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PLATES I TO VI.

THE JURASSIC AND CRETACEOUS AMMONITES AND BELEMNITES OF THE  
ATTOCK DISTRICT.

By

L. F. SPATH, D.Sc., F.G.S.

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# CONTENTS.

	PAGE.
Introduction . . . . .	1
Specific descriptions . . . . .	2
A. Order: AMMONOIDEA . . . . .	2
a. Family: STEPHANOCERATIDAE . . . . .	2
Sub-family: MAYAITINAE . . . . .	2
Genus: EPTMAYAITES . . . . .	2
1. <i>Epimayaites polyphemus</i> (Waagen) . . . . .	2
2. <i>Epimayaites</i> aff. <i>lemoini</i> , Spath . . . . .	3
b. Family: PERISPINCTIDAE . . . . .	4
Sub-family: PERISPINCTINAE . . . . .	4
Genus: PERISPINCTES . . . . .	4
1. <i>Perispinctes orientalis</i> , Siemiradzki . . . . .	4
2. <i>Perispinctes</i> cf. <i>indogermanus</i> , Waagen . . . . .	5
3. <i>Perispinctes jelskii</i> , Siemiradzki . . . . .	6
Genus: BIPLICES . . . . .	7
1. <i>Biplices</i> aff. <i>de-riazi</i> (Siemiradzki) . . . . .	7
2. <i>Biplices</i> aff. <i>subrota</i> (Choffat) . . . . .	7
3. <i>Biplices</i> sp. ind. . . . .	8
Genus: PACHYPLANULITES . . . . .	8
1. <i>Pachyplanulites pralairi</i> (Favre) . . . . .	8
Genus: DICHOTOMOSPINCTES . . . . .	9
1. <i>Dichotomosphinctes</i> cf. <i>orbigny</i> (P. de Loriol) . . . . .	9
2. <i>Dichotomosphinctes</i> , sp. ind. . . . .	10
3. <i>Dichotomosphinctes</i> aff. <i>grossouvrei</i> (Siemiradzki) . . . . .	11
4. <i>Dichotomosphinctes</i> , sp. nov. ? aff. <i>waehneri</i> (Siemiradzki) . . . . .	11
Genus: PROSOSPINCTES . . . . .	12
1. <i>Prososphinctes virguloides</i> (Waagen) . . . . .	12
c. Family: BERRIASSELLIDAE . . . . .	13
1. Sub-family: BERRIASSELLINAE . . . . .	13
Genus: BERRIASSELLA . . . . .	13
1. <i>Berriasella</i> ? sp. ind. . . . .	13
Genus: BLANFORDICERAS . . . . .	15
1. <i>Blanfordiceras wallichi</i> (Gray) . . . . .	15
2. <i>Blanfordiceras</i> aff. <i>boekmi</i> (Uhlig) . . . . .	16
2. Sub-family: HIMALAYITINAE . . . . .	17
Genus: AULACOSPINCTES . . . . .	17
1. <i>Aulacosphinctes</i> sp. juv. cf. <i>proximus</i> (Steuer) . . . . .	17
d. Family: OLCOSTEPHANIDAE . . . . .	17
2. Sub-family: SPITICERATINAE . . . . .	17
Genus: SPITICERAS . . . . .	17
1. <i>Spiticeras</i> sp. ind. . . . .	17
e. Family: DIPOLOCERATIDAE . . . . .	18
Genus: OXYTROPIDOCERAS . . . . .	18
1. <i>Oxytropidoceras</i> aff. <i>roissyanum</i> (d'Orbigny) . . . . .	18
2. <i>Oxytropidoceras</i> cf. <i>acutocarinaratum</i> (Shumard) . . . . .	20
B. Order: BELEMNOIDEA . . . . .	21
Family: BELEMNIPIDAE . . . . .	21
1. Sub-family: BELEMNOPSISINAE . . . . .	21
Genus: BELEMNOPSIS . . . . .	21
1. <i>Belemnopsis tangananensis</i> (Futterer) . . . . .	21
Genus: HIBOLITES . . . . .	22
1. <i>Hibolites budhaicus</i> (Stoliczka) . . . . .	22
2. <i>Hibolites tibeticus</i> (Stoliczka) . . . . .	23
3. <i>Hibolites</i> aff. <i>windhouveri</i> , Stolley . . . . .	24
4. <i>Hibolites</i> sp. nov. ? cf. <i>planohastatus</i> (Roemer) . . . . .	25
5. <i>Hibolites</i> ( <i>Hastites</i> ?) cf. <i>claviger</i> (Waagen) . . . . .	25
2. Sub-family: DUVALINAE . . . . .	26
Genus: RHOPALOTEUTHIS . . . . .	26
1. <i>Rhopaloteuthis</i> sp. nov. ? aff. <i>epissa</i> (Gilliéron) . . . . .	26
List of localities with their Cephalopod faunas . . . . .	27
Palaeontological and stratigraphical results . . . . .	30
Alphabetical index to species . . . . .	39

# THE JURASSIC AND CRETACEOUS AMMONITES AND BELEMNITES OF THE ATTOCK DISTRICT.

BY

L. F. SPATH, D.Sc., F.G.S.

(With Plates I-VI.)

## INTRODUCTION.

THE ammonites and belemnites described in this paper come from a number of localities in the Attock district, in the extreme north-west of the Punjab, on the borders of the North-West Frontier Province. They were sent to me marked partly 'Basal Giumal beds' (the Jurassic and Spiti shales species), partly 'Upper Giumal beds' (the Albian forms and some indeterminable belemnites). These cephalopods were accompanied by a number of brachiopods, also pelecypods and gastropods, which are being described by Miss H. M. Muir-Wood and by Mr. L. R. Cox respectively. The fauna has already been referred to in my Revision of the Jurassic Cephalopoda of Kachh, but the publication, in the meantime, of other works, especially on Upper Jurassic successions, makes it desirable to discuss the stratigraphical results afresh and in more detail in a final chapter.

I have to record my grateful acknowledgments to the past and present Directors of the Geological Survey of India in Calcutta (Sir Edwin Pascoe and Dr. L. L. Fermor) for entrusting me with the description of these interesting forms; also to the Keeper of the Geology Department of the British Museum (Natural History), Dr. W. D. Lang, for giving me all facilities in connexion with the study of the collections. I should like similarly to acknowledge the help I am continually receiving from colleagues all over the world by consignments of new material, literature or information, even if it may not seem to be directly concerned with the area here discussed.

The measurements of ammonites are given in the usual order:—(1) diameter in millimetres, (2) whorl-height, (3) whorl-thickness, (4) width of umbilicus in percentages of the diameter. The localities are referred to under numbers 1-12 in the specific descriptions to avoid lengthy repetitions, but they are given in full in Chapter III. Since a number of the species here recorded have been described from Kachh, the synonymies are also generally condensed. A full list of literature on the subject is given in the last part of my Revision of the Jurassic Cephalopoda of Kachh.

## SPECIFIC DESCRIPTIONS.

## A. Order AMMONOIDEA.

a. Family: *STEPHANOCERATIDAE*, Neumayr emend.

Sub-family: *MAYAITINAE* Spath.

Genus: *EPIMAYAITES*, Spath, 1928.

1. *EPIMAYAITES POLYPHEMUS* (Waagen).

(Plate III, figs. 2a, b.)

1875. *Stephanoceras polyphemus*, Waagen. Jurassic Fauna of Kutch, I, Cephalopoda, *Pal. Ind.*, Ser. IX, No. 4, p. 116; Pl. XXIX, fig. 2 only.
1894. *Macrocephalites polyphemus* (Waagen). Tornquist, Über Macrocephaliten im Terrain-à-chailles, *Abh. Schweiz. Pal. Ges.*, Vol. XXI, pp. 14, 18, 25.
1894. *Macrocephalites polyphemus* (Waagen). Pompeckj, Über Ammonoideen mit 'anomalener Wohnkammer'. *Jahresh. Ver. vaterl. Nat. K. Stuttgart*, Vol. 50, p. 254.
1895. *Stephanoceras polyphemus* (Waagen). Nœtling, Fauna of the Kellaways of Mazar Drik, *Pal. Ind.*, Ser. XVI, Vol. I, Pt. I, p. 14; Pl. XII only.
1910. *Macrocephalites polyphemus* (Waagen). Lemoine, Paléontologie de Madagascar. VIII. Ammonites d'Analalava. *Ann. Pal.*, Vol. V, fasc. 4, p. 30.
1924. *Mayaites polyphemus* (Waagen). Spath. On the Blake Collection of Ammonites from Kachh, India, *Pal. Ind.*, N. S., Vol. IX, Mem. No. I, p. 9.
1924. '*Stephanoceras*' *polyphemus*, Waagen. Buckman. Type Ammonites, Vol. V, p. 46.
1928. *Epimayaites polyphemus* (Waagen). Spath. Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), *Pal. Ind.*, N. S., Vol. IX, Mem. No. 2, Pt. III, p. 233.

The fragmentary example here figured was at first taken to be merely a variety of the common *Mayaites maya* (J. de C. Sowerby)<sup>1</sup>, or one of the passage-forms to more coarsely-ribbed species like *M. jumarensis*, Spath<sup>2</sup>, previously recorded. It differs from *M. maya* in having the primary ribs less closely spaced, there being 33 secondary ribs to eight primaries, *i.e.*, about four outer ribs to each umbilical costa, as against only three in Sowerby's species. In the more finely-ribbed variety which I previously<sup>3</sup> figured as *M. cf. maya* but which may be considered a transition to the (typically more compressed) *M. smeei*, Spath<sup>4</sup>, the secondary ribs may increase to four for each primary, but the latter as well as the former are, then, much more closely spaced. On the other hand, in *M. jumarensis* and especially in *M. subkobyi*<sup>5</sup> with similarly distant primaries, the outer ribs are much coarser.

<sup>1</sup> In Sykes, A Notice respecting some Fossils collected in Kutch, etc., *Trans. Geol. Soc.*, Ser. 2, Vol. V, p. 719, Pl. LXI, fig. 8.

<sup>2</sup> *Loc. cit.*, p. 228; Pl. XLIII, figs. 1a, b, (1928).

<sup>3</sup> Spath, *loc. cit.*, Pl. XXXIX, fig. 5, (1928).

<sup>4</sup> *Ibid.*, p. 230; Pl. XLV, fig. 7.

<sup>5</sup> *Ibid.*, p. 229; Pl. XLV, fig. 1.

If the distant spacing of the umbilical ribs in the present form be constant, then the inner whorls would differ considerably from those of *M. maya*. There is a portion of the large next outer whorl preserved, not shown in the figure, but while indicating that the example was septate even then and therefore of considerable size, it is too corroded to help in specific identification.

*Epimayaites polyphemus* (Waagen emend. Nøtting), as interpreted by the writer, seems to have longer primary ribs than the example here described, but the umbilical margin is damaged and the obtuseness of the ribs conspicuous in the illustration (Plate III, fig. 2a) is also probably due to wear. The rib-curve is the same in the two forms, slightly more sigmoidal than in *M. maya* and projected near the venter, but the suture-line is too incompletely exposed to show the characteristic curve of the present species. The dimensions of the Attock example were approximately:—103 —48 —49 —19, as against 238 —50 —45 —15 in the lectotype of *E. polyphemus*, but the sizes are rather different.

*E. axonoides*, Spath<sup>1</sup>, is also very similar to the present form at a comparable size and I have previously mentioned that the inner whorls of this species, as of the allied *E. batavo-indicus* (G. Böhm)<sup>2</sup>, from the Sula Islands, may not be readily distinguishable.

*Horizon*.—Argovian (Upper Oxfordian), probably about *transversarius* zone.  
*Locality*.—1 (near Burjianwala Laman), No. K. 23-698.

## 2. EPIMAYAITES aff. LEMOINI, Spath.

(Plate III, figs. 1a, b.)

1928. *Epimayaites lemoini*, Spath. *Loc. cit.* (Kachh Revision), Pt. III, p. 234; Pl. XXVI, fig. 4; Pl. XXXIV, fig. 1. (See there for synonymy.)

This form is represented by a septate fragment which, however, is even less favourably preserved than that last described. It shows fine secondary ribbing, slightly projected, as in the holotype of the present species, and a somewhat compressed whorl-section, with the ventral area tending to become narrow. The number of secondary ribs to each primary is about six to seven, which character alone excludes comparison with any species of *Mayaites*, even such finely-ribbed forms as *M. smeei*, already mentioned, having only three or at most four.

The suture-line is not distinctly visible and there is no trace of the inner whorls. The dimensions, apparently, were as follows:—150 —50 —46 —17. In the holotype the thickness is only 38 per cent. but it is crushed and partly corroded and in a paratype, in any case, it amounted to 46 per cent. *E. axonoides*, mentioned above, is more inflated, but has coarser ribbing.

<sup>1</sup> *Loc. cit.*, p. 236; Pl. XLVII, fig. 2; Pl. XLVIII, fig. 4, (1928).

<sup>2</sup> Beiträge zur Geologie von Niederländisch-Indien, I, Die Südküsten der Sula Inseln Taliabu und Mangoli, Pt. 2, Der Fundpunkt am oberen Lagoi auf Taliabu, *Palæontogr.*, Suppl., IV, I, 2, p. 87; Pl. XVIII, figs. 1-2; Pl. XIX, figs. 1-2, 1907.

*E. excentricus*, Spath<sup>1</sup>, shows general resemblance but has lost the primary ribs at a corresponding size; *E. sublemoini*, Spath<sup>2</sup>, based on one of G. Böhm's examples of his *E. palmarus* similarly tends to weaken its inner ribs.

*Horizon*.—Argovian (Upper Oxfordian), probably about *transversarius* zone.

*Locality*.—I (near Burjianwala Laman), No. K. 23-694.

b. Family: *PERISPHINCTIDAE*, Hyatt.

Sub-family: *PERISPHINCTINAE*, Spath.

Genus: *PERISPHINCTES*, Waagen (1869) s. s.

1. *PERISPHINCTES ORIENTALIS*, Siemiradzki.

(Plate IV, figs. 1a, b.)

1931. *Perisphinctes orientalis*, Siemiradzki. Spath, Revision of the Jurassic Cephalopod Fauna of Kachh, *loc. cit.*, p. 416; Pl. LXIX, fig. 1; Pl. LXXII, fig. 2. (See there for synonymy.)

It might be held that a poorly preserved Perisphinctid like that here figured is not definitely recognisable; and, indeed, apart from the subquadrate whorl-section and the regular bifurcation of the ribs there is little to go on, the suture-lines of the specimen (septate to the end) being only very indistinctly visible. The comparison to *P. orientalis* may thus be considered provisional, yet the large, septate example of this species from the Kantcote ironstone which I figured in 1931, in spite of appearing more sharply-ribbed, is undoubtedly extremely close to the Attock form. The differences in the ribbing seem to be due largely to the different preservation and the smaller specimen of *P. orientalis* previously<sup>4</sup> illustrated seems to be identical in regard to ribbing with the earlier half of the Attock form. This apparently is more closely-ribbed than the corresponding portion in Plate LXIX, fig. 1, but only because the figure is reduced. The obsolescence of the ventral costæ which sets in on the large Kantcote example (an internal cast in limonitic ironstone) at an earlier stage is probably also not of specific significance.

