
4. "Middle limestone," fossiliferous..2 m.
5. Red shales..15 m.
6. "Lower limestone" several layers or lenses, fossiliferous (Trilobites only)..20 m.
7. Quartzite and consolidated arkose..2 m.
8. Archaean floor.

The Pteropod-like organisms are found in the beds 2 and 4. In 4, the fossils are indistinct on account of the coarse and crystalline grain of the rock. But, in 2, the state of preservation is perfect. In the present paper, only the material collected in the bed 2 is studied.

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1. E. Licent and P. Teilhard de Chardin, On the basal beds of the sedimentary series in SW. Shansi. Bull. Geol. Soc. China, vol. VI, 1927, p. 63. In Dr. Grabau's paper, Terms for the Shell Elements on the Holochoanites, (ibid. Vol. VIII, p. 121, 1929), the fossils were alluded to under the name of *Teilhardoceras*.
2. The locality is indicated, as a fossiliferous Cambrian exposure, on the map given by P. Teilhard de Chardin and C. C. Young, in: Preliminary observations on the Pre-Loessic and Post-Pontian Formations of W. Shansi and N. Shensi, Mem. Geol. Surv. China, Ser. A, No. 8, 1930.

II. Palæontological Study

A. Number and Preservation of the Fossils.

The bed 2 consists of a hard blue-grey oolitic limestone containing numerous small grains of glauconite.

In this matrix, the Pteropod-like fossils are extremely abundant and crowded, lying horizontally, in the same way as *Hyolites* are generally found. On the broken pieces of rock, the specimens are frequently seen projecting

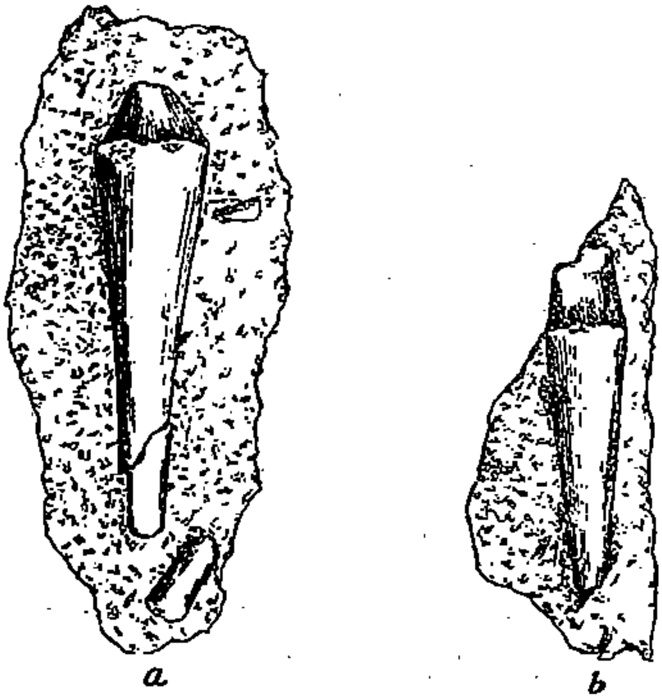


Fig. 1. Two specimens of *Biconulites grabaui*, in the rock matrix, enlarged twice. Observe the long direct central cone, and the shorter, opercule-like, inverted cone.

in a free condition. But, in this case, the shell is generally broken, and the internal cast only is preserved. When preserved, the shell proves to be coarse, externally without any clear zones of growth.

In sections, the shell looks sometimes very thin, but sometimes also decidedly thick (specially the "direct cones"). The shell itself is transformed into crystalline calcite. The filling material of the fossils is formed either by introduced silt (very fine grained), or by secondarily developed oolites and glauconite, or again by a hard, homogeneous, greenish substance of doubtful origin, chiefly met with in those places where a stereoplasmatic substance would be expected.

