

## LATE JURASSIC—EARLY CRETACEOUS BELEMNITES FROM SOUTHERN TIBET, CHINA

YANG TSUN-YI AND WU SHUN-BAO

(Peking Geological Institute)

The belemnites described here were collected by two field parties visiting southern Tibet respectively in 1960 and 1961 from (1) the Lungma—Kapula area, east of Ziangzhi and (2) Dingje and Dingri, all of which are situated southwest of Lhasa. They consist of two genera and twelve species with six new species and they may be differentiated into two assemblages: the first assemblage of upper Oxfordian—lower Tithonian age with *Belemnopsis gerardi* (Oppel) as its leading species and the second of early Cretaceous age with *Hibolites subfusiformis* (Raspail) as its chief element.

The geologic sections which bear the belemnites are given as follows (in descending order):

### I. Section at Chazo, Dingri (text-figure 1 in the Chinese text):

Sinmudi Limestone (Tithonian?)

8. Massive limestone, about 100 m.
7. Dark grey limestone intercalated with marly limestone, about 100 m.
6. Marly limestone, about 80 m.

————conformable————

Chazo formation (Oxfordian—early Tithonian?)

5. Shale intercalated with thin-bedded sandstone, containing some indeterminable ammonites, about 150 m.
4. Belemnites bed: calcareous shale with some limestone lenses, about 5 m., rich in belemnites, viz.: *Belemnopsis gerardi* (Oppel), *B. alfuriscus* (Boehm), *B. taliabuticus* (Boehm), *B. dingriensis* sp. nov. The first two species occur in great abundance, making up about half of the specimens obtained.
3. Shale with concretionary sandstone, about 150 m., fairly rich in ammonites, such as *Lithacoceras* sp., *Virgatosphinctes* sp., *Perisphinctes*? sp.
2. Bluish grey shale with round clayey concretions, about 100 m.

————conformable————

1. Sandy shale, sandstone with limestone lenses, 200 m., but bottom not exposed.

The Chazo formation with *Belemnopsis gerardi* (Oppel) may be equivalent to the *Belemnopsis gerardi* bed of the Spiti which is of late Oxfordian age (Uhlig, 1910; Arkell, 1956). *Belemnopsis gerardi* and *B. taliabuticus* reported from Timor (Stolley, 1928) are also of Oxfordian age. Ammonites, on the whole, range from the Oxfordian to Tithonian. Hence the Chazo formation is taken to be of late Jurassic Oxfordian to Tithonian (?) age.

It is worthy of note that in our section the ammonites (*Virgatosphinctes*, etc.) occur beneath the belemnites (*Belemnopsis gerardi*), while at Spiti the reverse is true, that is that the perisphinctids occur above *Belemnopsis* beds. If the succession at both places is normal, one ought to find out the reason for such a difference in faunal distribution. However, this point can only be cleared up in the future when more data are available.

### II. Section at Kapula, east of Ziangzhi (text-figure 2 in the Chinese text):

Early Cretaceous (lower Zongzo formation)

8. Dark grey calcareous shale with iron lenses bearing some ammonites, about 200 m.
7. Marls, rich in pyrite with a fine-grained sandstone at its lower part, occasionally with belemnites, about 120 m.
6. Dark grey thick slabby siliceous shale, iron-stained on weathered surface, about 500 m.
5. Grey marls, alternated with calcareous shale and siliceous shale, about 50 m.
4. Grey marls, calcareous shale with some iron lenses, rich in belemnites, with thin ferruginous fine-grained sandstone and many limestone lenses at base, about 120 m. Belemnites identified: *Hibolites subfusiformis* (Raspail), *H. subfusiformis* var. *baluchistanensis* Noetling, *H. jiangzhiensis* sp. nov., *H. xizangensis* sp. nov., *H. parhastatus* sp. nov., *Belemnopsis* cf. *africana* (Tate), *B. sinensis* sp. nov., *B. extenuatus* sp. nov.
3. Dark grey shale plus iron concretions, containing a few ammonites, about 100 m. thick.

————conformable————

Late Jurassic (Kapula formation=upper Tithonian—Berriasian)

2. Dark grey shale and sandy shale with calcareous concretions, its upper part bearing ammonites and a few belemnites, about 250 m. Ammonites identified: *Himalayites* sp., *Spiticeras* sp., etc.
1. Light grey, thick-bedded quartzitic sandstone, locally with quartzite lenses and dark grey shale, about 50 m.

Bed 2 of the above section is equivalent to Kapula formation of Sun and Liu (1962) and is of late Tithonian—Berriasian in age. Bed 4 equal to the lower Zongzo formation of Sun and Liu (1962) is of Valangian age and is characterized by *Hibolites* not seen in Spiti (vide Spath, 1939).

Acknowledgements. Grateful acknowledge is made to Prof. Y. C. Sun who encouraged and advised us during the present study, especially in dealing with the question of the Jurassic—Cretaceous boundary and to Prof. T. H. Yin who also advised us and examined our study. Thanks are due to Mr. Feng Mao-sheng and Mr. J. X. Yin for supplying geological data, and to the photographic section of our Institute for preparing all the photos.

## DESCRIPTION OF SPECIES

### Family Belemnitidae Orbigny 1845

#### Subfamily Belemnopsinae Naef 1922

#### (Hastatidae Stolley 1919)

#### Genus *Belemnopsis* Bayle, 1878

#### *Belemnopsis gerardi* (Oppel)

(Pl. I, figs. 1—7)

*Belemnites gerardi* Oppel. Waagen, 1873, Pal. Indica, ser. ix, 1, pl. II, fig. 3.

*Belemnites gerardi* Oppel. Uhlig, 1910, Pal. Indica, ser. 15, vol. 4, fasc. 3, p. 386, pl. 93, fig. 5.

*Belemnopsis gerardi* (Oppel). Spath, 1933, Pal. Indica, new ser. vol. ix, no. 2, pt. vi, pl. 1.