There are also slight differences in the proportions, those of the present example (190 — 28 — 28 — 50) showing a less depressed whorl-section than the large Kantcote specimen or Waagen's largest example, but this is due to corrosion of the Attock form.

A gigantic example of over 300 mm. diameter is unfortunately so fragmentary and so badly corroded as to be almost unrecognisable. Part of the outer whorl may have belonged to the body-chamber, but on the first half the

<sup>1</sup> *Loc. cit.*, p. 239; Pl. XLIV, fig. 4, (1928).

<sup>2</sup> *Ibid.*, p. 223.

<sup>3</sup> *Loc. cit.*, p. 90 (pars); Pl. XXII, fig. 4 only, (1907).

<sup>4</sup> *Loc. cit.*, Pl. LXXIV, figs. 3a, b, (1931).

square whorl-section with obsolescent secondary ribs at the ventro-lateral edges and a smooth periphery can be seen, as in the Kantcote specimen (at a smaller diameter). Towards the end, the ribbing becomes more distant, so that the last half whorl has only twelve ribs of which the first seven are fairly approximate and the last five distant. This change in ornamentation is similarly gradual in (the much more evolute) *Perisphinctes cristatus*, E. v. Klebelsberg<sup>1</sup>, but more sudden in *P. martelli* (Oppel).

The three Franconian ammonites recently figured by P. Dorn<sup>2</sup> as *Perisphinctes orientalis* do not belong to the Kachh species.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—1 and 2 (near Burjjanwala Laman), Nos. K. 23-692b and K. 23-700.

## 2. PERISPINCTES cf. INDOGERMANUS, Waagen.

(Plate V, figs. 1a, b, 5.)

1931. *Perisphinctes indogermanus*, Waagen. Spath, Revision of the Jurassic Cephalopod Fauna of Kachh, *loc. cit.*, p. 418. (See there for synonymy.)

The larger example here figured has been slightly deformed in the rock, and has approximate dimensions:—105 —25 —29 —55. It is entirely septate but the suture-line is not distinctly visible and the general preservation is so poor that only the costation of the last quarter of the outer whorl can be relied on for provisional comparison with Waagen's species. Like the holotype of the latter, at the same diameter, the Attock form has an occasional single rib and the characteristic serpentine coiling, but the peripheral ribbing may have been rather coarser and sharper than in the Kachh form. Even if not identical with Waagen's species, however, the present example must have belonged to a closely allied form, though it represents only its inner whorls; for the ribbing changes considerably at a larger size, becoming first closer on the periphery and then (on the body-chamber or before) developing the distant and blunt *Perisphinctes* ornamentation.

A second, slightly larger example (diameter = 120 mm.) of presumably the same species is badly worn and the third example, of which the peripheral view is given in Plate V, fig. 5, also owes its apparent slenderness merely to the corrosion of the lateral areas, and in side-view closely resembles the original of fig. 1.

Since I discussed this species on a previous occasion, Dorn<sup>3</sup> figured some Franconian examples of *Perisphinctes*, of which only the smallest (Plate X, fig. 4 only) has the typical ribbing, and may perhaps be attributed to Waagen's species. But the two larger fragments are much too closely-ribbed at a corresponding

<sup>1</sup> Die Perisphincten des Krakauer Unteroxfordien, *Beitr. Pal. Geol. Osterr.-Ung.*, Vol. XXV, p. 192; Pl. XVIII, fig. 3, (1912).

<sup>2</sup> Die Ammoniten-Fauna des untersten Malm der Frankenalb., *Paläontogr.*, Vol. LXXIII, p. 123; Pl. I, figs. 2, 5; Pl. II, fig. 5, (1930).

<sup>3</sup> *Loc. cit.* p. 148; Pl. X, figs. 2, 4; Pl. XI, fig. 6, (1930).

size and in any case, it is difficult to see how this author could group together in one species such widely different forms as the originals of his Plate X, fig. 4 and Plate XI, fig. 6, unless he considered the suture-lines or the rounded whorl-section as the decisive factor.

The bluntness of the ribbing in the Indian example is due to corrosion, but there is some resemblance to certain *Torquatisphinctes*, e.g., to *T. (?) romanicus* (Simionescu).<sup>1</sup> But size alone prevents exact comparison and the general assemblage favours reference to a form of *Perisphinctes*.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—1 and 4 (near Burjianwala Laman), Nos. K. 23-695c, d, i, j and K. 24-740, K. 24-759b.

### 3. PERISPHINCTES JELSKII, Siemiradzki.

(Plate IV, figs. 2-4; Plate V, figs. 6a, b.)

1931. *Lithacoceras jelskii* (Siemiradzki). Spath, Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), *loc. cit.*, p. 457. (See there for synonymy.)

1930. *Perisphinctes jelskii*, Siemiradzki. Dorn, Ammoniten Fauna des untersten Malm der Frankenalb, *loc. cit.*, p. 142; Pl. X, fig. 1.

As in the case of *Prososphinctes virguloides*, Waagen's original of his *Perisphinctes martelli* is now refigured (Plate V, fig. 6) to enable palæontologists to check the accuracy of the somewhat idealised illustration. Unfortunately, the new material is too poorly preserved to throw any additional light on the question of the true affinities of this species, and while the two young examples represented in Plate IV, figs. 2-3 are, of course, too small to be definitely identified, the fragment illustrated in fig. 4 on account of oblique crushing now has an entirely different whorl-section.

This species is left in the original genus *Perisphinctes*, because I now have before me examples of the true *P. biplex* (J. Sowerby)<sup>2</sup> which also have already the body-chamber at a comparable size. They scarcely differ from this species, except, perhaps, in having slightly shorter secondaries (in some individuals) and until fully grown individuals are known it is impossible to class this species either with *Discosphinctes* (*lucingensis* group) or *Torquatisphinctes* (*alterneplicatus* group) or to consider it intermediate between the two.<sup>3</sup> Dorn's *Perisphinctes jelskii*, not being based on Siemiradzki's<sup>4</sup> original description is quite different from the form here understood and comparable to *Discosphinctes lucingensis* (Favre).

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Localities*.—1 (near Burjianwala Laman), No. K. 23-695 f. g, k and 7 (near Talidhok), No. K. 24-751c-f, j, k.

<sup>1</sup> Studii geologice si paleontologice din Dobrogea, I, Fauna Cefalopodelor jurasice dela Harsova, *Acad. Romana Publ. etc.*, No. XXI, p. 128; Pl. III, fig. 6.

<sup>2</sup> Mineral Conchology, Vol. III, p. 168; Pl. CCXCIII, fig. 1 only.

<sup>3</sup> J. Siemiradzki, Monographische Beschreibung der Ammonitengattung Perisphinctes, *Paleontogr.*, Vol. XLV, p. 275, (1899).

<sup>4</sup> Fauna Kopalna, etc., *Pam. Wydz. mat.-przzyr. Akad. Umiej. Krakowie*, T. XVIII, p. 47, (1891).



Genus: BIPLICES (v. Sutner) Siemiradzki, 1898.

1. BIPLICES *aff.* DE-RIAZI (Siemiradzki).

(Plate II, figs. 2a.)

1898. *Perisphinctes subrota* (non Choffat) de Riaz. Description des couches à *Peltoceras transversarium* de Trept (Isère), p. 31; Pl. XIV.

1899. *Perisphinctes* (*Procerites*) *de-riazi*, Siemiradzki. Monographische Beschreibung der Ammoniten-gattung *Perisphinctes*, *loc. cit.*, p. 309.

A number of fragments like that here figured, but some with more inclined ribbing, may be compared to the Trept form separated by Siemiradzki from Choffat's *Perisphinctes subrota*, discussed below, and Bukowski's similar *Per. promiscuus*. The figured example has approximate dimensions 135 — 31 — 31 — 48 which indicate a more involute form than the two species just mentioned, but the ribbing is very similar. Dorn's<sup>1</sup> example of his *P. promiscuus* (non Bukowski) with dimensions:—155 — 32 — 31 — 50 apparently also belongs to the present species and I am accepting Siemiradzki's species as valid, in spite of Dorn's<sup>2</sup> objections.

One fragment, in its slightly more oblique costation, resembles the example of *Perisphinctes chlorolithicus* (Gümbel) figured by Dorn<sup>3</sup>, but if this form is a *Dichotomosphinctes* of the *wartae* group, as appears from Dorn's redescription, then the resemblance is only accidental. The restored whorl-section in Plate II (fig. 2b) may be too rounded ventrally, but the Attock specimens are all worn and none shows a suture-line.

Horizon.—Argovian (Upper Oxfordian), *transversarium* zone.

Localities.—1 (near Burjjanwala Laman), Nos. K. 23-692c and K. 23-697i; 7 (near Talidhok) K. 24-750g.

2. BIPLICES *aff.* SUBROTA (Choffat).

(Plate II, figs. 7a, b; Plate III, fig. 7.)

1931. *Biplices subrota* (Choffat). Spath, Revision of the Jurassic Cephalopod Fauna of Kachh, Pt. IV, *loc. cit.*, p. 415.

1931. *Dichotomosphinctes* cf. *subrota* (Choffat). Spath, *ibid.*, p. 438. (See there for synonymy.)

This species which is at least as close to *Biplices promiscuus* (Bukowski)<sup>4</sup> as to the typically more discoidal and more compressed *Dichotomosphinctes* (*plicatilis* group), is taken to be represented by the larger fragment figured in Plate II, fig. 7 and characterised by its quadrate whorl-section as well as the long lateral ribs. In *B. promiscuus*, the periphery is much more rounded and

<sup>1</sup> *Loc. cit.*, p. 151; Pl. XII, figs. 6a, b, (1930).

<sup>2</sup> *Ibid.*, p. 150.

<sup>3</sup> *Ibid.*, p. 131; Pl. XVII, fig. 1.

<sup>4</sup> Über die Jura-Bildungen von Czenstachau in Polen, *Beitr. Pal. Osterr.-Ung.*, etc., Vol. V, p. 137; Pl. XXVIII, fig. 1; Pl. XXIX, figs. 1-2, (1887).

the secondary ribs encroach more on the whorl-sides. Unfortunately the suture-line is not visible and the smaller fragment, represented in Plate III, fig. 7. is altogether doubtful, as are the other examples listed below.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* zone.

*Localities*.—7 (near Talidhok), Nos. K. 24-750a, and K. 24-751h, i; 9 (near Bagh Nilab), K. 24-759a.

### 3. BIPLICES sp. ind.

(Plate I, fig. 5.)

This form is discussed separately only because its more compressed whorl-section clearly differentiates it from the other serpenticonic Perisphinctids here described, but the preservation is very poor and comparison with a species like Choffat's<sup>1</sup> *Per. tiziani* (Oppel) var. *occidentalis* must be very tentative. What can be seen of the ribbing, especially the secondaries on the outer whorl-portion, is very similar, but there is no trace of suture-line, except on a septal surface at the end, and the sides are very corroded.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* zone.

*Locality*.—7 (near Talidhok), No. K. 24-751a.

Genus: PACHYPLANULITES, Spath, 1930.

### 1. PACHYPLANULITES PRALAIRESI (Favre).

(Plate III, figs. 4a-c.)

1875. *Ammonites pralairi*, Favre. Description des fossiles du terrain jurassique de la Montagne des Voirons (Savoie), *Mém. Soc. pal. Suisse.*, Vol. II, p. 32; Pl. III, figs. 6-7.
1876. *Ammonites (Perisphinctes) pralairi*, Favre. Description des fossiles du terrain Oxfordien des Alpes Fribourgeoises, *ibid.*, Vol. III, p. 46; Pl. V, fig. 4.
1890. *Perisphinctes pralairi* (Favre). Michalski, Ammoniten der unteren Wolga-Stufe, *Mém. Com. géol.*, Vol. VII, p. 229.
1891. *Perisphinctes pralairi* (Favre). Siemiradzki, Fauna Kopalna, etc., *Pam. Wydz. mat.-przycz. Akad. Umiej. Krakowie*, T. XVIII, p. 69.
1892. *Perisphinctes pralairi* (Favre). Siemiradzki, Die Oberjurassische Ammoniten-Fauna in Polen, *Zeit. Deutsch. Geol. Ges.*, Vol. XLIV, p. 477.
1894. *Perisphinctes pralairi* (Favre). Futterer, Beiträge zur Kenntnis des Jura in Ost-Afrika, *ibid.*, Vol. XLVI (1893), p. 11; Pl. VI, fig. 4.
1899. *Perisphinctes pralairi* (Favre). Siemiradzki, Monographische Beschreibung der Ammoniten-Gattung *Perisphinctes*, *loc. cit.*, p. 285.
1910. [?] *Perisphinctes pralairi* (Favre). Dacqué, Dogger und Malm aus Ostafrika, *loc. cit.*, p. 19; Pl. II, fig. 3.
1928. *Perisphinctes pralairi* (Favre). Welsch, Contribution à la connaissance des faunes jurassiques du Poitou. Étage Oxfordien-Argovien, *C. R. Acad. Sci. Paris* Vol. 187 (II), p. 165.

<sup>1</sup> *Loc. cit.*, p. 32; Pl. V, fig. 6 (5, 7), (1893).

1930. *Perisphinctes pralairi* (Favre). Dorn, Die Ammoniten-Fauna des untersten Malm der Frankenalb. *Palaeontogr.*, Vol. LXXIII, p. 155; Pl. XIII, figs. 6a, b.
1932. *Perisphinctes pralairi* (Favre). Lanquine, Sur l'extension, les facies, et les faunes de l'Argovien dans les chaines provencales, *C. R. Acad. Sci.*, Paris, Vol. 194, No. 7, p. 635.

The fragment under discussion consists of portions of four whorls and on account of partial limonitisation it is in a better state of preservation than the other *Perisphinctids* from the Attock district. It shows a comparatively simple suture-line, with deep external and short lateral lobes, comparable to that figured by Dorn, but less indented and with the principal lateral lobe especially somewhat simpler. The fragment has the *Stephanoceras*-like whorl-shape to which Siemiradzki has directed attention (1891, figure on page 69), with a broad periphery, and there is one pair of parabolæ (in the dark shadow at the lower end of fig. 4c) as in other *Pachyplanulites*. A conspicuous feature of the Attock example is the change in the direction of the costation from strongly oblique (on the three inner whorls) to radial (on the outer whorl). According to Siemiradzki a similar change is observed in *P. pralairi*, but it is not seen in Dorn's latest illustration.

The Kachh *P. subcolubrinus* (Waagen)<sup>1</sup> has a less coronate whorl-shape, while *P. pagri* and *P. subevolutus* (Waagen)<sup>2</sup> are still more depressed at a corresponding young stage. Dacqué's *Perisphinctes* cf. *pralairi* (non Favre?) which had already been included by Dietrich<sup>3</sup> in the synonymy of *P. africanus*, may be more doubtful but I have previously<sup>4</sup> recorded the existence of small and fragmentary specimens that appeared to be transitional between *Biplices africanus* and forms of *Pachyplanulites*.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* and *bimammatus* zones (fide Dorn).