Some 250 specimens have been studied before writing the present paper. Most of them were polished sections, or thin sections. But, for the most part, the characters noticed in these sections can be recognised and fully understood in the free specimens.

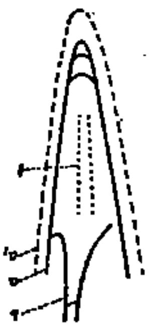


Fig. 2. Structure of *Biconulites* (schematic). a, Central "direct cone"; a_1, Accessory or external "direct cone"; b, Inverted cone; t, Central tube.

B. Geometrical Reconstitution of the Fossil.

As explained below, it is uncertain whether, and how far, the fossils here described should be held as a composite association of shells accidentally inserted one into the other. Nevertheless, assuming first, *as a hypothesis*, that they represent a true individual organism, we will try, with the help of the numerous sections we have now at hand, to reconstruct its *geometrical* appearance.

In short, the fossil is found as a biconical organism, made of two sets of inserted cones : the direct cones (a), and the inverted cones (b), to which has possibly to be added a central tube (c). (text-fig. 2).

a) The direct cones.

There are two kinds of direct cones : the central one (a), and the external ones (a1, a2, etc.).

1) *The central direct cone* represents evidently the chief and true part of the shell (corresponding, f. i. to the *Hyolites* shells). It is 20 mm. long in average (the largest specimens do not exceed 40 mm).

In many specimens, the lower end of the central cone is distinctly curved (as, f. i., in a *Dentalium*). A much more important feature is that, in ten cases, it shows clearly three or four septa (Pl. I, figs. 2 and 5; Pl. II, fig. 3). This embryonic camerated part is probably broken in most of the specimens, which, in consequence, look as if they were truncated. No trace of a siphuncle has been detected, so far, across the septa.

2) *The external direct cones* are sometimes missing. But, in most cases (see the statistics below), they are present: generally one only, but in many cases two, regularly inserted around the central cone. In the case of such a complex set of two or three concentrical cones, the elementary cones seem to be free and loose, each one within the other. At least, in all our thin sections, on trace of fusion of the calcitic walls can be detected between the adjoining cones.[1]

No traces of septa have been observed on any external cone.

b) The inverted cones.

The *inverted cones* are the most puzzling feature of our enigmatic fossil. As indicated by the statistical computation made below, they are a very constant character: to them is due the highly characteristic biconical shape of the freely exposed specimens.

Concerning the inverted cones, the following chief points have to be mentioned:

1) The shape of the inverted cones is different from the shape of the direct cones:

First because they never show any initial part with septa. Their summit, on the contrary, seems to have been an open one.

And also because their marginal border, along the base of the cone, is distinctly curved and tapering outwards (in the same way as the "goulot" of a bottle). This outward inflexion of the marginal border is perfectly clear on the internal casts protruding from the fossiliferous rock (see fig. 1, cf. Pl. I, fig. 4).

1 It could be supposed, however, either that the various cones did not fuse before the "oral cap" (?) which is possibly shown by the specimen, fig. 5, pl. I, or that they were cemented with the help of the stereoplasm-like green substance above mentioned.

2) In addition to the chief, opercular-like, inverted cone, many specimens show more or less distinct traces of smaller, more internal, similar cones, distinctly thinner. The number of those *accessory internal cones* is very variable: generally one, but also two, or three, or even four (see Pl. I, fig. 3).

3) The inverted cones are always free, and in some cases loose; but, in many cases, they seem to be taken in the stereoplasm-like green substance, when their margin approaches the walls of the central direct cone.

4) The geometrical axis of the inverted cones does not correspond exactly to the axis of the direct cones; but it runs obliquely to it, so that the general symmetry of the body is slightly bilateral (see Pl. I, figs. 1 and 3).

5) *The central tube.* The central tube is a very obscure feature, distinctly recognisable in a small number of specimens. See f. i. fig. 3 of Plate II.