This is a leading species in the belemnites bed near Dingri and is represented by numerous fairly well-preserved specimens.

**Description:** Rostrum of moderate size, slenderly cylindrical, with well-preserved ventral groove commencing from anterior part and disappearing near the apex which is sharply pointed.

With the exception of *O*, all the signs are after Tetsuro Hanai (1953). *L*, actual length of rostrum; *l*, estimated length of rostrum; *Lal*, actual length of alveolus; *lal*,

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB 001	69	78	18	27	30	21	9/10	9/10	570	25°
XB 015	60	>80			37±	23	9/10		650	24°

estimated length of alveolus; *Lap*, length of apex; *Ls*, length of stem; *Dt<sub>1</sub>*, anterior diameter of stem; *d.v.*, dorso-ventral; *l.l.*, lateral; *Dt<sub>2</sub>*, anterior diameter of apex; *Aap*, apical angle of apex; *O*, *O*-value.

**Horizon and locality:** Middle part of Chazo formation (Oxfordian—early Tithonian?); Chazo, 6 km NW of Dingri, S. Tibet. Figured specimens: XB046, XB015, XB026, XB029, XB030, XB033.

### *Belemnopsis alfuricus* (Boehm)

(Pl. I, figs. 8—12)

*Belemnites alfuricus*, Boehm, 1907, Palaeontographica, Suppl. iv, lief. 2, s. 72, taf. viii, fig. 5, 7, 11.

*Belemnites alfuricus*, Uhlig, 1910, Pal. Indica, ser. 15, vol. 4, fasc. 3, p. 388, pl. 93, fig. 6.

This species is quite similar to the preceding one, but it may be distinguished from the latter by the following points: (1) it is more slender, (2) it is slightly compressed laterally and (3) it has a narrower ventral groove. Young individuals of both species, however, are hardly distinguishable from each other.

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB 019	68	75	16	23	29	23	7.5/7	8.5/7.5	700	22°
XB 037	55	75			38	17	7.0/7.2	7.7/7.7	790	25°

**Horizon and locality:** Middle Chazo formation (Oxfordian—early Tithonian?); Chazo, 6 km NW of Dingri, S. Tibet. Figured specimens: XB037, XB023, XB027, XB028.

### *Belemnopsis taliabuticus* (Boehm)

(Pl. II, figs. 2—3)

*Belemnites taliabuticus* Boehm, 1907, Palaeontographica, suppl. iv, lief. 2, s. 74, taf. xi, figs. 5—8.

*Belemnopsis taliabuticus* (Boehm), Stolley, 1929, Palaeontologie von Timor, lief. 16, s. 159, taf. 249, figs. 5—6.

**Description:** Our specimens of this species are of great size, over 105 mm in length, with well-developed ventral furrow and short phragmocone. The maximum diameter lies at the junction between the apical portion and the trunk.

**Horizon and locality:** Middle part of Chazo formation, from Chazo, NW of Dingri, and from Kunmä, north of Kanpa, South Tibet. Figured specimens: XB063, XB025.

***Belemnopsis dingriensis* Yang et Wu, sp. nov.**

(Pl. II, fig. 1)

**Diagnosis:** Rostrum moderately large, subcylindrical; phragmocone deep, its length equal to half that of the rostrum; ventral furrow well-developed, extending almost to the apex.

**Description:** Rostrum reaches a length of over 108 mm, cylindrical, with its maximum diameter (18—20 mm) situated at alveolar region, but diameter decreases towards the pointed apex with apical angle of  $45^\circ \pm$ . The cross-section of rostrum is sub-circular, with comparatively flatter laterals and subcircular dorsum.

Phragmocone is a well-developed asymmetrical cone, having a length equal to half that of the rostrum, with an angle of about  $18^\circ$ , curved dorsum, straight venter; its apex and axial line is situated slightly ventrad.

Septa and siphuncle are not seen due to poor preservation.

Ventral furrow is well-developed, 5 mm wide,  $2 \pm$  mm deep, commencing from the front, becoming obscure and disappearing near the apex. Slit-plane is seen on the plane between furrow and alveolus.

Most of our specimens are preserved as apical segments and there is only one complete specimen which gives the following measurements:

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB 008 (holotype)	108	108	46	50	45	17	17.5/17.5	19/18.5	350	$45^\circ$

**Comparison:** Our species is distinguished from *Belemnopsis gerardi* (Oppel) by the following points: (1) its phragmocone is much deeper, reaching half the length of rostrum; (2) larger and stouter guard but with smaller O; (3) its apical angle is much larger. It differs from *Belemnopsis taliabuticus* (Boehm) in that the maximum diameter of rostrum of the latter species is situated more posteriorly and rostrum cylindrical.

**Horizon and locality:** Middle part of Chazo formation, Chazo about, 6 km NW of Dingri, South Tibet. Cat. no. of holotype: XB008.

***Belemnopsis cf. africana* (Tate)**

(Pl. II, fig. 4)

Several specimens are referred to this species on similarities in size, shape but they differ from Tate's species in being more slender. Their small size and shorter ventral furrow mark them off from *Belemnopsis sinensis* Yang et Wu sp. nov.

**Horizon and locality:** Lungma—Kapula, east of Giangzi, South Tibet. Figured specimen: XB111.

***Belemnopsis extenuatus* Yang et Wu, sp. nov.**

(Pl. IV, fig. 5)

Few specimens including one complete rostrum.

**Diagnosis:** Rostrum slender, cylindrical, with pointed apex and well marked furrow which does not reach the apex; phragmocone equal to  $1/6$  the length of rostrum.

**Description:** Rostrum slender, cylindrical, 92 mm long, with greatest diameter (about 7 mm) situated at the middle portion of rostrum. From here the diameter decreases slightly forward and maintains the size as far as the front, but it decreases gradually along the stem and more rapidly at apex, which is pointed and with apical angle of  $18^\circ$ . Apex central in position. Cross-section subcircular and axial line central in position.