*Locality*.—1 (near Burjianwala Laman), No. K. 23-695e.

Genus: DICHOTOMOSPINCTES, Buckman, 1926.

1. DICHOTOMOSPINCTES cf. ORBIGNYI (P. de Loriol).

(Plate II, fig. 5; Plate III, figs. 6a, b.)

1930. *Perisphinctes orbignyi*, P. de Loriol. Dorn, Ammoniten-Fauna des untersten Malm der Frankenalb, *loc. cit.*, p. 125 (pars).
1931. *Dichotomospinctes orbignyi* (de Loriol). Spath, Revision of the Jurassic Cephalopod Fauna of Kachh, *loc. cit.*, Pt. IV, p. 434.

The small fragment figured in Plate II, fig. 5, shows the ribbing of this form more typically than some larger examples which are too much worn to

<sup>1</sup> See Spath, *loc. cit.* (Kachh Revision, III), p. 432.

<sup>2</sup> *Ibid.*, pp. 428-431.

<sup>3</sup> Über eine dem mittleren Sauriermergel am Tendaguru äquivalente, rein marine Kimmeridge-bildung in Mahokondo, etc., *Palaeontograph.*, Suppl. VII, II Reihe, Pt. 1, p. 12, (1925).

<sup>4</sup> *Loc. cit.*, p. 42, (1930).

be figured or definitely identified. The absence of a distinct point of bifurcation of the ribs and the apparently greater length of the secondaries are believed to be due to the corrosion of the fragments, but the suture-line is only very imperfectly preserved in some. They are referred to the present form merely because of their general resemblance to the *Perisphinctes plicatilis* (d'Orbigny *non* Sowerby) figured by de Riaz<sup>1</sup>, especially the originals of his Plate III, figs. 1-3, which were cited by P. de Loriol<sup>2</sup> in the synonymy of his species. The smaller example represented in Plate III, fig. 6, is not complete enough for definite specific identification but also compares well with de Riaz's figures above cited, if not with Dorn's Franconian examples, most of which probably do not belong to this species.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* and *bimammatus* zones (fide Dorn).

*Localities*.—1 and 5 (near Burjianwala Laman), Nos. K. 23-695*h* K. 23-697*d*, K. 24-742*b*; and 7 (near Talidhok), K. 24-750*b*.

## 2. DICHOTOMOSPINCTES sp. ind.

(Plate I, figs. 2*a*, *b*.)

The septate fragment here figured is worn, and the suture-line (with strongly dependent umbilical elements) is incompletely shown; but it is discussed separately from the last species because it combines greater involution and increased whorl-height with an apparently different type of ribbing. This is merely slightly curved forward on the whorl-side, but there is no distinct peripheral sinus in the costation. The proportions are:—98 —34 —23 —42, but while these indicate a smaller umbilicus than that of *D. orbigny* the differences in ribbing might be due entirely to the corrosion, causing obliteration of the point of bifurcation of the ribs and an apparently more compressed whorl-section.

The example, however, is interesting because it shows good agreement (except possibly in its less closely-ribbed inner whorls) to the form figured by Dorn<sup>3</sup> as *Perisphinctes* aff. *rhodanico* (Dumortier). This form, in my opinion, has nothing to do with Dumortier's<sup>4</sup> species which is a *Discosphinctes*, with extremely fine and close costation and rapid increase in whorl-height, but the great resemblance in costation between Dorn's form and the Attock example may be due only to the corrosion of the latter. It is thus believed to represent some worn *Dichotomosphinctes* of the group of *D. orbigny*.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* and *bimammatus* zones (fide Dorn).

*Locality*.—1 (near Burjianwala Laman), No. K. 23-695*a*.

<sup>1</sup> *Loc. cit.*, p. 9, (1898).

<sup>2</sup> Étude sur les Mollusques et Brachiopodes de l'Oxfordien supérieur et moyen du Jura Ledonien, *Mém. Soc. F. S. Suisse*, Vol. XXIX, p. 81, (1902).

<sup>3</sup> *Loc. cit.*, p. 141; Pl. XI, fig. 1, (1930).

<sup>4</sup> Sur quelques gisements de l'Oxfordien inférieur de l'Ardèche, p. 62; Pl. III, (1871).

3. *DICHOTOMOSPINCTES* aff. *GROSSOUVREI* (Siemiradzki).

(Plate III, figs. 5a, b; Plate VI, figs. 3a-c.)

1899. *Perisphinctes grossouvrei*, Siemiradzki. Monographische Beschreibung der Ammonitengattung *Perisphinctes*, *loc. cit.*, p. 193; Pl. XXVII, figs. 54-5.
1916. *Perisphinctes occultefurcatus* (non Waagen). Ronchadzé, *Perisphinctes de l'Argovien de Chézery et de la Faucille*, *Mém. Soc. Pal. Suisse*, Vol. XLIII, p. 31 (pars); Pl. III, figs. 24-25 only.
1924. *Perisphinctes* cf. *stenocycloides*, Siemiradzki. Spath, On the Blake Collection of Ammonites from Kachh, *loc. cit.*, p. 14.
1928. *Ataxioceras grossouvrei* (Siemiradzki). Welsch, Contribution à la connaissance des faunes jurassiques du Poitou, Étage Oxfordien-Argovien, *loc. cit.*, p. 465.

The larger example here figured has dimensions 62 — 36 — 28 (?) — 36, but it is entirely septate and the suture-line is not clearly traceable. As the specimen, moreover, is worn and the primary ribbing almost effaced, reference to this species is based largely on the pronounced peripheral projection of the secondary ribs. The whorl-section seems to differ from that of the holotype or the form figured by Ronchadzé (Text-fig. 14), but this is due to the absence of the body-chamber. On the other hand, the Attock example may represent merely the inner whorls of a homœomorphous, larger species.

*D. helenae* (de Riaz)<sup>1</sup> or at least the Kachh examples figured<sup>2</sup> differ from the form here described in their more rigid costation and larger umbilicus. *D. elizabethae* (de Riaz)<sup>3</sup> and *D. thevenini* (Ronchadzé)<sup>4</sup> are distinguished by slightly finer ribbing, but belong to the same group.

A second, larger, but worn example resembles the Kachh specimen previously<sup>5</sup> referred to *Discosphinctes* ('*Lithacoceras*') *dybowskii* (Siemiradzki) and might, perhaps, equally well have been attached to this species. The third small fragment figured in Plate VI, fig. 3, is, of course, also doubtful, being deformed.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* and *bimammatus* zones (fide Dorn).

*Locality*.—1 (near Burjianwala Laman), Nos. K. 23-692a, K. 23-697c; 7 (near Talidhok), K. 24-751g.

4. *DICHOTOMOSPINCTES* sp. nov. ? aff. *WAEHNERI* (Siemiradzki).

(Plate I, figs. 1a, b.)

1891. *Perisphinctes michalskii*, Bukowski. Siemiradzki, Fauna Kopalna, etc., *loc. cit.*, p. 62; Pl. V, fig. 1.
1898. *Perisphinctes wachneri*, Siemiradzki. Monographische Beschreibung der Ammonitengattung *Perisphinctes*, *loc. cit.*, p. 255.
1928. *Perisphinctes wachneri*, Siemiradzki. Welsch, Contribution à la connaissance des faunes jurassiques du Poitou, Étage Oxfordien-Argovien, *loc. cit.*, p. 465.
1930. *Perisphinctes stenocycloides*, Siemiradzki. Dorn, Ammoniten-Fauna des untersten Malm der Frankenalb, *loc. cit.*, p. 133 (pars).

<sup>1</sup> *Loc. cit.*, p. 15; Pl. VIII, figs. 1 (and 3?), (1898).<sup>2</sup> Spath, *loc. cit.*, p. 436; Pl. LXVIII, fig. 9; Pl. LXX, fig. 5, (1928).<sup>3</sup> *Loc. cit.*, p. 22; Pl. XII, figs. 4-5, (1898).<sup>4</sup> *Loc. cit.*, p. 33; Pl. III, figs. 26-27, (1916).<sup>5</sup> Spath, *loc. cit.*, p. 452; Pl. LXXI, figs. 3a, b, (1931).

The figured example shows undoubted resemblance to *Prososphinctes virguloides*, but the ribbing is not so distinctly projected and differs from that of Siemiradzki's holotype merely in having longer secondaries. The periphery is also more evenly rounded than in Waagen's species and the whorl-section compares well with that of Dorn's *Perisphinctes stenocycloides* (Text-fig. 19, p. 134). The specimen is entirely septate, but the suture-lines have suffered from corrosion. Apparently they agree with the suture-line of *P. virguloides* previously figured<sup>1</sup>, although the lateral saddle is higher than the external.

The comparison to *D. waehneri* is open to objection, if this species be identical with *D. stenocycloides* (Siemiradzki)<sup>2</sup>, for then its short secondary ribs are against closer relationship. The forms figured by Lee<sup>3</sup> and Neumann<sup>4</sup>, and especially Ronchadzé's<sup>5</sup> example are also more closely ribbed, but since they as well as Dorn's form do not seem to me to belong to the original *D. waehneri* I am provisionally retaining that species. It is probable that the Attock form represents a new species, transitional between the *waehneri* group and *Prososphinctes* of the group of *P. virguloides* and *P. idoceroideis*, Spath.<sup>6</sup> In this connexion it seems significant to me that Siemiradzki considered his *P. waehneri* to show resemblance to *Ammonites championneti*, Fontannes<sup>7</sup>, for this also has comparatively long secondaries, although it probably belongs to another group.

*Biplices africanus* (Dacqué)<sup>8</sup>, which at first sight shows great similarity to the present species, has almost straight peripheral ribbing and probably belongs to a slightly later horizon.

*Horizon*.—Argovian (Upper Oxfordian), *transversarius* and *bimammatus* zones (fide Dorn).

*Localities*.—1 (near Burjianwala Laman), No. K. 23-690; 7 (near Talidhok), No. K. 24-750h ? (very doubtful fragment).

Genus: PROSOPHINCTES, Schindewolf 1925, emend.

### 1. PROSOPHINCTES VIRGULOIDES (Waagen).

(Plate I, figs. 3, 4a, b, 6; Plate II, figs. 3, 4a, b; Plate IV, figs. 5a, b; Plate V, fig. 7.)

1928. *Prososphinctes virguloides* (Waagen). Spath, Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), *loc. cit.*, Pt. IV, p. 441 (see there for synonymy).

non 1932. *Perisphinctes virguloides*, Waagen. Lanquine, *op. cit.* (C. R. Acad. Sci. Paris, Vol. 194, No. 7), p. 635.

<sup>1</sup> Spath, *loc. cit.*, Pl. LXX, fig. 3, (1931).

<sup>2</sup> *Loc. cit.*, p. 254; Pl. XX, fig. 11, (1898).

<sup>3</sup> Contribution à l'étude stratigraphique et paléontologique de la Chaîne de la Faucille, *Mém. Soc. Pal. Suisse*, Vol. XXXII, p. 77, (1905).

<sup>4</sup> Die Oxfordfauna von Cetechowitz, *Beitr. Pal. Geol. Öst.-Ung.*, Vol. XX, p. 27; Pl. III, fig. 21, (1907).

<sup>5</sup> *Loc. cit.*, p. 23; Pl. III, fig. 21, (1917).

<sup>6</sup> The Ammonite Faunas of the Neighbourhood of Mombasa, *Monogr. Hunterian Museum*, Univ. Glasgow, IV, Pt. 3, p. 46; Pl. III, figs. 5a, b, (1930, 20th March). Dorn (*loc. cit.*, p. 168; Pl. XIV, fig. 3 [lectotype]), later in 1930, again used this name, but his form (*Prososphinctes evolutoideis*, nom. nov.) is not an *Idoceras* any more than *Grossouviria calloviensis* (Loosy). (See Spath, *loc. cit.*, p. 363, [1931].)

<sup>7</sup> In Dumortier and Fontannes, Description des Ammonites de la zone à *Ammonites tenuilobatus* de Crussol, etc., p. 79; Pl. IX, (1876).

<sup>8</sup> See Spath, *loc. cit.*, p. 42, text-fig. 1; Pl. IV, fig. 12, Mombasa, (1930).

Since this species has so frequently been misinterpreted and since Waagen's original illustration may be thought to be too diagrammatic I am now refiguring the holotype (Plate I, fig. 6; Plate II, fig. 3). The small example depicted in 1928 (Plate XC, fig. 4) was marked as doubtful and shows neither the characteristic peripheral projection of the ribs nor the narrowness of the ventral area, although this is partly the fault of the photograph. Waagen's figure, on the other hand, will be seen to be quite successful, considering it is largely restored.

There is little to add to my previous discussion of this species, but the dimensions quoted (after Waagen and Siemiradzki) were not checked. Since the material from Attock includes a number of typical specimens as well as some varieties, I am now figuring several and hope that they will help to make this species more widely known. The best example is that represented in Plate II, fig. 4, which has dimensions:—92 —33 —26 —42 as against 108 —30 —27 —48 in the holotype. It thus differs in having a smaller umbilicus, probably not a specific difference, but the ribbing is identical as is the suture-line, with its short lateral lobe, so far as can be seen. The present termination of the shell being damaged, it is probable that the whorl-section (fig. 4b) is too rounded, *i.e.*, not compressed enough at the periphery, as it is on the earlier portion and in the holotype. Conversely the typical fragment figured in Plate IV, fig. 5, is too compressed, but only by accidental deformation in the rock like the more doubtful example represented in Plate I, fig. 4. This shows traces of the last suture-line and although the whorl-section may not be relied on, owing to the fracturing, the agreement in ribbing is unmistakable. The proportion of whorl-height to thickness in this fragment is as 32:26.

Some more examples attached to the present species, like those figured in Plate I, fig. 3 (peripheral view), and Plate V, fig. 7 (side-view), are rather poorly preserved, but the peripheral sinus in the ribbing is considered characteristic. In the case of a still greater number, unfortunately, the identification must remain altogether problematical.

*Horizon.*—Argovian (Upper Oxfordian), *transversarius* (or *bimammatus* ?) zone.

*Localities.*—1 and 5 (near Burjianwala Laman), Nos. K. 23-693; K. 23-697a, b, e-h; K. 24-742a; 7 (near Talidhok), Nos. K. 24-750c-f; K. 24-751b.

c. Family : *BERRIASELLIDAE*, Spath.

1. Sub-family : *BERRIASELLINAE*, Spath.

Genus : *BERRIASELLA*, Uhlig 1905, emend.

1. *BERRIASELLA* ? sp. ind.

(Plate VI, figs. 9a, b.)

[ Compare :—*Berriasella vetusta* (Steuer), Argentinische, Jura-Ablagerungen, *Pal. Abh.* N. F., Vol. III (1897), p. 57 (183); Pl. XVI (XXX), figs. 4-5 (lectotype).]