6) *General relations between the direct and inverted tubes.* We could not recognise any regular relation between the numbers of the direct and inverted cones. If the fossils were recognised as a true individual (and not an accidental composite) form, this irregularity could be explained by the fact that, on account of the fragile conditions of the accessory cones, all the specimens are more or less incomplete. In many cases, the secondary cones are poorly, but clearly represented by very small fragments; in such conditions, the various specimens can not be exactly compared with each others.

III. Zoological interpretation and Conclusions.

We have two rather strong reasons for supposing that the above described organism represents a real zoological form:

1) *The striking geometrical regularity of the fossils.* In each specimen, the various cones are perfectly balanced for the size, and perfectly concentrical (this last fact is specially obvious in the numerous transversal sections we have studied). And, taken together, all our 200 or more specimens are practically reducible to a single and constant formula.

2) *The constancy of their complexity.* It is difficult to understand how a fortuitous association could be repeated many hundred times in the same place, with the exclusion of the simpler types of combination. Of the 125 specimens studied in thin sections: 24 show both "external direct" and "inverted" cones; 15 show "external direct" (without "inverted") cones; 33

show "inverted" (without "external direct") cones; 43 show a complex unanalysable structure (in transversal sections); 10 only are, *apparently*, of a simple *Hyolites* shape (this appearance being probably due to an accidental reason found in the preservation of the fossil or in the direction of the section).

But, on another hand, if we try to understand how such a complex organism might have been *biologically possible*, we meet the most serious difficulties.

First, the growth of the *external direct cones* and the localisation of any soft body in their associated sheet seem almost impossible. So probably we have to admit that those external cones are nothing but foreign shells seriated and inserted each in the other, in consequence of some special mechanical action of the water currents in the course of sedimentation.

As to the *inverted cones*, their special shape, thin peculiar orientation, and their exceptionally constant association incline us to believe that they represent a natural part of the organism, something like an opercule (possibly retractile). Such tapering fore-ends of the shell are known in several Palæozoic Molluscs (*Hyolites, Conularia*). The *accessory* inverted cones are, of course, more difficult to explain.

In any case, even reduced to their *direct central cone*, the fossils here described would be still interesting, on account of the camerated structure of their embryonic part.

Under such uncertain conditions, the name *Biconulites grabaui* nov. gen., nov. sp., which we have given to the problematic organism in honour of our friend Dr. A. W. Grabau, has been adopted merely for the sake of convenience; and it does not convey any zoological meaning. But we hope that, one attention being drawn, the palæontologists interested in the study of the Cambrian fauna will bring out some similar cases from other parts of the world, helping us to decide, more definitely, the real nature of our Shansi "problematicum."

Explanation of

Plate I

PLATE I

1.—A large specimen, showing the central direct cone and a single inverted cone. Compare with text-figure 1. Another smaller specimen is seen in the lower left corner.

2.—A specimen showing four initial septa, and a faint inverted cone.