Ventral furrow is well-marked. It is 3 mm wide at front, weakens gradually backwards and disappears at 20 mm from apex. Phragmocone is not well preserved.

Measurements (in mm)

No. of specimen	<i>L</i>	<i>l</i>	<i>Lal</i>	<i>lal</i>	<i>Ls</i>	<i>Lap</i>	<i>d. v./l. l.</i>		<i>O</i>	<i>Aap</i>
							<i>Dt<sub>1</sub></i>	<i>Dt<sub>2</sub></i>		
XB 275 (holotype)	92	105	8	15	54	30	6.5/6.7	7/7	1300	$18^\circ$

**Comparison:** This new species resembles *Belemnopsis sinensis* sp. nov. in general outline, but differs from it in *O*, apical angle and the position of *Dt<sub>2</sub>* as shown in the following table:

	<i>O</i>	<i>Aap</i>	Position of <i>Dt<sub>2</sub></i>
<i>Belemnopsis sinensis</i>	550	$31^\circ$	at anterior part of rostrum
<i>Belemnopsis extenuatus</i>	1300	$18^\circ$	at middle part of rostrum

Similar belemnite fragments found from the Neocomian Belemnite Bed of Salt Range were identified as *B. gerardi* by Spath, but they should be more correctly referred to the present species as easily seen from the following comparison:

	<i>O</i>	<i>Aap</i>	Position of disappearance of ventral furrow	Length of phragmocone
<i>Belemnopsis gerardi</i>	600	$25^\circ$	5 mm from apex	1/4 rostrum
<i>Belemnopsis extenuatus</i>	1300	$18^\circ$	20 mm from apex	1/6 rostrum

**Horizon and locality:** Lower Zongzho formation (*K<sub>1</sub>*); Lungma, east of Giangzi, South Tibet. Holotype: XB275.

***Belemnopsis sinensis* Yang et Wu, sp. nov.**

(Pl. I, figs. 13—14; Pl. III, figs. 1—5)

**Diagnosis:** Rostrum large, roughly cylindrical, with well developed ventral furrow which does not reach the apex. Phragmocone short, of 1/3 the length of rostrum.

**Description:** Large rostrum measures more than 200 mm in length, with its maximum dorso-ventral diameter situated at the alveolar region, and the whole rostrum tapers gradually from the front toward the apex, with an apical angle of about  $31^\circ$ ; apex is central in position.

The maximum diameter of rostrum reaches 27 mm, with an average of  $20 \pm$  mm. In longitudinal section the lateral sides are straight except the apical region which is

slightly curved. Transverse section is subcircular, with flat laterals and dorsum wider than the venter.

Phragmocone is short, being equal to  $1/3$  the length of rostrum, inserted in the rostrum with an apical angle of about  $25^\circ$ , its apex and axial line centrally situated. Septal interval is about  $1/5$  the maximum diameter.

Ventral furrow is well-developed, measuring 6 mm in width and 3 mm in depth, commencing from front of rostrum, and extending as far as 15 mm short of the apex.

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB274 (holotype)	140	145	42	51	70	28	17.5/17	19/18	550	31°
XB276 (paratype)	180	200		70			27/28	27/27	500	35°

**Comparison:** Our new species is close to *Cylindroteuthis volgensis* (Orbigny) in shape and size, but differs in the position of ventral furrow which in the latter species commences from the apex and stops short at the front, whereas in our species the furrow commences from the front. The latter species is also dorso-ventrally compressed. Comparison of our species with *Belemnopsis gerardi* (Oppel) is shown in the following table.

	Size of rostrum	Aap	Length of phragmocone	Where v. f. terminated
<i>B. sinensis</i>	large sized	35	$1/3$ of rostrum	15 mm from apex
<i>B. gerardi</i>	medium sized	25	$1/4$ of rostrum	near the apex

**Horizon and Locality:** Late Jurassic—early Cretaceous Kapula and the lower Zongzo formation, Lungma—Kapula, east of Giangzi, S. Tibet. Holotype: XB274; paratypes: XB276, XB277, XB147, XB278, XB279.

### *Hibolites* Montfort 1808

#### *Hibolites subfusiformis* (Raspail)

(Pl. IV, figs. 6—9)

*Belemnites subfusiformis* Raspail, Noetling, 1897, Pal. Indica, ser. xvi, vol. 1, pt. 2, pl. 1, figs. 4—11.

*Hibolites subfusiformis*, Spath, 1939, Pal. Indica, n. ser. vol. 25, No. 1, pl. 23, figs. 1, 3, 8.

*Hibolites subfusiformis*, Друщин, В. В. и Кудряцев, М. П., 1960, Атлас нижнемеловой фауны северного кавказа и крыма, с. 358, таб. 1, фиг. 13.

**Description:** As seen from our specimens, the rostrum is of medium to relatively large size, slenderly fusiform, with its maximum thickening (diameter) at the middle part of rostrum; phragmocone short; ventral furrow weak. Our specimens of this species represent mostly the lower portions of rostra.

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB 253	93	>93	—	—	65	28	9/9	10/10	930	20°
XB 113	94	>94	—	—	62	32	13/13	14/14	720	22°

**Discussion:** The specific name, *Hibolites subfusiformis*, has been used by various authors for different belemnites (homonym). O. Abel's (1916) species (text-figure 6-3) is distinctly fusiform, with maximum diameter at the posterior third of rostrum, and its ventral furrow measures one-third the length of the latter. Spath's citation (1939) of Besairie's identification (1930) from Malgache shows that the species under consideration is characterized by uniform diameter (text-figure 6-1) and absence of ventral furrow. The Salt Range specimen (Spath, 1939) (text-figure 6-2) is similar to that of Malgache.