The characteristic features of the fragmentary example here figured, in the absence of the suture-line, are the evolute whorl-shape, with a conspicuous, rounded and smooth umbilical edge and somewhat flattened sides, also the

irregular ribbing and the hoplitid periphery, agreeing with that of Oppel's<sup>1</sup> *Amm. theodorii*. This species refigured by Uhlig<sup>2</sup>, however, has umbilical tubercles and even in a less nodate form like *Hoplites* (*Neocomites*) *indicus* Uhlig<sup>3</sup> the strongly sigmoidal ribbing denotes a different group of forms so that the Attock example is not now referred to *Neocomites* but (doubtfully) to *Berriasella*. The resemblance to the small example figured by Blanford<sup>4</sup> as *Amm. wallichi*, which made me record this fragment first as *Neocomites*, is however very close.

The presence of one pair of ribs separating near the umbilical border and of single costæ between others that bifurcate at the middle of the side definitely differentiates the Attock form from the more regularly and finely-ribbed species of *Parodontoceras* like *P. calisto* (d'Orbigny)<sup>5</sup> or *P. carpathica* as figured by Killan<sup>6</sup>, although the original illustration of Oppel's type (in Zittel)<sup>7</sup> with irregular costation seems to differ merely in its narrower umbilicus. There is better agreement, however, with the restricted *Berriasella* of the *privasensis* group, to which the South American *B. vetusta* belongs. Pictet's holotype<sup>8</sup> has somewhat coarser ribbing than the Attock form and is more involute whereas the variety figured in his fig. 2, although it has a larger umbilicus, is less closely comparable in ribbing. In *B. vetusta*, which is somewhat transitional to *Blanfordiceras*, the more inflated whorl-section causes a rather different aspect. *B. subprivasensis*, Krantz<sup>9</sup>, which is a similar passage-form to *Blanfordiceras*, if Weaver's<sup>10</sup> identification is correct, is also closely comparable to the Attock form, but more bluntly ribbed.

Since species like the present occur in the uppermost Jurassic as well as in the lowermost Cretaceous, a single fragment of doubtful preservation would not seem to be of much stratigraphical value. *B. vetusta*, in any case, has been found in South America<sup>11</sup> to be definitely below the border-line, while *B. privasensis* also has been taken to be the zonal ammonite of the uppermost Tithonian to be replaced, in the lowest Infra-Valanginian, by *Parodontoceras calisto* (d'Orbigny), *P. callistoides* (Behrendson)<sup>12</sup> passing from the upper Tithonian unchanged into the Cretaceous.<sup>13</sup> Blanford's Niti pass specimen, above referred to, partly pyritic, is undoubtedly from the upper (Cretaceous) beds.

<sup>1</sup> Paläontologische Mitteilungen, IV, Über ost-indische Fossilreste, I, p. 280; Pl. LXXVIII, figs. 3a-c, (1863).

<sup>2</sup> Fauna of the Spiti Shales, Fasc. 2, *Pal. Ind.*, Ser. XV, Vol. IV, p. 260; Pl. LXXXIX, fig. 1, (1910).

<sup>3</sup> *Ibid.*, p. 262; Pl. LXXXIX, fig. 4.

<sup>4</sup> In Salter and Blanford, Palaeontology of Niti, p. 84; Pl. XIX, figs. 1a, b (reversed and restored), (1865).

<sup>5</sup> Paléontologie Française, Terrains jurassiques, Vol. I, Céphalopodes, p. 551; Pl. CCXIII, figs. 1-2, (1850).

<sup>6</sup> Mission d'Andalousie, I, Le Gisement tithonique de Fuente de los Frailes, II, Etudes paléontologiques, *Mém. Acad. Sci. Paris*, Vol. XXX, p. 660; Pl. XXX, fig. 1, (1889).

<sup>7</sup> Cephalopoden der Stramberger Schichten, *Pal. Mitteil.*, Vol. II, I, p. 107; Pl. XVIII, figs. 4a-d (lectotype), (1868).

<sup>8</sup> Etudes paléontologiques sur la faune à *Terebratula diphyoides* de Berrias (Ardèche), *Mélanges pal.*, II, p. 84; Pl. XVIII, fig. 1 only, (1867).

<sup>9</sup> Die Ammoniten des Mittel- und Obertithons, *Geol. Rundschau*, Vol. XVIIa, p. 438 (unfigured), (1926).

<sup>10</sup> Palaeontology of the Jurassic and Cretaceous of West Central Argentina, *Mem. Univ. Washington*, Vol. I, p. 443; Pl. LVI, figs. 356-7, (1931).

<sup>11</sup> See Gerth, Contribuciones a la estratigrafía y paleontología de los Andes Argentinos, *Act. Acad. Nac. Cienc. Córdoba*, Vol. IX, p. 41.

<sup>12</sup> See Spath, Ammonites of the Speeton Clay and the Subdivisions of the Neocomian, *Geol. Mag.*, Vol. LXI, p. 80 (Table III), (1924).

<sup>13</sup> Gerth, La Fauna neocomiana de la Cordillera Argentina en la parte meridional de la Provincia de Mendoza, *Act. Acad. Nac. Cienc. Córdoba*, Vol. IX, p. 88.



*Horizon.*—Uppermost Tithonian, *privasensis* zone? or Lower Cretaceous?

*Locality.*—9 (near Bagh Nilab), No. K. 24-760.

Genus: BLANFORDICERAS, Cossmann, 1907.<sup>1</sup>

1. BLANFORDICERAS WALLICHI (Gray).

(Plate VI, figs. 6a, b.)

- 1830-32. *Ammonites wallichi*, Gray. Illustrations of Indian Zoology, Vol. I, Pl. C, fig. 3.
1863. *Ammonites wallichi*, Gray. Blanford, On Dr. Gerard's Collection of Fossils from the Spiti Valley, *Journ. As. Soc. Beng.*, Vol. XXVII, p. 127; Pl. III, figs. 2-3.
1865. *Ammonites wallichi* (Gray). Blanford in Blanford and Salter, Palæontology of Niti, p. 84; Pl. XV, fig. 1; Pl. XIX, fig. 1.
1865. *Ammonites parkinsoni* (Sowerby), Stoliczka, Geological Sections across the Himalayan Mountains, etc., *Mem. Geol. Surv. Ind.*, V, p. 98.
1903. *Ammonites wallichi* (Gray). Crick, Note on Dr. Gray's Type-specimens of Jurassic Ammonites from India, *Proc. Malac. Soc.*, Vol. V, p. 287.
1903. *Hoplites wallichi* (Gray). Uhlig in Burekhardt, Beiträge zur Kenntnis der Jura- und Kreide-Formation der Cordillere, *Palæontogr.*, Vol. I, p. 65.
1904. *Ammonites wallichi* (Gray). Crick, Notes on the Cephalopoda belonging to the Strachey Collection from the Himalaya, *Geol. Mag.*, Dec. V, Vol. I, p. 13.
1904. *Hoplites wallichi* (Gray). G. Böhm Beiträge zur Geologie von Niederländisch Indien I, 1, Grenzschichten zwischen Jura und Kreide, *Palæontogr. Suppl.*, IV, I, 1, p. 31; Pl. III, fig. 4; Pl. IV; Pl. V, fig. 1.
1905. *Blanfordia wallichi* (Gray). Uhlig, Einige Bemerkungen über die Ammoniten-Gattung *Hoplites*, Neumayr, *Sitzb. Math.-Nat. Kl. Akad. Wiss. Wien*, Vol. CXIV, p. 605.
1910. *Hoplites (Blanfordia) wallichi* (Gray). Uhlig, Fauna of the Spiti Shales, Fasc. 2, *loc. cit.*, p. 186; Pl. XXIX, figs. 1-3; Pl. XXX, fig. 1; Pl. XXXI, figs. 1, 2.
1923. *Blanfordiceras wallichi* (Gray). Spath in Trechmann, Jurassic of New Zealand, Appendix, *Quart. Journ. Geol. Soc.*, Vol. LXXIX, p. 302.
1925. *Blanfordiceras wallichi* (Gray). Spath, Ammonites and Aptychi from Somaliland, *Monogr. Hunterian Mus.*, Univ. Glasgow, Vol. I, p. 145.
1925. *Blanfordiceras wallichi* (Gray). Gerth, La Fauna neocomiana de la Cordillera Argentina, etc., *Act. Acad. Nac. Cienc. Rep. Argentina*, Vol. IX, p. 93.
1926. *Hoplites (Blanfordia) wallichi* (Gray). Kruizinga, Ammonieten en eenige andere fossielen uit de jurassische afzittingen der Soela eilanden, *Jaarb. Mijnwezen Ned. Ind.*, Vol. 54, p. 79, (1925).
1928. *Blanfordia wallichi* (Gray). Grabau, Stratigraphy of China, Vol. II, p. 486, fig. 610.
1933. *Blanfordiceras* sp. Spath, Revision of the Cephalopod Fauna of Kachh, *loc. cit.*, Pt. VI, p. 694.

Gray's holotype (B. M. No. C 5041) is before me and the Attock example is indistinguishable from it at a corresponding diameter; but as it was originally pyritic and is now limonitised, it has suffered the usual distortion by swelling. Uhlig himself had stated that not one of his many examples was identical with

<sup>1</sup> *Revue Critique de Paléozoologie*, Vol. XI, No. 1, p. 64, (Jan. 1907).

Gray's holotype: conversely I have before me varieties that have more finely-ribbed inner whorls than are shown in any of Uhlig's figures and seem somewhat transitional to *Andiceras*. Yet although the species has been interpreted too widely in the past when it was taken to include, e.g., forms of the Cretaceous genus *Pseudoblanfordia*<sup>1</sup> and although it has even been confused by Grabau with the Lower Liassic *Schlotheimia*<sup>2</sup>, it is an easily recognised form. Its horizon, however, in the Spiti Shales, has never been determined, and while Uhlig<sup>3</sup> was inclined to consider it mainly of Upper Tithonian age, but possibly passing up into the Cretaceous, Burckhardt<sup>4</sup>, more recently recorded his Mexican '*Blanfordia*' cfr. *wallichi* from beds (with *Kossmatia*) about 400 feet below the *Steuero-ceras* beds which (with a similar thickness) are themselves overlain by the Infra-Valanginian *Spiticeras* beds.

*Horizon*.—Uppermost Tithonian, *privasensis* zone?

*Locality*.—1 (near Burjianwala Laman), No. K. 23-691.

## 2. BLANFORDICERAS AFF. BOEHMI (Uhlig).

(Plate VI, figs. 7a-c.)

1910. *Hoplites (Blanfordia) boehmi*, Uhlig. Fauna of the Spiti Shales, Fasc. 2, *loc. cit.*, p. 195; Pl. XXXIV, figs. 1a-d.

1928. *Blanfordia boehmi*, Uhlig. Grabau, Stratigraphy of China, Vol. II, p. 487, fig. 611.

The identification of the limonitic fragment here figured must remain provisional since it is so small and does not show the suture-line distinctly. The *Reineckeia*-like spines at the points of branching of the ribs are sharp and prominent, whereas in the typical *Blanfordiceras* of the *wallichi*-group, the finely ribbed inner whorls are quite perisphinctoid. This species, thus, is transitional to *Himalayites*.

Comparison may also be made to forms like '*Berriasella*' *spinulosa*, Gerth<sup>5</sup>, on the one hand and to *Himalayites egregius* (Steuer) Gerth<sup>6</sup> on the other; for the former was referred to the lowest Infra-Valanginian (zone of *Kilianella burckhardti*) and the latter to the highest (zone of '*Thurmannia*' *fraudans*) so that forms like the present are likely to be found (together with *Spiticeras*) in the lowest Cretaceous.

*Horizon*.—Lowest Infra-Valanginian (*Spiticeras* beds)?

*Locality*.—6 (near Talidhok), No. K. 24-749.

<sup>1</sup> Spath, *loc. cit.* p. 145, (1925)=group of *Hoplites australis*, Burckhardt, *loc. cit.* p. 64; Pl. XI, figs. 9-12, (1903).

<sup>2</sup> A Lower Cretaceous Ammonite from Hongkong, *Bull. Geol. Surv. China*, No. 5, Pt. 2, p. 199; Pl. 1, (1923). Also Geology of China, II, pp. 494 and 774; Pl. IX, (1928).

<sup>3</sup> Die Fauna der Spiti-Schiefer des Himalaya, ihr geologisches Alter und ihre Weltstellung, *Denkschr. Math.-Nat. Kl. K. Akad. Wiss. Wien.*, Vol. LXXXV, p. 552, (1910).

<sup>4</sup> Étude synthétique sur le Mésozoïque mexicain, *Mém. Soc. Pal. Suisse*, Vol. XLIX, Table 6, p. 76.

<sup>5</sup> *Loc. cit.* (1925, Fauna Neocomiana), p. 91; Pl. VI, figs. 1-2.

<sup>6</sup> *Ibid.*, p. 73; Pl. II, fig. 7.

2. Sub-family: *HIMALAYITINAE*, Spath.Genus: *AULACOSPINCTES*, Uhlig 1905, emend. Spath.1. *AULACOSPINCTES* sp. juv. cf. *PROXIMUS* (Steuer).

(Plate VI, figs. 10a, b.)

1897. *Reineckeia proxima*, Steuer. Argentinische Jura-Ablagerungen, *Pal. Abh.*, N. F., Vol. III, p. 160; Pl. XXII (VIII), figs. 7-11.
1907. *Perisphinctes proximus* (Steuer). Haupt, Beiträge zur Fauna des oberen Malm und der unteren Kreide in der argentinischen Cordillere, *N. Jb. f. Min.*, etc., Beil.-Bd. XXIII, p. 192.
1910. *Perisphinctes (Aulacosphinctes) proximus* (Steuer). Uhlig, Fauna of the Spiti Shales Fasc. 3, *loc. cit.*, p. 347.
1926. *Aulacosphinctes proximus* (Steuer), Krantz. Die Ammoniten des Mittel-und Obertithon, *Geol. Rundschau*, Vol. XVII a, p. 458.
1931. *Aulacosphinctes proximus* (Steuer). Weaver, Paleontology of the Jurassic and Cretaceous of West Central Argentina, *loc. cit.*, p. 411; Pl. XLIV, figs. 298-9 (?).

There is only a small fragmentary specimen, in a poor state of preservation, and the comparison to a South American species must not be taken to imply that the Attock example could not represent the inner whorls of a similar Himalayan species of the group of *A. mörikeanus* (Oppel)<sup>1</sup>, although these do not seem to have so many single ribs. The suture-line is not distinctly visible but the peripheral groove is as pronounced as in Steuer's fig. 11 which also shows the greatest similarity in ribbing and whorl-shape.

*A. proximus* has been recorded by Stehn<sup>2</sup> from his zone of *Berriasella* [*Corongoceras*] *mendozaana* and the absence of the typical *Aulacosphinctes* in the *Virgatosphinctes* beds of Kachh and Madagascar makes it probable that the Himalayan *mörikeanus*-group is of Upper Tithonian age, as Uhlig<sup>3</sup> held.

*Horizon*.—Uppermost Tithonian, *-privasensis* zone?