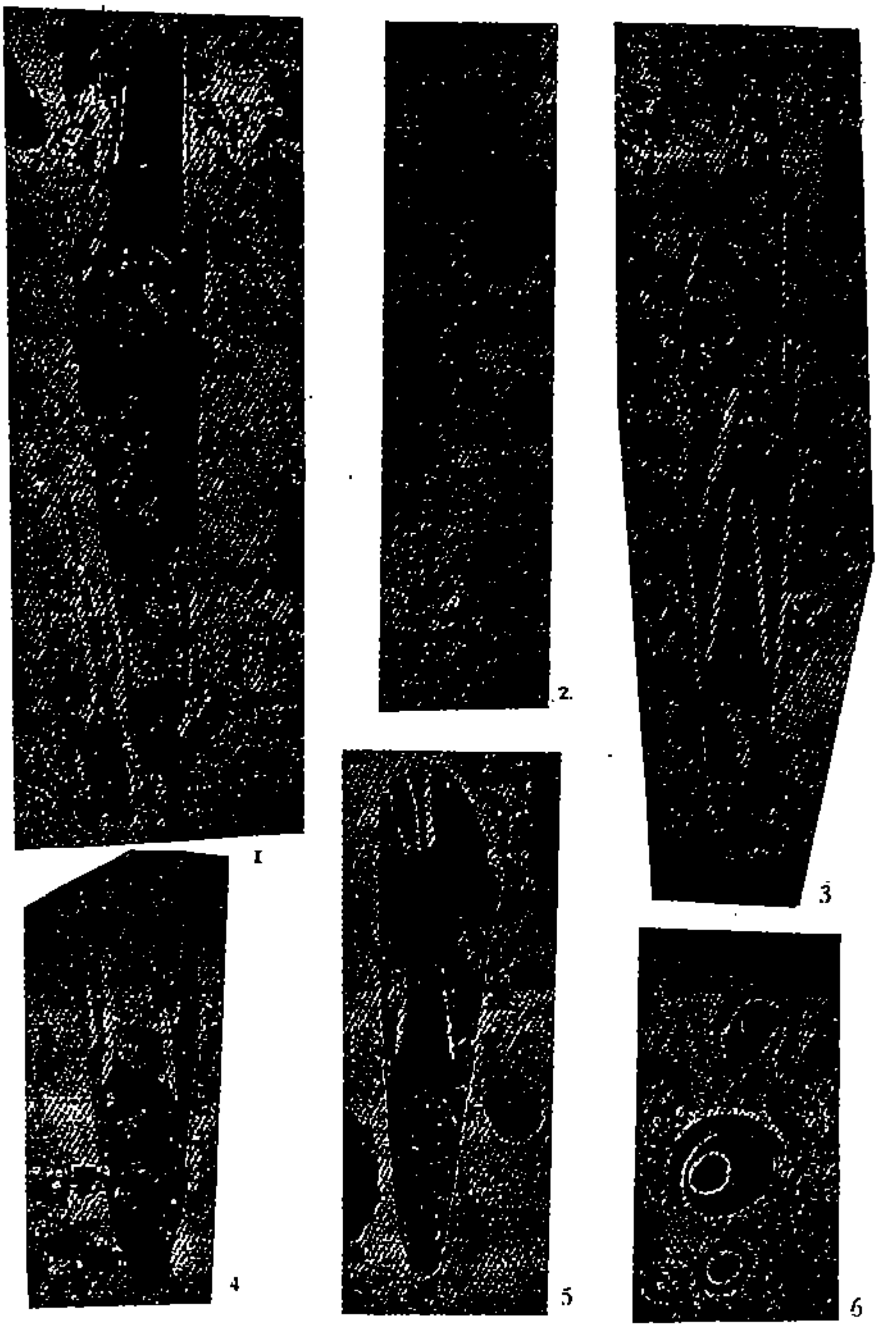
3.—A specimen with a chief inverted cone, one (or two) accessory inverted cone, and probable traces of lower septa. Observe the asymmetrical position of the inverted cone.

4.—A specimen with an inverted cone and, around this latter, an accessory sheet (compare with fig. 5 of Plate II). Observe the particular shape of the lower border of the inverted cone, and the resulting "bottle-shaped" appearance of the internal cast (cf. text-fig. 1).

5.—A remarkably preserved specimen. with lower septa, inverted cone, and suggestions of a closed shell.

6.—Some transversal sections.

All the specimens enlarged three times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Explanation of

Plate II

Plate II

1.—A queer specimen, with an external direct cone and evidences of an axial structure ("central tube").

2.—A specimen with an external direct cone and one inverted cone. Observe the very small conical organisms crowding the inverted cone.

3.—A specimen with lower septa, external direct cone, and "central tube".

4.—A specially complex transverse section.

5.—A specially complex apparatus. Compare with fig. 4, Plate I.

6.—A group of fine specimens.

All the specimens enlarged three times.


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