Our specimens from Tibet differ markedly from that of the Alps, but quite similar to those of Malgache and the Salt Range, hence they are identified to *H. subfusiformis* as analyzed by Spath in 1939.

The age of this species is taken as Valangian by Spath.

**Horizon and Locality:** Lower Zongzo formation (lower Cretaceous)—partly middle Zongzo, formation; Lungma—Kapula, Giangzi, S. Tibet. Figured specimens: XB253, XB113, XB213, XB086.

### ***Hibolites subfusiformis* var. *baluchistanensis* Noetling**

(Pl. IV, figs. 10—11)

*Hibolites subfusiformis* var. *baluchistanensis* Noetling, Spath, 1939, Pal. Indica, n. ser. vol. 25, p. 111—113, pl. xxiii, fig. 8.

Fragments of specimens identified to this variety are distinguished by characters of apical region. This variety differs from *Hibolites subfusiformis* in the following features: (1) its swollen part situated nearer to the apex; (2) its apex being blunter; and (3) rostrum stouter.

**Horizon and Locality:** Same as the preceding species. Figured specimens: XB092, XB084.

### ***Hibolites parahastatus* Yang et Wu, sp. nov.**

(Pl. III, figs. 6—7)

**Diagnosis:** Rostrum large-sized, subhastate, with maximum diameter at its lower fifth. Ventral furrow extending to  $1/2$  the length of rostrum. Both alveolar and stem regions laterally compressed, but apical region with round section, without forward-tapering.

**Description:** Rostrum reaches a length of over 135 mm, with its maximum diameter situated at junction of stem and apex; slight tapering occurs for a short distance in front of maximum diameter, but from there the diameter maintains as far as the front margin and the anterior portion appears to be cylindrical; from the maximum diameter backwards the rostrum tapers at first gradually, then more suddenly near the apex which is not too sharp with an apical angle of  $55^{\circ}$ — $61^{\circ}$ .

Rostrum is slender, laterally compressed at stem and alveolar regions, ventral convex slightly, narrower than the dorsum. Apex appears to be subcircular in cross-section.

Alveolar cone is short, equal to less than  $1/4$  the length of rostrum, subconical, with its apex inserted in the center of rostrum with an apical angle of  $25^{\circ}$ ; septa not seen as it is filled up with rock matrix.

Ventral furrow is distinct, commencing from the front, becomes gradually obscure posteriorly and disappears altogether at the middle portion of rostrum. It is narrow

and deeper anteriorly. Apical line is central in position. Venter of apical region tapers more rapidly, so that the apex is situated dorsad.

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB269 (holotype)	130	135	18	23	85	27	12.5/11	13/12	900	55°

**Comparison:** This species is similar to *Hibolites subfusiformis* in many respects, but differs from the latter in having (1) the larger rostrum with maximum diameter near the posterior portion and (2) more developed ventral furrow. It is distinguished from *H. xizangensis* by having a more slender rostrum, larger O-value and its maximum diameter situated at the posterior portion of rostrum.

**Horizon and Locality:** Lower Zongzo formation (lower Cretaceous); Lungma-Kapula, east of Giangzi, S. Tibet. Cat. no. of holotype: XB269.

### *Hibolites xizangensis* Yang et Wu, sp. nov.

(Pl. IV, fig. 1)

**Diagnosis:** Rostrum of large size, stout, slightly fusiform, with maximum diameter at middle part of rostrum, the anterior part of which is cylindrical, but posteriorly from it, the rostrum gradually tapering posteriorly with acute apex. Ventral furrow broad and shallow, equal to one third the length of rostrum.

**Description:** Rostrum measures over 130 mm in length, with maximum, diameter at its middle portion. The anterior portion of rostrum does not taper, hence parallel-sided when viewed ventrally; when viewed laterally tapering is more distinct. Posterior to the maximum diameter the guard tapers gradually at first, but more rapidly at apical region with an apical angle of about 51°. The rostrum is stout, laterally compressed all through, more conspicuously so at stem. Diameter at apex of alveolar cavity is equal to 93.\* Apex and axial line central in position. Alveolar cone is one fourth the length of rostrum.

Measurements (in mm)

No. of specimen	L	l	Lal	lal	Ls	Lap	d. v./l. l.		O	Aap
							Dt <sub>1</sub>	Dt <sub>2</sub>		
XB082 (holotype)	126	130±	31	35	77	18	15/14	16/15	650	51°

**Comparison:** This species is distinguished from *Hibolites parahastatus* sp. nov. by being stouter and having smaller O and maximum diameter situated at medium position. It differs also from *Hibolites flemingi* Spath (text-figure 7) in that the latter is dorso-ventrally compressed and marked by shorter ventral furrow, and greater maximum diameter.

**Horizon and Locality:** Same as the preceding species. Cat. no. of holotype: XB082.

\* The dorso-ventral diameter of rostrum at apex of phragmocone is taken as 100.



## 图 版 說 明

标本保存在北京地质学院博物馆。图版全部原大。

### 图 版 I

图 1—7. *Belemnopsis gerardi* (Oppel)

1a. 腹视; 1b. 侧视; 1c. 纵断面, 表示出闭锥形态。登记号: XB001.

2—7. 表示个体由大到小的形态, 7. 未见腹纵沟。登记号分别为: XB046, XB015, XB026, XB029, XB030, XB033.

图 8—12. *Belemnopsis alfuricus* (Boehm)

8a. 腹视; 8b. 侧视。登记号: XB019.

9—12. 表示个体由大到小的形态。登记号分别为: XB037, XB023, XB027, XB028.

图 13—14. *Belemnopsis sinensis* Yang et Wu, sp. nov.

13a. 腹视; 13b. 侧视; 13c. 横断面。正型标本登记号: XB274.

14. 鞘的腔区断面, 表示出闭锥腔的一部分。登记号: XB123.