*Locality*.—1 (near Burjianwala Laman), K. 23-692d.

d. Family: *OLCOSTEPHANIDAE*.Sub-family: *SPITICERATINAE*, Spath 1925.Genus: *SPITICERAS*, Uhlig, 1903.1. *SPITICERAS* sp. ind.

(Plate VI, figs. 8a, b.)

There is no doubt about the generic position of this form, but its fragmentary condition prevents specific identification with any of the Himalayan types described by Uhlig. There is no recognisable suture-line and while the whorl-section (fig. 8b) is common to various species of *Spiticeras*, the evolution and

<sup>1</sup> See Uhlig, *loc. cit.* (Fasc. 2, 1910), p. 351; Pl. XXXIII, fig. 2.

<sup>2</sup> Fauna und Gliederung des Neocoms in der argentinischen Cordillere, *Centralbl. f. Min.*, etc., p. 148, (1921).

<sup>3</sup> *Loc. cit.*, p. 551, (1910).

narrowness of the penultimate whorl indicate a serpenticone form of the group of *S. subbilobatum* (Uhlig).<sup>1</sup> The fragment figured by Uhlig<sup>2</sup> as *S. sp. nov. indet.* is also very similar, but in the typical *S. spitiense* (Blanford)<sup>3</sup>, the tubercles are stronger, especially on the inner whorls.

Among the numerous European and especially French forms more recently described by Djanelidzé<sup>4</sup>, there is also none that agrees with the Attock form, but it is important to note that the comparable Spiti forms are all listed as Cretaceous and as true *Spiticeras*, in the restricted sense, and that the Tithonian fore-runners like *S. celsum* (Oppel) and *S. pseudogroteanum*, 'Djanelidzé' are less closely comparable.

*Horizon*.—Lowest Infra-Valanginian, *Spiticeras* beds.

*Locality*.—1 (near Burjianwala Laman), No. K. 23-696.

e. Family : *DIPLOCERATIDAE*, Spath.

Genus : *OXYTROPIDOCERAS*, Stieler, 1921.

1. *OXYTROPIDOCERAS* aff. *ROISSYANUM* (d'Orbigny).

(Plate VI, figs. 1a-c.)

1840. *Ammonites roissyanus*, d'Orbigny. *Paléontologie Française, Terrains Crétacés*, p. 302; Pl. LXXXIX, figs. 1-3.
1895. *Schloenbachia roissyana* (d'Orbigny). Parona and Bonarelli, *Fossili albiani d'Escrag-nolles, etc., Pal. Italica*, Vol. II, p. 88; Pl. XI, figs. 7-8.
1906. *Schloenbachia* cf. *roissyana* (d'Orbigny). R. Douvillé, *Sur des Ammonites du Crétacé Sud-Américain. Ann. Soc. Roy. Zool. Malac. Belgique*, Vol. XLI, p. 147; Pl. IV, figs. 3, 3a.
1907. *Mortoniceras ? roissyana* (d'Orbigny). Jacob, *Études paléontologiques et stratigraphiques sur la partie moyenne des terrains crétacés, etc., Trav. Lab. Géol. Grenoble*, p. 383.
1910. *Schloenbachia roissyana* (d'Orbigny). Böse, *Monografia geologica y paleontologica del Cerro de Mulero, Bol. Inst. Geol. Mexico*, No. 25, p. 66.
1911. *Schloenbachia (Mortoniceras) roissyana* (d'Orbigny). Schlagintweit, *Die Fauna des Vracon und Cenoman in Peru, N. Jahrb. f. Min., etc., Beil.-Bd. XXXIII*, p. 64, (pars).
1920. *Oxytropidoceras roissyana* (d'Orbigny). Stieler, *Über sogenannte Mortoniceraten des Gault, Centralbl. f. Min., etc.*, p. 398.
1921. *Pseudophacoceras roissyana* (d'Orbigny). Spath, *Cretaceous Cephalopoda from Zululand, Ann. S. Afr. Mus.*, Vol. XII, Pt. VII, No. 16, p. 281.
1922. *Pseudophacoceras (Oxytropidoceras) roissyana* (d'Orbigny). Spath, *Cretaceous Ammonoidea from Angola, etc., Trans. Roy. Soc. Edinburgh*, Vol. LIII, Pt. 1, No. 6, p. 98.

<sup>1</sup> *Loc. cit.* (Fauna of the Spiti Shales, Fasc. 1), p. 98; Pl. X, fig. 2, (1908).

<sup>2</sup> *Ibid.*, p. 129; Pl. XI, fig. 4.

<sup>3</sup> See Uhlig, *ibid.*, p. 89; Pl. VIII, fig. 1.

<sup>4</sup> Les *Spiticeras* du S.-E. de la France, in Kilian, *Contributions à l'étude des céphalopodes paléo-crétacés du S. E. de la France, Mém. Expl. Carte géol. dét. France*, p. 207; Pls. I-XXII, (1922).

1924. *Mortoniceras (Schloenbachia) peruanum* (v. Buch). Lisson, Edad de los Fosiles Peruanos, etc., *Contr. Geol. Peru* (3rd ed.), p. 146.
1926. *Inflatoceras roissyanum* (d'Orbigny). Jayet, Étude stratigraphique de la Perte-du-Rhône, etc., *Eclogae geol. Helvet.*, Vol. XX, No. 2, pp. 176, 179.
1930. *Oxytropidoceras roissyanum* (d'Orbigny). Spath, Lower Cretaceous Ammonoidea, in Fossil Fauna of the Samana Range, etc., Pt. V, *Pal. Indica*, N. S., Vol. XV, p. 61; Pl. IX, fig. 12.
1931. *Oxytropidoceras roissyanum* (d'Orbigny). Spath, Monograph of the Ammonoidea of the Gault, *Pal. Soc.*, Pt. 8, p. 348.

This form is represented by two fragments of which the one here figured is less corroded than the other. It formed part of the body-chamber, with the septal surface at the smaller end representing the termination of the camerate stage, but the unfigured fragment of about similar dimensions (in the unweathered condition) is entirely septate. The suture-line, however, is simplified by wear and incomplete at the ventral end (left in fig. 1c), owing to the weathering off of the periphery. In the figured example, the ventral keel is also worn away and the restoration (fig. 1b) of the high carina is based on the section of the previous whorl. The inner half of the whorl-side is also corroded, which accounts for the apparently more sigmoidal course of the ribbing, but the general whorl-shape is undoubtedly that represented in d'Orbigny's fig. 2.

In view of the many species of this genus in existence the specific identification, of course, is not meant to be more than approximate, yet the large fragment figured by Parona and Bonarelli is closer to the Attock example than any of the other illustrations to be found in geological literature. Even the difference in the section of the inner whorl is probably without significance, owing to the obliquity of the section, and the differences in the suture-line are equally unimportant.

*Schloenbachia* sp. (cf. *chihuahuensis*, Böse) figured by Douglas<sup>1</sup> is similar, and the Mexican type<sup>2</sup>, with straighter ribs, has a similar whorl-section, but the peripheral termination of the ribs is typically far less projected in Böse's species. On the other hand *O. buarquianum* (White)<sup>3</sup> to which Douglas's Peruvian form just mentioned may belong, has slightly coarser ribbing and is apparently transitional to *O. trinitense* (Gabb).<sup>4</sup>

*Amm. peruvianus*, v. Buch<sup>5</sup>, which according to Steinmann<sup>6</sup> has narrow ribs and broader inter-spaces, may be closer to the present species than to *O. acutocarinatum*, discussed below, but the large Colombian fragment which I previously attached to v. Buch's species is too finely ribbed and may only represent the body-chamber of a large *O. supani* (Lasswitz)<sup>7</sup>, itself only a variety of *O. acutocarinatum*, discussed below. As the type of *O. peruvianum*, however,

<sup>1</sup> Geological Sections through the Andes of Peru and Bolivia, III, from the Port of Callao to the River Perene, *Quart. Journ. Geol. Soc.*, Vol. LXXVII, p. 269; Pl. XVII, fig. 3, (1921).

<sup>2</sup> *Loc. cit.*, p. 73; Pl. VII, figs. 3-4; Pl. VIII, figs. 1-2, (1910).

<sup>3</sup> Contributions to the Geology of Brazil, p. 222; Pl. XXIV, figs. 3-4, (1887).

<sup>4</sup> See Adkins, Handbook of Texas Cretaceous Fossils, *Univ. Texas Bull.*, No. 2838, p. 227; Pl. V, fig. 3, (1928).

<sup>5</sup> Pétrifications recueillies en Amérique par M. A. de Humboldt et M. Ch. Degenhardt, p. 5; Pl. I, figs. 5-7.

<sup>6</sup> Über Tithon und Kreide in den peruanischen Anden, *Neu. Jahrb. f. Min.*, etc., II, p. 140, (1881).

<sup>7</sup> Kreide-Ammoniten von Texas, *Geol. und Pal. Abhandl.*, Vol. IV, Heft 4, p. 22; Pl. IV, fig. 3, (1904).

is in Berlin (*vide* Steinmann) it ought to be possible to decide whether it is the same as d'Orbigny's *O. roissyanum* as e.g., Schlagintweit and Lisson maintained, for in that case the older name would have to be used. Judging by the figure (v. Buch's fig. 5) *Amm. peruvianus* is more like *O. acutocarinarum*, i.e., it is what Marcou<sup>1</sup> considered to be *Amm. peruvianus*.

*Horizon*.—Middle Albian, about upper part of Lower Gault.

*Locality*.—12 (near Sujhanda), Nos. K. 24-775a, b.

## 2. OXYTROPIDOCERAS cf. ACUTOCARINATUM (Shumard).

(Plate VI, figs. 2a-c).

1854. *Ammonites acutocarinarus*, Shumard. Palæontology, Description of the species of Carboniferous and Cretaceous fossils collected, in R. B. Marcy, Exploration of the Red River of Louisiana in the year 1852, p. 183; Pl. III, fig. 1.
1920. *Oxytropidoceras acutocarinarum* (Shumard). Stieler, Über sogenannte Mortoniceraten des Gault, *loc. cit.*, p. 398.
1921. *Pseudophacoceras acutocarinarum* (Shumard). Spath, Cretaceous Cephalopoda from Zululand, *loc. cit.*, p. 283.
1928. *Oxytropidoceras acutocarinarum* (Shumard). Adkins, Handbook of Texas Cretaceous Fossils, *loc. cit.*, p. 226.

This is a slightly more finely-ribbed form than the last and the ribbing is characterised by being sometimes bifid and by being (on the side not figured, which was oyster-coated, but retained the test) of that peculiar *multifida*-type which was described by Douglas<sup>2</sup> from some South American forms. The costae are flattened and the intervening grooves are very narrow compared with the broad ribs, but on the weathered side (figured), the ribs are apparently sharper, as in the many transitions to the last species and to *Adkinsites (belknapi)* group). It is, of course, often found that the ribbing varies greatly in these forms with the mode of preservation, and since I have had the opportunity of examining many specimens from Texas, by the kindness of Prof. W. S. Adkins, I am prepared to accept forms like *O. carbonarium* (Gabb)<sup>3</sup>, *O. multifidum* (Steinmann)<sup>4</sup>, and *O. supani* (Lasswitz)<sup>5</sup> all previously<sup>6</sup> taken as distinct species, to be mere varieties of *O. acutocarinarum*. Since Prof. Adkins has shown that the identity of this species is somewhat doubtful and since I have already mentioned that there is a possibility of its being the same as v. Buch's *Amm. peruvianus*, the continued use of the name *O. acutocarinarum* may seem open to criticism. But the examination of a suite of large specimens of the *supani* type will convince most palæontologists that the closeness of the ribbing in any given fragment is not of specific significance, varying with size in often a quite erratic manner. Similarly the separation of a form like *Schloenbachia* aff.

<sup>1</sup> Geology of North America, p. 34; Pl. V, figs. 1, 1a, b, (1858).

<sup>2</sup> *Loc. cit.*, Text-fig. 4 A, B, p. 268, (1921).

<sup>3</sup> Notes on American Cretaceous Fossils, with Descriptions of some new species, *Acad. Nat. Sci. Phila. Proc.* 3, Vol. XXVIII, p. 269; Pl. XXXVIII, figs. 2, 2a, b.

<sup>4</sup> *Loc. cit.*, p. 139; Pl. VII, fig. 1 (*Schloenbachia acutocarinarum* var. *multifida*), (1881).

<sup>5</sup> *Loc. cit.*, p. 22; Pl. IV, fig. 3 ('*Sonneratia*'), (1904).

<sup>6</sup> Spath, *loc. cit.*, p. 283, (1921).

*acutocarinata* (Shumard) Marcou in Böse<sup>1</sup> on account of its more inflated whorl-section alone would be insufficient, but this (new) species has different inner whorls, judging by Texas material before me.

A typical large fragment (No. 568) of the present species, indistinguishable from body-chambers of *O. supani*, has lately been sent to me by Dr. Besairie from Berambo, Province of Analalava, Madagascar. It was found together with very fine examples of several new species of *Manuaniceras*, Spath<sup>2</sup> (first *Pseudophacoceras*), to be figured separately, which clearly show the entire independence of this group. Thévenin<sup>3</sup> already recorded the occurrence of *O. acutocarinatum* in north-west Madagascar, but the confirmation of this record is important, partly because this species was not again described in Boule, Lemoine and Thévenin's<sup>4</sup> later and larger work, partly because it is so widely distributed in North, Central and South America, and the occurrences at Hazara and in the Attock District, added to the great abundance of *Oxytropidoceras* in South-western Persia<sup>5</sup>, are of palæo-geographical interest.

*Horizon*.—Middle Albian, about upper part of Lower Gault.

*Locality*.—12 (near Sujhanda), No. K. 24-775c.

## B. Order: BELEMNOIDEA.

Family: *BELEMNITIDAE*, d'Orbigny.

1. Sub-family: *BELEMNOPSINAE*, Naef.

Genus: *BELEMNOPSIS*, Bayle, 1878.

1. *BELEMNOPSIS TANGANENSIS* (Futterer).

1929. *Belemnopsis tanganensis* (Futterer). Stolley, Über ostindische Jura-Belemniten, *Pal. Timor.*, Lief. XVI, No. XXIX, p. 177; Pl. CCLII (5), figs. 13-20.

1933. *Belemnopsis tanganensis* (Futterer). Spath, Revision of the Jurassic Cephalopod Fauna of Kachh, *loc. cit.*, p. 660.

Among the 120 belemnites here recorded, there is only a single individual of a *Belemnopsis* and it is now referred to Futterer's species, recently discussed, because it is characterised by its slender shape and rather broad and deep ventral furrow which does not reach to the apex. The guard, however, is only 50 mm. in length, *i.e.*, it represents merely the apical half of an individual comparable to Futterer's<sup>6</sup> second example and the cross-section, slightly deformed by lateral crushing, as is indicated by the asymmetry, was probably originally circular. In the Somaliland specimens, recently discussed, from beds III*d-d*,

<sup>1</sup> *Loc. cit.*, p. 65; Pl. II, figs. 1-3, (1910).

<sup>2</sup> On Upper Albian Ammonoidea from Portuguese East Africa, with an Appendix on Upper Cretaceous Ammonites from Maputoland, *Ann. Transv. Mus.*, Vol. XI, Pt. 5, p. 182, (1925).