### Explanation of Plates

All specimens are kept in the Museum of Peking Geological Institute. Unless otherwise stated, all figures are of natural size.

### Plate I

*Belemnopsis gerardi* (Oppel)

Figs. 1a—1c. Ventral, lateral and longitudinal views, the latter view showing also shape of phragmocone (no. of specimen XB001).

Figs. 2—7. A series of individuals of different sizes; all, ventral views except 7, which shows the dorsal aspect. Cat. no. XB046, XB015, XB026, XB029, XB030, XB033.

*Belemnopsis alfuricus* (Boehm)

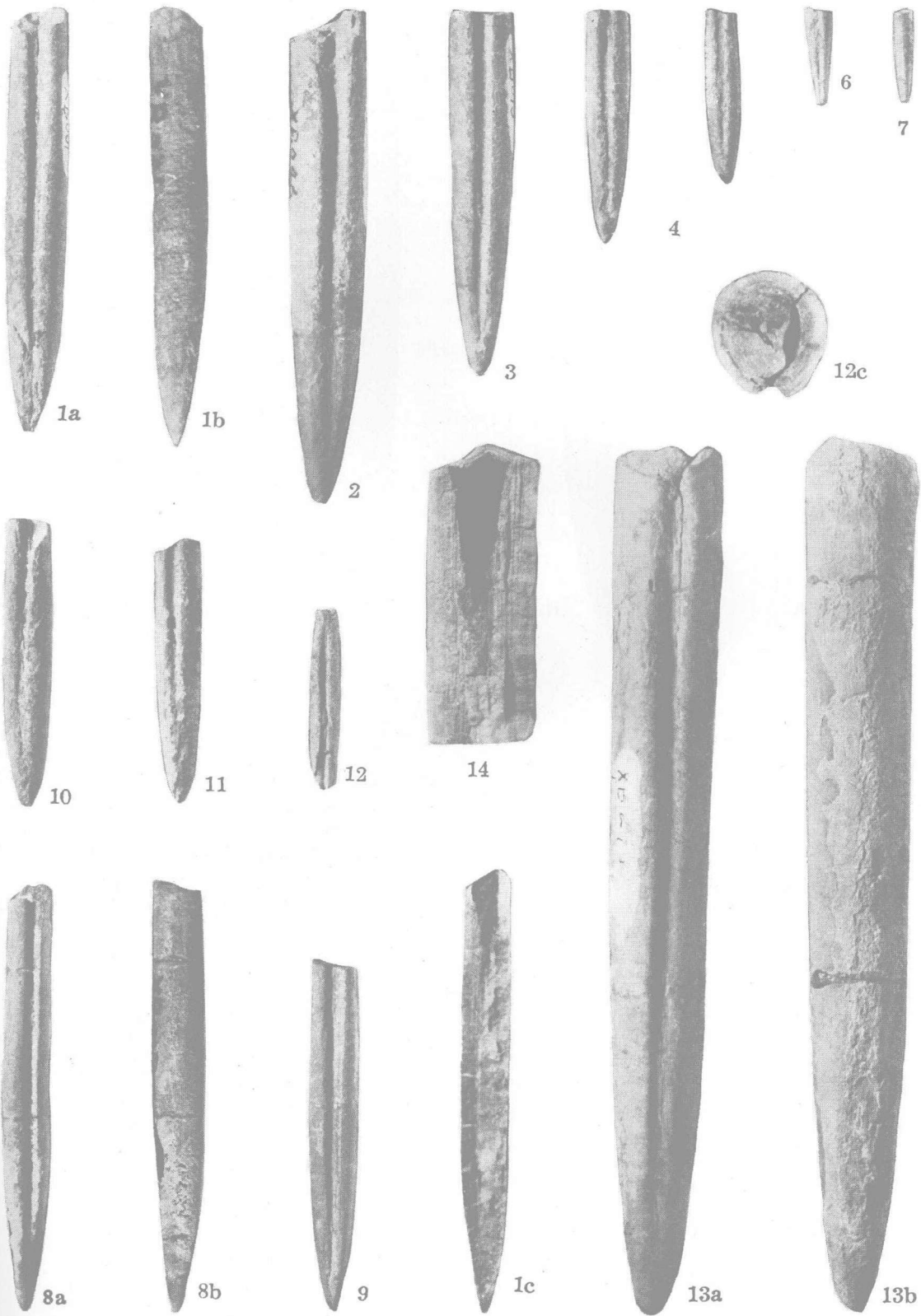
Figs. 8a—8b. Ventral and lateral views. Cat. no. XB019.

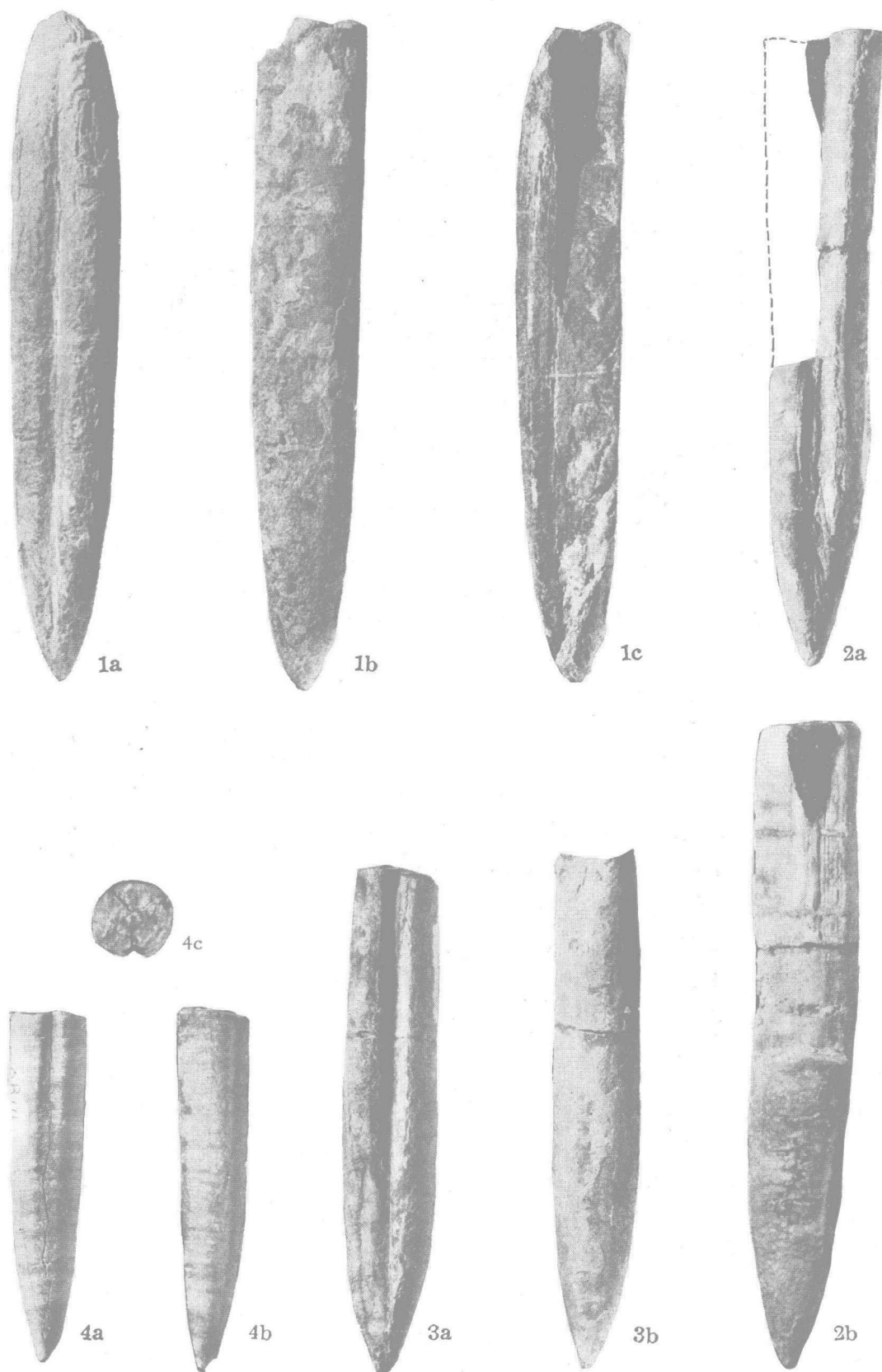
Figs. 9—12. A series of individuals of different sizes. Cat. no. XB037, XB023, XB027, XB028.

*Belemnopsis sinensis* Yang et Wu, sp. nov.

Figs. 13a—c. Ventral, lateral and cross-sectional views of the holotype (Cat. no. XB274).

Fig. 14. Longitudinal section of alveolus showing part of phragmocone. Cat. no. XB123.





## 图 版 II

- 图 1. *Belemnopsis dingriensis* Yang et Wu, sp. nov.  
1a. 腹視; 1b. 側視; 1c. 縱断面, 表示出閉錐形态。正型标本登記号: XB008
- 图 2—3. *Belemnopsis taliabuticus* (Boehm)  
2a. 腹視, 前部斷去一半, 見到閉錐的一部分; 2b. 側視。登記号: XB063  
3a. 腹視; 3b 側視。登記号: XB025
- 图 4. *Belemnopsis cf. africana* (Tate)  
4a. 腹視; 4b. 側視; 4c. 横断面。登記号: XB111.

## Plate II

*Belemnopsis dingriensis* Yang et Wu, sp. nov.

Figs. 1a—c. Ventral and lateral views and longitudinal section of the holotype (Cat. no. XB008);  
1c. revealing alveolus.

*Belemnopsis taliabuticus* (Boehm)

Fig. 2a. Ventral view showing one half of anterior portion broken away and part of phragmocone preserved. Cat. no. XB063.

Fig. 2b. Lateral view of the same specimen. Cat. no. XB063.

Fig. 3a—b. Ventral and lateral views. Cat. no. XB025.

*Belemnopsis cf. africana* (Tate)

Figs. 4a—c. Ventral, lateral and cross-sectional views. Cat. no. XB111.

### 图 版 III

图 1—5. *Belemnopsis sinensis* Yang et Wu, sp. nov.

这是孙云鑄教授赠送的标本(登記号: W53)

1a. 腹視, 虛綫表示尖端原形的恢复; 1b 側視。副型标本登記号: XB276.

2. 表示后部的形态 副型标本登記号: XB277.

3、5. 閉錐, 可見到隔壁, 推断属于本种。登記号分别为: XB278, XB279.

4. 鞘的腔区縱断面, 表示出閉錐腔的一部分。登記号: XB147.

图 6. *Hibolites parahastatus* Yang et Wu, sp. nov.

6a. 腹視; 6b. 側視。正型标本登記号: XB269.

图 7. 閉錐外核。副型登記号: XB193.

### Plate III

*Belemnopsis sinensis* Yang et Wu, sp. nov.

Figs. 1a—b. Ventral and lateral views, partly reconstructed (dotted line). Cat. no. of paratype: XB276.

Fig. 2. Ventral posterior view of paratype: Cat. no. XB277.