<sup>3</sup> Fossiles d'âge albien provenant du N.-O de Madagascar, *C. R. Soc. géol. France*, p. 105, (1905, session du 6 juin).

<sup>4</sup> Paléontologie de Madagascar, III, Céphalopodes crétaoés des environs de Diego-Suarez, *Ann. de Paléont.*, Vols. I, II, (1906-07).

<sup>5</sup> Here recorded on the strength of large, new collections before me.

<sup>6</sup> Beiträge zur Kenntnis des Jura in Ost-Afrika, *Zeit. Deutsch. Geol. Ges.*, Vol. XLVI, 1894, p. 30; Pl. V, fig. 3, (1893).

at the junction of the Oxfordian and Kimmeridgian, the section is only slightly less compressed, but *B. alfurica* (G. Boehm)<sup>1</sup> seems equally close.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—10 (near Bata), No. K. 24-762d.

Genus: HIBOLITES (Montfort) Mayer-Eymar, 1883.

1. HIBOLITES BUDHAICUS (Stoliczka).

(Plate II, figs. 1a, b; Plate III, figs. 3a-h; Plate VI, figs. 5a-d.)

1865. *Belemnites budhaicus*, Stoliczka. Geological Sections across the Himalayan Mountains, etc., *Mem. Geol. Surv. Ind.*, V, p. 78; Pl. VI, figs. 3-6.

1920. *Dicoelites budhaicus* (Stoliczka). Bülow-Trummer in Diener, Fossilium Catalogus, I, Pt. II, p. 134.

1925. *Belemnites budhaicus*, Stoliczka. Lissajous and Roman, Répertoire alphabétique des Bélemnites jurassiques, etc., *Trav. Lab. Géol. Lyon*, Fasc. VIII, Mém. No. 7, p. 65.

1929. *Hibolites budhaicus* (Stoliczka). Stolley, Über ostindische Jura-Belemniten, *Pal. Timor*, Lief. XIII, No. XXIX, p. 213.

This species was originally described as having a cylindrical guard, very slightly tapering towards the apex, smooth, and without vascular impressions, but with a deep ventral, furrow which extended from about the middle of the guard to its lower termination. The section was usually circular and the species must have attained a great length since no trace of the alveolus was to be seen on any of the specimens, of which that figured in Stoliczka's fig. 4 was the largest. They were

'very often and at different localities found with a number of transverse breaks which were no doubt accidents but which had the appearance of joints'.

This last feature which characterises a number of the Attock specimens (see Plate III, fig. 3d), also coming from 'beds below the Spiti Shales', of course, is of no diagnostic value and it must also be remembered that Stoliczka's figures were not only inverted (and therefore generally misinterpreted) but represented mere fragments that might be held to be incapable of identification. Yet Stolley, who re-examined Stoliczka's originals (in Vienna), was right in including the present species and the slightly shorter and more inflated *H. tibeticus*, described below, in the genus *Hibolites* and in considering them to be closely related to *H. lagoicus* (Boehm), *H. windhouweri*, Stolley, *H. brouweri* and *H. verbeeki*, Kruizinga. Unfortunately, the many fragments now before me, from several localities, are not in a better state of preservation than Stoliczka's type (fig. 3) at a corresponding size (e.g., No. K. 24-757c) and there is only a single phragmocone in a cylindrical guard, embedded in matrix, which has an alveolar angle of 19°, but cannot definitely be assigned to this species. On the other hand, there are many smaller examples, like those here figured, in a slightly better state of preservation and characterised by the same elongated smooth guard.

<sup>1</sup> *Loc. cit.*, p. 56; Pl. VIII, figs. 4a-c, etc., (1907).



distinctly flattened or depressed where it is spindle-shaped, cylindrical nearer the apex and towards the alveolar end. The ventral groove is not distinct in any one example; sometimes there is a mere crack (Plate III, fig. 3a), many are corroded (Plate II, fig. 1), most again are too short (Plate III, fig. 3e) to show this groove but the two lateral lines are visible in a number of the less weathered guards (Plate VI, fig. 5a).

Deformation in the rock, again, has caused an abnormal appearance in some (Plate III, fig. 3d) for the transverse fractures suggest that the curve is accidental, not pathological and some of the ammonites from the same beds are also deformed. In others again the weathering has made the apex as acute as in the form referred below to *H. windhouweri* and the identification of many of the belemnites listed below is therefore extremely doubtful.

*Horizon.*—Argovian (Upper Oxfordian), about *transversarius* zone.

*Localities.*—1, 3, 4 (near Burjianwala Laman), No. K. 23-701 (pars, 18 specimens), No. K. 24-738 (pars, 31 specimens), No. K. 24-739; 7a (near Talidhok), No. K. 24-755 (19 specimens); 8 (near Bagh Nilab), No. K. 24-757 (pars, 8 specimens); 10 (near Bata), No. K. 24-762 (pars, 16 specimens).

## 2. HIBOLITES TIBETICUS (Stoliczka).

(Plate V, fig. 3.)

1865. *Belemnites tibeticus*, Stoliczka. Geological Sections across the Himalayan Mountains, etc., *Mem. Geol. Surv. Ind.*, V, p. 79; Pl. VIII, figs. 5-6.
1910. *Dicoelites tibeticus* (Stoliczka). Uhlig, Fauna der Spiti-Schiefer, *loc. cit.*, p. 539.
1920. *Dactyloteuthis* (?) *tibetica* (Stoliczka). Bülow-Trummer, in Diener, Fossilium Catalogus, I, Pt. II, p. 100.
1925. *Hastites* ? *tibeticus* (Stoliczka). Lissajous and Roman, Répertoire alphabétique des Bélemnites jurassiques, etc., *Trav. Lab. Géol. Lyon*, Fasc. VIII, Mém. No. 7, p. 144.
1929. *Hibolites tibeticus* (Stoliczka). Stolley, Über ostindische Jura-Belemniten, *Pal. Timor*, Lief. XIII, No. XXIX, p. 213.

The original description was as follows:—

'A cylindrical guard, resembling *Bel. digitalis*. The surface is quite smooth, and on some of the small specimens two fine and only very short grooves near the point are indicated, others have slight and simple vascular impressions on the sides. On larger specimens nothing of either is usually visible, but the guard has on its upper portion a slight [ventral] groove and the shell becomes at the same time somewhat slender. The section is nearly round, sometimes a little compressed laterally. Nothing of the alveolus is seen on any of our specimens.'

Stoliczka thought that his species was closely allied to *B. semihastatus* figured by Zieten<sup>1</sup>, but since this, according to Lissajous and Roman<sup>2</sup> is only a young *Hibolites hastatus*, it may be assumed that the present form, indeed, differs from *H. budhaicus* merely in being shorter and plumper, as Stolley stated. The original of Stoliczka's fig. 6 may represent a distinct form, as Lissajous

<sup>1</sup> Die Versteinerungen Württembergs, Pl. XXII, fig. 4, (1830-33).

<sup>2</sup> *Loc. cit.*, p. 133, (1925).

and Roman suggested who (erroneously ?) compared it to a Liassic species. The type (fig. 5) is characterised by its circular section, smoothness and ventral groove and may thus be taken to differ from *H. verbeeki*, Kruizinga<sup>1</sup>, merely in being less hastate, *i.e.*, more cylindrical.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Localities*.—7 (near Talidhok), No. K. 24-754*b*; and 9 (near Bagh Nilab), No. K. 24-761*a*.

### 3. HIBOLITES aff. WINDHOUWERI, Stolley.

(Plate VI, figs. 4*a-d*.)

1907. *Belemnites* cf. *lagoicus*, G. Boehm. Oxford des Wai Galo, *Beitr. z. Geol. v. Niederländ. Indien*, I, 3, *Palæontogr.*, Suppl. IV, p. 57; Pl. VII, figs. 14-16.

1925. *Belemnopsis lagoicus* (Boehm). Lissajous and Roman, *Repertoire alphabétique des Bélemnites jurassiques*, *loc. cit.*, p. 104.

1929. *Hibolites windhouweri* (G. Boehm). Stolley, *Über ostindische Jura-Belemniten*, *loc. cit.*, p. 204; Pl. CCLVI (9), figs. 1-4 (non 5).

The fragments doubtfully referred to this form are distinguished from the associated *H. budhaicus* by a more pointed, more acutely conical shape and by a sub-circular cross-section. None is long or perfect enough to show grooves or lateral lines, but the figured example, at the upper end, has a somewhat sub-quadrate shape, with very slight flattening in a dorso-ventral as well as in a lateral direction. There is also slight excentricity of the apex which makes it probable that figs. 4*a, b* represent the lateral aspect, while fig. 4*c* is not at right angles to the other two. Stolley's fig. 2*b* seems to show the closest resemblance, but the fragments could, of course, also be matched by individuals of such European species as *H. semisulcatus* (Münster)<sup>2</sup> or *H. diceratinus* (Étallon).<sup>3</sup> These are of later age, while *H. lagoicus* (Boehm)<sup>4</sup> and the very similar *H. verbeeki*, Kruizinga, already mentioned, are less acute. Conversely *H. fusticulus* (Waagen)<sup>5</sup> is still more slender, but *H. stoliczkanus* (Waagen)<sup>6</sup>, again, is a closely allied species. Unfortunately there is not enough material of these species to appraise their real differences and the poor state of preservation of the Attock forms, of course, makes definite identifications impossible.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Localities*.—1 and 3 (near Burjjanwala Laman), Nos. K. 23-701*c-e*, and K. 24-738 (pars, 7 specimens); 7 (near Talidhok), No. K. 24-754*a*; 9 (near Bagh Nilab), No. K. 24-761*b*; 10 (near Bata), No. K. 24-762*c*.

<sup>1</sup> Belemniten uit de Jurassische Afzettingen van de Soela-Eilanden, *Jaarb. v. Mijnwezen*, Vol. XLIX (1920), Verh., p. 179; Pl. VI, fig. 1, (1921).

<sup>2</sup> See Zittel, *Fauna der älteren Cephalopoden-führenden Tithonbildungen*, *Palæontogr.*, Suppl., Pl. I (XXV), fig. 5, (1870).

<sup>3</sup> See Loriol and Bourgeat, *Études sur les Mollusques des couches coralligènes de Valfin*, *Mém. Soc. Pal. Suisse*, Vol. XIII, p. 37; Pl. I, figs. 1-4, (1886).

<sup>4</sup> *Loc. cit.*, p. 57; Pl. VIII, fig. 12 (lectotype), (1907).

<sup>5</sup> *Loc. cit.*, (Jurassic Fauna of Kutch), p. 9; Pl. I, figs. 2*a-e*, (1873).

<sup>6</sup> *Ibid.*, p. 10; Pl. I, figs. 1*a-f*.

4. *HIBOLITES* sp. nov. ? cf. *PLANOHASTATUS* (Roemer).

(Plate II, figs. 6a-c.)

1920. *Hibolites planohastatus* (Roemer). Bülow-Trummer in Diener, *Fossilium Catalogus*, I, pars 11, p. 150.1925. *Belemnopsis planohastatus* (Roemer). Lissajous and Roman. *Repertoire alphabétique des Bélemnites jurassiques*, *loc. cit.*, p. 122.

The deformed guard here figured is too corroded to show any diagnostic characters except the flattened shape; it seems to belong to a new form of *Hibolites* allied to Roemer's species, but there is no certainty that the flattening is not due to lateral compression rather than to ventro-dorsal depression. *Hibolites girardoti* (P. de Loriol)<sup>1</sup> is less depressed and more hastate but probably also closely allied; for if some other fragments before me (e.g., No. K. 23-701a) belong to the same species, then this must be interpreted as differing from *H. budharicus* merely in the greater depression of the guard, giving it an elliptical shape (fig. 6c) almost from the apex. No ventral grooves, however, not to mention signs of the alveolus, have been observed in any of the short Attock fragments.

Most of the latter could have been attached to the Portlandian *H. flemingi*, Spath<sup>2</sup>, which according to abundant new Madagascar material before me, has more flattened varieties than the type previously figured. If I am now attaching the present form to the earlier *H. planohastatus* and *H. girardoti*, it is done not only on account of the difference in age, but also because the figured example, although deformed, appears to be a far more extreme form than *H. flemingi*.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—1 (near Burjianwala Laman), Nos. K. 23-701a, b; 8 (near Bagh Nilab), No. K. 24-757a.

5. *HIBOLITES* (*HASTITES* ?) cf. *CLAVIGER* (Waagen).

(Plate V, figs. 4a-c.)

1920. *Hibolites claviger* (Waagen). Bülow-Trummer in Diener, *Fossilium Catalogus*, I, pars 11, p. 137.1927. *Hibolites* (*Hastites* ?) *claviger* (Waagen). Spath, *Revision of the Jurassic Cephalopod Fauna of Kachh*, *loc. cit.*, Pt. I, p. 17. (See there for synonymy.)1933. *Hibolites* (*Hastites* ?) *claviger* (Waagen). Spath, *Revision of the Jurassic Cephalopod Fauna of Kachh*, *loc. cit.*, Pt. VI, p. 664.

There is only a single corroded example of this form and the reference to Waagen's species is suggested merely by the club-shape. I have previously pointed out that Waagen's figure was restored and there is no justification for Stolley's<sup>3</sup> describing the type as having a depressed (or transversely-oval) sec-

<sup>1</sup> Étude sur les Mollusques et Brachiopodes de l'Oxfordien supérieur et moyen du Jura ledonien, *Mém. Soc. Pa. Suisse*, Vol. XXIX, p. 6; Pl. I, figs. 2-3, (1902).

<sup>2</sup> *Loc. cit.*, Kachh Revision, Pt. I, p. 13; Pl. I, fig. 2, (1927).

<sup>3</sup> *Loc. cit.* (Pal. Timor.), p. 201, (1929).

tion, as against the laterally flattened or compressed section of his doubtfully dated *H. boloides*.<sup>1</sup> In the Portlandian marls of Andranosamontana in Madagascar, *H. claviger* (No. 603a) and the more extreme *H. boloides* (No. 603b) occur together and they are both very slightly compressed laterally. But a *claviger*-like form (No. 608) occurs already in the Oxfordian of Marodaba (associated with *Metapeltoceras*) and this is indeed slightly depressed. Since, however, the two club-shaped forms of *Hibolites* I figured<sup>2</sup> from the Dhosa oolite of Kachh are again slightly compressed, there is no connection between shape of the cross-section and date of existence in this group and the typical *H. claviger* may occur in the Oxfordian as well as higher.

The narrowing of the guard at the upper end might be held to be due to the corrosion and beginning (?) exfoliation, but the outer layer seems to have been removed too symmetrically to make it probable that the *claviger*-like shape is accidental and that the fragment originally belonged to a more elongated guard like that of *H. brouweri*, Kruizinga.<sup>3</sup>

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—10 (near Bata), No. K. 24-762a.

## 2. Sub-family: DUVALINAE, Pavlow.

Genus: RHOPALOTEUTHIS, Lissajous, 1915.