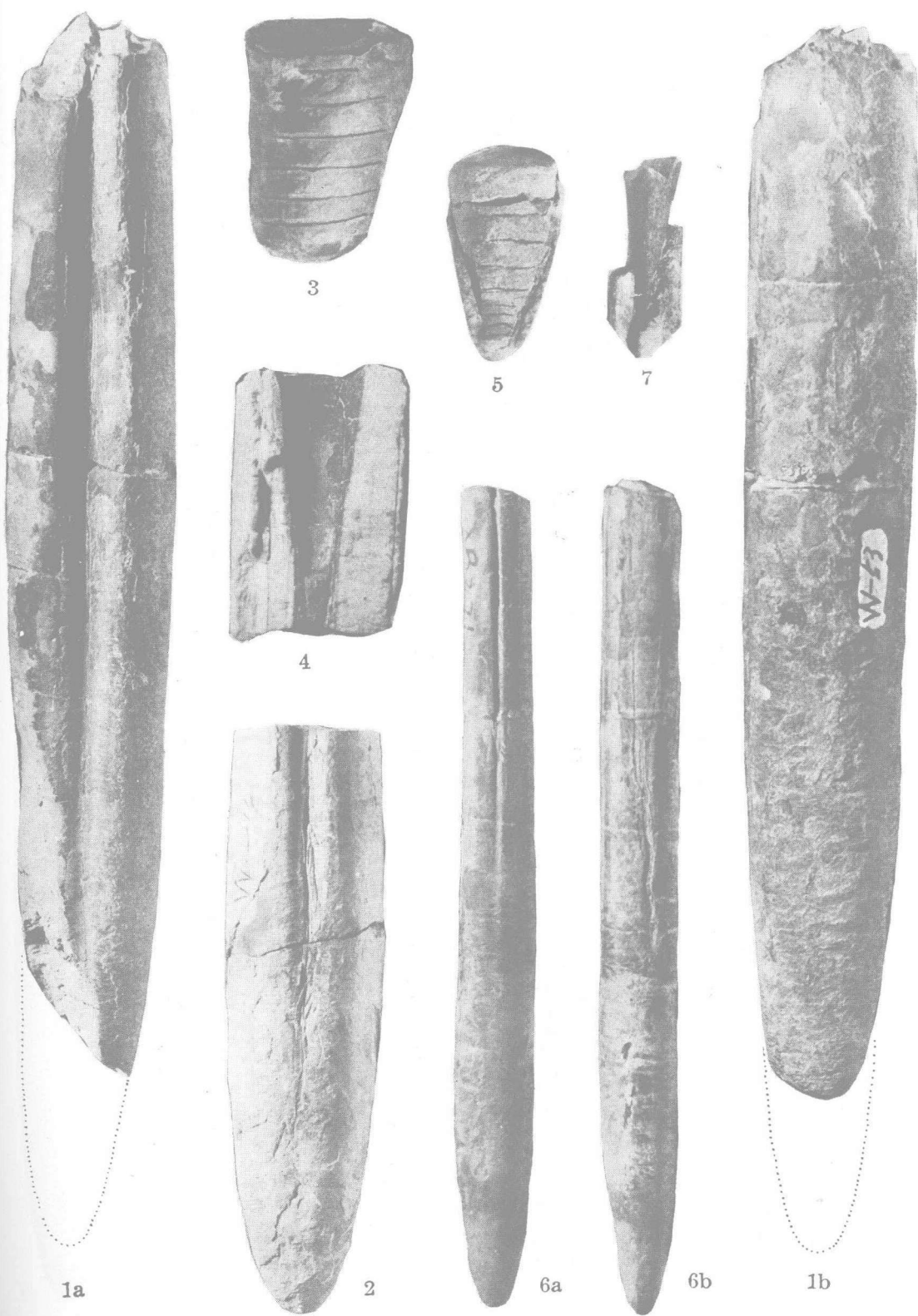
Figs. 3, 5. Portions of internal molds of phragmocone referred to this species. Cat. no. XB278, XB279.

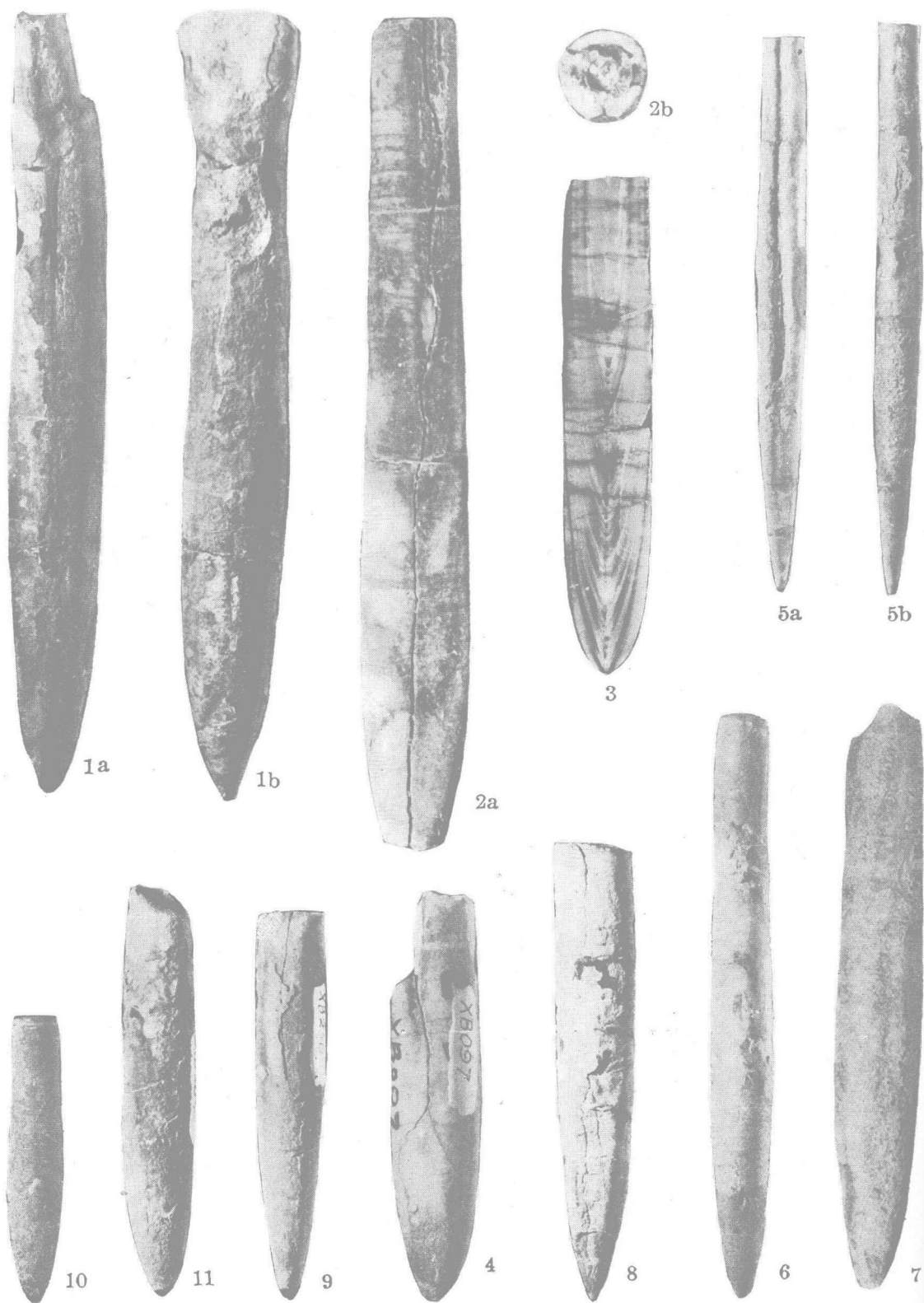
Fig. 4. Longitudinal section of part of alveolar portion. Cat. no. of paratype: XB147.