### 1. RHOPALOTEUTHIS sp. nov.? aff. SPISSA (Gilliéron).

(Plate V, figs. 2a-d.)

1920. *Hibolites* (?) *spissus* (Gilliéron). Bülow-Trummer in Diener, Fossilium Catalogus, I, pars 11, p. 153 (with synonymy).

1925. *Rhopaloteuthis spissus* (Gilliéron). Lissajous and Roman, Répertoire alphabétique des Bélemnites jurassiques, *loc. cit.*, p. 138.

The example here figured has been deformed in the rock and is thus difficult to place, but the cross-section at the upper end is subquadrate, with distinct lateral flattening, as in *R. voironensis* (Favre)<sup>4</sup> which was taken by Lissajous to be identical with *Belemnites monsalvensis*, Gilliéron.<sup>5</sup> Since the cross-section of the latter, however, was stated by Lissajous<sup>6</sup> to have been represented as too square, it is possible that it is at least as close to the Attock form here discussed as is the more rounded *R. spissa*.

The guard is also slightly more club-shaped, as in *R. gillieronii* (Mayer)<sup>7</sup> which, however, is of earlier (Callovian) age, like the more stumpy *R. bzoviensis*

<sup>1</sup> *Ibid.*, p. 201; Pl. CCIV (8), figs. 10, 11.

<sup>2</sup> Revision of the Jurassic Cephalopod Fauna of Kachh, Pt. 5, Pl. CXIV, figs. 6a, b; Pl. CXXI, fig. 10, (1931).

<sup>3</sup> *Loc. cit.*, p. 176; Pl. V, fig. 1, (1921).

<sup>4</sup> Description des fossiles du terrain Jurassique de la montagne des Voiron, *Mém. Soc. Pal. Suisse*, Vol. II, p. 15; Pl. I, figs. 4-5, (1875).

<sup>5</sup> Aperçu géologique sur les Alpes de Fribourg en general et Monsalvens en particulier, *Mat. Carte Géol. Suisse*, Vol. XII, Pl. VIII, fig. 10, (1873).

<sup>6</sup> In Lissajous and Roman, *loc. cit.*, p. 111, (1925).

<sup>7</sup> See Lissajous and Roman, Description de quelques nouvelles espèces de Bélemnites jurassiques, *Trav. Lab. Géol. Lyon*, Fasc. X, *Mém. No. 7* (suppl.), p. 38; Pl. IV, figs. 8-11, (1927).

(Zeuschner).<sup>1</sup> As one of the cotypes of d'Orbigny's *Belemnites sauvanaus*<sup>2</sup> with a somewhat similar shape is also included in *R. spissa* it seems advisable provisionally to attach the Attock form to this species, although the restricted *R. sauvanausa* itself<sup>3</sup> is similarly clavate.

*Horizon*.—Argovian (Upper Oxfordian), about *transversarius* zone.

*Locality*.—3 (near Burjianwala Laman), No. K. 24-737.

#### LIST OF LOCALITIES WITH THEIR CEPHALOPOD FAUNAS.

Listing the fossils above described according to their localities, the following assemblages are obtained:—

*Locality 1*.—One mile 5° S. of E. from Burjianwala Laman (33° 39' : 72° 18', sheet 43c-6).

This locality has yielded many of the fossils here described, in addition to brachiopods and pelecypods to be dealt with by Miss Wood and Mr. Cox. The cephalopods are all marked as having come from the Lower Giumal beds, but even so they belong to two very distinct faunas. The following comprise the earlier assemblage, here referred to the Argovian (or Upper Oxfordian) and roughly corresponding to the *transversarius* zone:—

*Epimayaites polyphemus* (Waagen).

*Epimayaites* aff. *lemoini*, Spath.

*Perisphinctes orientalis*, Siemiradzki.

*Perisphinctes* cf. *indogermanus*, Waagen.

*Perisphinctes jelskii*, Siemiradzki.

*Biplices* aff. *de-riazi* (Siemiradzki).

*Pachyplanulites pralairei* (Favre).

*Dichotomosphinctes* cf. *orbignyi* (P. de Loriol).

*Dichotomosphinctes* sp. ind.

*Dichotomosphinctes* aff. *grossouvrei* (Siemiradzki).

*Dichotomosphinctes* sp. nov. ? aff. *waehneri* (Siemiradzki).

*Prososphinctes virguloides* (Waagen).

*Hibolites budhaicus* (Stoliczka).

*Hibolites* aff. *windhouveri*, Stolley.

*Hibolites* aff. *planohastatus* (Roemer).

The fossils came out of a calcareous (and generally glauconitic) sandstone, often full of belemnite fragments, but there is also one large fragment (No. K. 23-699) which seems to have a more uniformly fine-grained sandy matrix. Unfortunately this fossil is so worn as to be quite unrecognisable. I first thought that the ribbing of this fragment (which may not even have belonged to an ammonite) showed bifurcation at the umbilical border, as in *Peltoceratoides*, and I recorded this genus in my provisional account of the Attock faunas<sup>4</sup>, also *Mayaites maya*. Since both these determinations, however, are now corrected,

<sup>1</sup> See Lissajous and Roman, *Description de quelques nouvelles espèces de Bélemnites jurassiques*, *Trav. Lab. Géol. Lyon.*, Fasc. X, Mém. No. 7 (suppl.), p. 36 ; Pl. IV, figs. 4-6.

<sup>2</sup> *Paléontologie Française*, Terr. Jurass., p. 128 ; Pl. XXI, figs. 4-5, (1843).

<sup>3</sup> *Ibid.*, figs. 1-3 only.

<sup>4</sup> Spath, *loc. cit.*, Kachh Revision, Pt. VI, p. 803, (1933).

could even be held to come from a bed (unrecognised in the field) below the equivalent of the Spiti shales with the limonitic ammonites. The resemblance to the forms of the Neocomian beds of neighbouring areas is purely lithological, and further evidence is undoubtedly required.

*Locality 10.*—From a *nala* about one mile N. 35° E. of Bata. (33° 41' : 72° 2', sheet 43c-2).

The belemnites found at this locality include—

*Belemnopsis tangananensis* (Futterer)

*Hibolites budhaicus* (Stoliczka)

*Hibolites* aff. *windhouveri*, Stolley

*Hibolites* (*Hastites* ?) cf. *claviger* (Waagen)

and although many of the fragments are doubtful they indicate the same Argovian beds as those recorded above.

*Locality 11.*—East of Sujhanda, very close to the village (33° 45' : 72° 5', sheet 43c-1).

The five belemnite fragments from this locality are unfortunately small and quite unrecognisable. They are the only belemnites marked 'Upper Giumal beds' and they are associated with pelecypods and an indeterminable crushed echinoid, also fragments of echinoid radioles, in a more conglomeratic, calcareous sandstone or sandy limestone, weathering with an ochreous crust. They may be of Albian age like the ammonites from locality 12, for in the neighbouring Hazara Mountains similar belemnites, possibly *Neohibolites* but larger than any European Gault belemnites, occur together with Middle Albian ammonites.<sup>1</sup>

*Locality 12.*—About three furlongs south of Sujhanda.

The three ammonite fragments from this locality are described above as—

*Oxytropidoceras* aff. *roissyanum* (d'Orbigny).

*Oxytropidoceras* cf. *acutocarinatum* (Shumard).

There is no doubt about their Middle Albian age, but it is curious that no example of *Douvilleiceras* or *Lyelliceras*, so abundant in the corresponding beds of the Samana and Hazara ranges, has been collected. They are preserved in a more compact and more uniform, gray limestone, but one was oyster-coated and they must have been weathered out and picked up loose. There are not other fossils from exactly the same locality, though the Upper Giumal beds at other spots near the same village have yielded a number of pelecypods.

### PALAEONTOLOGICAL AND STRATIGRAPHICAL RESULTS.

It has been shown above that the cephalopods of the Attock district belong to three distinct faunas, the earliest of which is of Upper Oxfordian or Argovian age. Unfortunately the Argovian ammonites are all poorly preserved, but they mostly belong to species known in better examples from the Upper Dhosa oolite and the equivalent Kantcote ironstone of Kachh so that little could be added to our knowledge of these forms, except, perhaps, in the case of *Proso-*

<sup>1</sup> See Spath, *loc. cit.* (Fossil Fauna of the Samana Range), p. 62, (1930).

*sphinctes virguloides* (Waagen). This species has been widely quoted, but misinterpreted by most authors; and the illustration of some typical examples may prove useful. There are two or three Perisphinctids not yet recorded from Kachh, or indeed, from India, but they are forms closely related to the other species here described and their occurrence is of no palæontological significance.

It may be noted, however, that the commonest Perisphinctid is a Kachh species (*Prososphinctes virguloides*) and that the only other ammonites besides the Perisphinctids are two species of *Epimayaites*, also a Kachh genus that has not been found west or north of the area under discussion. It is known from Spiti and the Dutch East Indies, and may occur in Madagascar and the Salt Range, but the 'Polyphemus' Limestone of Baluchistan was named after one of the species here described by error, yielding in reality only true *Macrocephalites* of much earlier date.<sup>1</sup> With these distinctive Kachh elements represented, the Argovian ammonite fauna of the Attock district is thus undoubtedly more closely linked to that of the Indo-Madagascan Province than to that of the Mediterranean area. For even the Persian *Perisphinctes obliqueplicatus* and *P. alterneplicatus*, recorded by Fischer<sup>2</sup> are not identical with Waagen's Kachh species, as I have pointed out on previous occasions<sup>3</sup> and the few indifferent European Perisphinctids like *Dichotomosphinctes orbigny* (P. de Lorient) here listed, and also recorded from Kachh, might have been attached to local species or possibly described as new if available in complete specimens. It is true that as in the case of *Pachyplanulites pralairi* (Favre) from Attock, or of various Kachh Perisphinctids previously described, specific identity with common European or universal forms is suggested, but the Kachh fauna, in any case, includes no less than 70 per cent. of purely Indian or local elements.

The absence, from the Attock fauna, of such typical southern elements as *Phylloceras* and *Lytoceras*, and the occurrence of only two trachyostracous ammonite-groups, should not perhaps be unduly stressed, being merely negative evidence with the present, small, collections, but they support the view that the sometimes almost conglomeratic deposit was formed in a shallow epicontinental sea, not far from a coast-line, during a temporary transgression.

The belemnites from the same Argovian beds do not seem to agree with the evidence of the ammonites. First of all there is only a single individual of a *Belemnopsis* out of 120 specimens (and numerous fragments in the rock), whereas in Kachh, in the Dhosa oolite, *Belemnopsis* is at least as common as *Hibolites*. The species of the latter genus, also, are almost all of the *semisulcatus* group, not depressed, like most of the Attock forms, and the greatly flattened types are apparently altogether absent in Kachh. It is doubtful, however, whether this difference is of great importance; for the belemnites of the Dhosa oolite, although very plentiful, are always firmly embedded in the rock,

<sup>1</sup> See Spath, *loc. cit.* (Kachh Revision, Pt. VI), p. 808, (1933).

<sup>2</sup> Jura und Kreide aus Persien, *Beitr. Pal. Geol.-Österr. Ung.*, Vol. XXVII, pp. 240, 243; Pl. XX, figs. 3 and 7, (1915).

<sup>3</sup> Spath, *loc. cit.* (Kachh Revision, Pt. IV), pp. 409, 479, (1931).

rarely weathered-out like those here described, and no systematic collections have so far been made. Again, from the Kantcote ironstone, where they are in a far better state of preservation, or from the Belemnite marls of Jurun there are so far only few specimens and exact comparison of belemnite faunas is dependent on abundance of material. Moreover, the preservation of the Attock examples is such that identifications are mostly provisional and our knowledge of the two Himalayan forms (*B. budhaicus* and *B. tibeticus*), first described by Stoliczka from beds below the Spiti shales, but probably not from the Tagling limestone of the Spiti district, cannot be said to be anything like complete even now.

Yet it is probable that this difference is at least partly due to difference of facies. Some rock fragments before me, from locality 7a, are almost entirely made up of belemnite fragments, with a soft, glauconitic, marl in between, resembling a Cretaceous 'greensand'. Something like this is known from north-western Kachh, but there are no belemnites; on the other hand, the well-preserved forms from Kantcote are embedded in a pure, red, hæmatitic rock.

Now glauconite is a mineral which I believe to depend for its formation on long-continued action of sea-water, *i.e.*, slow deposition under the influence of currents in sediments probably never to be reduced to horizontality. It is known that it may determine the composition of a fauna, for Languine<sup>1</sup> has recently shown that in the Argovian of a certain region in the south-east of France, *Phylloceras* is particularly abundant at the two extremities where the beds are relatively thicker and very glauconitic; conversely *Ochetoceras*, not frequent at these two points, is numerous, with only a feeble proportion of *Phylloceras*, in the less glauconitic limestones elsewhere.

In Kachh again, although the Dhosa oolite may sometimes be conglomeratic and be succeeded by much younger beds, yet it always rests conformably on and merges insensibly into the *athleta* shales below, showing continuous deposition, whereas the corresponding Argovian beds of the Attock district (judging by the description of some of the fossils as either basal Giumal or uppermost Trias) are clearly transgressive after a long emergence of the land. Since the Argovian itself is immediately followed by the equivalents of the Spiti shales to be discussed presently, and since the few Upper Oxfordian deposits so far known from the Himalayan and Tibetan region also indicate merely temporary transgressions, it is probable that there was continuous submergence only in the south, *i.e.*, that the immigrants all came from the Indian Ocean or rather the Arabian Sea of the period.

The next higher assemblage unfortunately consists of only a few ammonites but they are all definitely recognisable and undoubtedly belong to species found only in the Lochambel beds of the Spiti shales. They are all of uppermost Tithonian or lowest Infra-Valanginian age, *e.g.*, from a narrow horizon at the limit of the Jurassic and Cretaceous and although they are limonitic (and, in one case, phosphatic) and different in preservation from the Argovian ammonites,

<sup>1</sup> *Loc. cit.* (*C. R. Acad. Sci. Paris*, Vol. 194), No. 7, p. 636, (1932).



above discussed, it appears that their bed has not been distinguishable in the field from that of the other 'basal Giumals'. The description as 'basal' alone suggests that the Argovian and Berriasian beds together are not of great thickness and since Albian ammonites apparently occur immediately above, the sequence must be extremely fragmentary.

While the affinity of this second fauna with that of the Lochambel beds of the Spiti area is undoubted, the three examples of *Oxytropidoceras* described as Middle Albian belong to a much more universal group. In fact they are referred to a French and a North American species, but as similar forms occur in many other European and African countries, in South America, and in Persia and India (Hazara) there is little significance in these specific names. In undescribed Persian collections before me, for example, these two species are associated with *O. sergipense* (White) and *O. trinitense* (Gabb), forms known from Brazil and Texas, and they are associated, as in those countries, with *Dipoloceras* while the occurrence of *Douvilleiceras* and other Middle Albian genera, as of the Upper Albian *Mortoniceras*, *Prohysterocheras* and *Elobiceras* shows that the Albian (and indeed the whole of the Cretaceous) succession in Persia is far more continuous than that of either the Samana and Hazara Mountains, the intervening Attock district, or of any Himalayan area so far explored. The Albian ammonites were therefore also probably immigrants from the southwest and judging by the fact that both at Samana and in the Hazara mountains, comparable forms are confined to a narrow band of rock, it is here again a case of merely temporary transgression.