*Hibolites parahastatus* Yang et Wu, sp. nov.

Figs. 6a—b. Ventral and lateral views of holotype (Cat. no. XB269).

Fig. 7. Cast of phragmocone. Cat. no. of paratype: XB193.





## 图 版 IV

- 图 1. *Hibolites xizangensis* Yang et Wu, sp. nov.  
1a. 腹視; 1b. 側視。正型标本登記号: XB082.
- 图 2—4. *Hibolites jiangziensis* Yang et Wu, sp. nov.  
2a. 腹視; 2b. 横断面。正型标本登記号: XB114.  
3. 纵断面, 可見到生长层。登記号: XB108.  
4. 后部一段, 表示尖端形态。登記号: XB097.
- 图 5. *Belemnopsis extenuatus* Yang et Wu, sp. nov.  
5a. 腹視; 5b. 側視。正型标本登記号: XB275.
- 图 6—9. *Hibolites subfusiformis* (Raspail), 登記号分别为: XB253, XB113, XB213, XB086.
- 图 10—11. *H. subfusiformis* var. *baluchistanensis* Noetling, 登記号分别为: XB092, XB084.

## Plate IV

*Hibolites xizangensis* Yang et Wu, sp. nov.

Figs. 1a—b. Ventral and lateral views of holotype (Cat. no. XB082).

*Hibolites jiangziensis* Yang et Wu, sp. nov.

Figs. 2a—b. Ventral and cross-sectional views of holotype (Cat. no. XB114).

Fig. 3. Longitudinal section, showing growth-lamellae. Paratype cat. no. XB108.

Fig. 4. Posterior portion of rostrum, showing apex. Paratype cat. no. XB097.

*Belemnopsis extenuatus* Yang et Wu, sp. nov.

Figs. 5a—b. Ventral and lateral views of holotype (Cat. no. XB275).

*Hibolites subfusiformis* (Raspail)

Figs. 6—9. Figured specimens. Cat. no. XB253, XB113, XB213, XB086.

*Hibolites subfusiformis* var. *baluchistanensis* Noetling

Figs. 10—11. Figured specimens. Cat. no. XB092, XB084.



***Hibolites jiangziensis* Yang et Wu, sp. nov.**

(Pl. IV, figs. 2—4)

**Diagnosis:** Rostrum of large size, subfusiform, with maximum diameter at the lower fourth of rostrum; ventral furrow not developed; phragmocone short, alveolar and stem regions slightly laterally compressed and tapering weakly towards the anterior part.

**Description:** Rostrum measures over 135 mm in length, with maximum diameter at junction of stem and apex, to the anterior of which it is cylindrical, but posteriorly it tapers more rapidly, with an apical angle of about  $45^\circ$ .

Rostrum is short, slightly laterally compressed along the lower part of stem and alveolar regions with lateral diameter of 86 mm; cross-section at apical region is circular. It is bilaterally symmetrical, but axial line and apex lies slightly ventrad.

Ventral furrow is indistinct, very narrow, measuring 20 mm long, commencing at the anterior part and running for a distance equal to  $1/6$  the length of rostrum.

Phragmocone is very short, occupying  $1/6$  the length of rostrum, obliquely conical in shape, with apex ventrad and apical angle of  $30^\circ$ . Septa not preserved.

Measurements (in mm)

No. of specimen	<i>L</i>	<i>l</i>	<i>Lal</i>	<i>lal</i>	<i>Ls</i>	<i>Lap</i>	<i>d. v./l. l.</i>		<i>O</i>	<i>Aap</i>
							<i>Dt<sub>1</sub></i>	<i>Dt<sub>2</sub></i>		
XB114 (holotype)	130	135	12	22	73	45	14/12	16/16	850	$45^\circ$
XB097	—	—	—	—	—	—	—	14.5/13.5	—	$46^\circ$

**Comparison:** This species differs from *Hibolites subfusiformis* (Oppel) in having stout appearance and position of maximum diameter at the more posterior part. It is similar to *H. flemingi* Spath in general appearance, but the latter is shorter, dorso-ventrally compressed and maximum diameter at the middle part of rostrum.

**Horizon and Locality:** Same as the preceding species. Cat. no. of holotype: XB114; paratypes: XB108, XB097.