Age and affinities of the three faunas discussed are thus definitely established. The extended Jurassic Mediterranean or Tethys was constantly in open communication across Persia with the Indian Ocean which was apparently already much as it is at the present day. In the area under discussion, as in the neighbouring districts, the submergence was always temporary and varied from place to place. For while it is possible that a Neocomian bed, below the Albian band, similar to the Belemnite beds of Samana or Thal has been overlooked at some or all of the Attock localities, there is apparently no equivalent of the Chidamu beds of the Spiti shales, although a *Virgatosphinctes* has been recorded from Hazara. Even the Spiti shales themselves illustrate the incompleteness of the Jurassic and Cretaceous record, for, even if they are separated by unfossiliferous beds, not recorded in literature, the Chidamu beds with Upper Kimmeridgian and Portlandian ammonites and the Lochambel beds with dominant *Spiticeras* and Neocomitids do not bridge the gap between the Jurassic and the Cretaceous as completely as appears at first sight.

According to Uhlig, a large number of his *Blansfordiceras*, probably ranging up to the base of the Cretaceous, came from the Lochambel beds; the specimens from Kuti came from the Upper and Middle Spiti shales; one example from Chojan was marked Middle Spiti shales. But the Portlandian *Hildoglochiceras* also was from the 'middle horizon' of the Spiti shales of Chidamu and Svikia, while undoubtedly Jurassic *Virgatosphinctes* were stated to be partly from the middle Spiti shales, partly from the lowest Chidamu beds.

Again *Oppelia* [*Gymnodiscoceras*] *acucinata* which, in Hazara, occurs together with *Virgatosphinctes frequens*, was found by A. v. Krafft in the 'middle and upper' Spiti shales of Kuti, whence came also some *Kossmatia* whereas others were from the 'middle stage' of Lochambelkichak. Of course, Uhlig himself directed attention to the desirability of ascertaining the exact horizon, within the Spiti shales, of the different elements of the fauna, but until this is done it seems to me that the discrepancies can only be explained by assuming that the few hundred feet of Spiti shales at the different localities do not include the same horizons, most of the successions, moreover, being probably incomplete. This fragmentary Jurassic is succeeded by an equally unrepresentative Cretaceous succession mostly unfossiliferous sandstones, with a maximum thickness of 300 feet, and compared to the European Flysch. Since this post-Spiti shales deposit represents the true Giurnal beds, it is of course clear that this name cannot be used for the Jurassic sediments of the Attock district.

I have previously spoken of the Chidamu beds as including the first (Upper Kimmeridgian to Portlandian) ammonites and resting unconformably on the Argovian Belemnite beds. But while '*Virgatosphinctes*' are like undoubted Upper Kimmeridgian forms in England and while *Perisphinctes biplicatus* (Uhlig) may belong to '*Pavlovia*' in the wider sense, as Ilovaïsky held, and resembles some ammonites I collected in the Portland sands of Dorset, there is an altogether inadequate representation of the many faunas known to exist between the Upper Kimmeridgian and the Spiti beds of the Lochambel stage. *Berriasella* itself is represented in the Spiti shales only by two doubtful fragments, comparable to the Neocomitid form here described (Plate VI, fig. 9), and significantly enough they are from 'Lochambelkichak, third stage', i.e., Cretaceous. There is no trace of the rich *Pronoceras*, *Substeueroceras*, and *Paradontoceras* faunas that in Mexico and South America occur in hundreds of feet of deposits whose position above the Portlandian and below the Spitioceratan dates them as undoubtedly Tithonian. The Upper Kimmeridgian and Portlandian, in England alone represent a thickness of a thousand feet and the succeeding Tithonian of, e.g., San Pedro de Gallo in Mexico ('Portlandien supérieur' of Burckhardt) includes up to 600 metres of deposits, not counting several hundred feet more of beds with '*Steueroceras*'.

When ammonite faunas are strictly homotaxial, if not contemporaneous, they show a remarkable similarity in widely distant areas. The San Vigilio fauna, occurring in similarly marmorised Lower Bajocian limestones in East Persia<sup>1</sup>, or the Italian Domerian faunas being found almost identical in Baluchistan<sup>2</sup>, the Speeton Valanginian ammonite fauna recorded from Uitenhage<sup>3</sup>, or the Lower Portlandian *Anavirgatites* fauna of Neuburg on the Danube discovered in Somaliland<sup>4</sup> are some examples. There is little or no evidence of any of these in the Himalayan region; nor is there anything like the magnificent

<sup>1</sup> In a collection from near Ravar, to be described in a future part of the *Pal. Ind.*

<sup>2</sup> See Spath, *Cretaceous Cephalopoda from Zululand, loc. cit.*, p. 272, (1921).

<sup>3</sup> Spath, On the Cephalopoda of the Uitenhage Beds, *Ann. S. Afr. Museum*, Vol. XXVIII, Pt. II, pp. 131-157, (1930).

<sup>4</sup> Hunterian Museum Monographs, Vol. I, p. 162, (1925).

development of all the Cretaceous formations in south-western Persia, even in Tibet. The Jurassic sequence in the Himalayan 'geosyncline' compares very unfavourably with that of Kachh, admittedly of neritic, marginal, facies.

For exact correlation it is necessary to compare only strictly homotaxial or contemporaneous formations. Now the Jurassic and Cretaceous in the Attock district includes disconnected portions of the Argovian, 'Berriasian' and Albian, of unknown but slight thickness, since they were all mapped in the field as Giumal beds. In the neighbouring northern part of Hazara the Spiti shales and succeeding (true) Giumal beds and Albian band, together only vary from 36-210 feet, following also directly on Trias (or so-called 'Trias'); but in the southern part which almost adjoins the district under discussion, the sequence is still more interesting. For the beds between the 'Trias' and the Nummulitic limestone form a heterogeneous mixture of about 300 feet of 'Giumal' sandstones and shelly limestones, sometimes crowded with *Trigonia*. Judging by Middlemiss's account<sup>1</sup> this succession again includes Argovian beds (with the inocerami and belemnites of the basal Spiti shales), an equivalent of part of the middle Spiti shales (with *Gymnodiscoceras acucinatum* and *Virgatospinectes frequens*), also undoubtedly Cretaceous beds with a thin Albian band at the top. In the Samana range, as has recently been shown by L. M. Davies, the lower beds are not exposed or at least not explored, but they certainly indicate a greater thickness down to the 'Trias' than in the areas just discussed, but as they have only yielded (near the top) a *Rhynchonella*, doubtfully referred to the Callovian, they are probably earlier than the three faunas here described. The succeeding black Samana Suk limestone, from 400 to 500 feet thick, I have previously stated to occupy about the position of the Spiti shales, since it is followed by a Neocomian belemnite bed of a thickness of 30-50 feet. The latter is assumed to be of the same age as a similar glauconitic bed on Kadimak mountain, near Thal, thirty miles to the west. And as this has yielded *Olcostephanus* aff. *astierianus* (d'Orbigny), ascribed to the Lower Hauterivian, it is clear that, even if the Samana Suk limestone exactly correspond to the 500 feet of Spiti shales at Giumal, it includes only a feeble representation of the Upper Jurassic.

The thickness of the Jurassic in the Salt Range has also been estimated at only 500 feet<sup>2</sup> and there (in the west) it certainly includes equivalents of the *macrocephalus* shales and Golden Oolite of Kachh, so similar in all respects that the ammonites cannot be distinguished in hand specimens. The Upper Jurassic portion, partly even carbonaceous and certainly neritic, must be extremely incomplete and the Cretaceous (Neocomian) beds in the western part of the range were found by Koken<sup>3</sup> to rest unconformably on eroded *Nerinea* beds, apparently of mid-European facies. According to this author there is neither Jurassic nor Cretaceous in the eastern part of the Range. The few Jurassic ammonites known from the Karakoram and other localities in Central

<sup>1</sup> The Geology of Hazara and the Black Mountain, *Mem. Geol. Surv. Ind.*, XXVI, p. 32, (1896).

<sup>2</sup> Wynne, Geology of the Salt Range in the Punjab, *op. cit.*, XIV, (1878).

<sup>3</sup> Kreide und Jura in der Saltrange, *Centralbl. f. Min.*, etc., p. 442, (1903).

Asia which I discussed in connexion with the Kachh fauna are of *Callovian* age and there is no reason for assuming the Spiti shales, which certainly have a much wider extension to the east into Tibet and as far as Sikkim, to be more representative there than in the Spiti or Niti areas. In the exotic blocks of Malla Johar, supposed to have been derived from much farther in the north, in Tibet, there has again been found a Lower Liassic ammonite fauna indistinguishable from that of Adneth in the Salzburg Alps, another case of homotaxis. But the lithological resemblance is probably due merely to similar action of igneous activity and local metamorphism. Corresponding red beds with abundant *Phylloceras* in the northern Alps, even if we concede them to be as abyssal as Waehner<sup>1</sup> thought, may represent but a very small portion of the whole Jurassic.

Now Uhlig<sup>2</sup>, when endorsing Waagen's views as to the difference between the Kachh and Spiti Jurassics, stated that the marine deposits in the Himalayas were uninterrupted from the Triassic into the Cretaceous. He considered the Upper Jurassic of the Himalayan series, even if composed of terrigenous sediments, to be 'bathyal' to a greater extent than the more neritic deposits of Kachh. This view, however, seems to me debatable and the very opposite might, perhaps, be claimed. I have shown that, in Kachh, there is not only similarity of facies throughout and absence of cycles of sedimentation, but a succession from at least the Bathonian to the Argovian, *i.e.*, through some 1,800-2,000 feet of deposits, so continuous as to serve as a standard for universal comparison. There is nothing like this known in the whole of the Jurassic of the Himalayan so-called geosynclinal area, and the Cretaceous compares more unfavourably still, even with that of England. *Phylloceras* and *Lytoceras*, Haug's two characteristic 'stenothermal' ammonites, occur throughout in Kachh, and even in the Umia ammonite bed, with coarse quartz grains and glauconite, they are commoner than in the Spiti shales. These have yielded ammonites in abundance, but only a few examples of a single species of each of these two genera, while in the Tithonian and Lower Cretaceous of the Mediterranean troughs farther west *Phylloceras* and *Lytoceras* simply swarmed.

Of course it is possible that more detailed knowledge of the extensive tract of Jurassic in southern Tibet may necessitate a modification of the views here put forward, but from present evidence it appears that the wide-spread Spiti shales do not differ from those of the Himalayan areas and that the varied congeries of neritic deposits below include nothing like the richly ammonitiferous Jurassic of Kachh, although at different times there may have been marine communication with the Karakoram and Bokhara region to the west.

Apart, perhaps, from the few Lower Liassic ammonites known in the derived blocks of Malla Johar there is not a single Himalayan Jurassic fauna that could be claimed as bathyal and there is not anywhere a succession—quite distinct from the mere quantity of sediment—that could be claimed as having been formed in a geosyncline in Haug's sense, or that even denotes a general trough

<sup>1</sup> Aus der Urzeit unserer Kalkalpen, *Zeitschr. Deutsch. Öst., Alp. Ver.*, Vol. XXII, p. 108, (1891).

<sup>2</sup> *Loc. cit.* (Fauna der Spiti-Schiefer), p. 588, (1910).

of sedimentation throughout Jurassic and Cretaceous times. During the Argovian, an enlarged Persian Gulf covered parts of south-western Persia and probably was in open communication with the Mediterranean to the west, across Syria and Asia Minor.<sup>1</sup> It is known that Afghanistan formed part of the ancient Angaraland to the north, while thick deposits accumulated in Kachh and Rajputana, along the sinking western margin of the landmass of Peninsular India. The temporary transgressions of the Argovian sea into the Attock and neighbouring areas must thus have taken place from a trough of deposition on the site of the present Indus plains. The Argovian belemnite beds at the base of the Spiti shales were probably also formed during a transgression of this same sea in a northerly and easterly direction. But the incursion of the sea into the Himalayan area was only very temporary. For the next higher Chidamu beds, following on the Argovian, are of much later age and there is no evidence that this gap is only apparent and really represents an abyssal interval. In any case the whole of the Spiti succession only covers part of the Upper Jurassic and Lowest Cretaceous and in spite of occasional slight metamorphism, natural in a formation in this zone of tectonic disturbance, it is no more of a deep-water deposit than the comparable bituminous Upper Lias shales of Whitby. They contain exactly the same type of nodule, a compact black rock, with occasional pyritisation; there is the same absence of many groups of fossils, although ammonites are predominant throughout. No liquid bitumen has been found, so far as I know, in the Spiti shales cementstone nodules, and no reptiles and fishes have been recorded, but they represent the same comparatively shallow-water sediment accumulating under Black Sea conditions as other black shales in far more thoroughly explored areas. If it is further remembered how minute by comparison is the trough in which the far more representative Jurassic sediments across England were deposited and how ancient were some of the major features determining the shape of this trough, it will be seen how speculative is the assumption of a Himalayan 'geosyncline'. The heterogeneous Mesozoic sediments, far from being excessive, are below the average of those formed in European epicontinental areas, and there is no sign of an oceanic deep as visualised by Haug.<sup>2</sup>

From a study of the Jurassic deposits so far known and the close affinity of, for example, the ammonite faunas of Kachh and the Salt Range or the Attock district, it is clear that there was not at any time during the Jurassic, except perhaps temporarily in the Callovian, a continuous arm of the Tethyan sea across Asia as indicated in Dacqué's<sup>3</sup> and Stefanini's<sup>4</sup> maps.

*Hildoglochiceras*, known only from the Spiti shales, Kachh, Tanganyika and Madagascar, *Bouleiceras* from Baluchistan and Madagascar, in addition to ele-

<sup>1</sup> See Krenkel? Der Syrische Bogen, *Centralbl. f. Min., etc.*, p. 277, (1924).

<sup>2</sup> The views expressed here are those of Dr. Spath. The hypothesis of a Himalayan geosyncline is not based on the consideration of Jurassic and Cretaceous beds only, but on a consideration of deposits from Cambrian times onwards; further, this hypothesis does not require that the conditions of deposition should have been bathyal throughout this vast length of time.—*Ed.*

<sup>3</sup> Der Jura in der Umgebung des lemurischen Kontinents, *Geol. Rundschau*, Vol. I, p. 164 (text-fig.), (1910).

<sup>4</sup> Molluschi e Brachiopodi calloviani del Caracorum, *Sped. Ital. de Filippi nell'Himalaia Caracorum e Turchestan Cinese*, Ser. II, Vol. VI, p. 17, (1913-14).

ments like the Mayaitids, already discussed, are in my opinion sufficient evidence for the distribution of seas in the Jurassic, but the Upper Cretaceous and Eocene flooding of Tibet may be due to the same subsidence that allowed the Cenomanian sea to enter the Ferghana region through Bokhara from the west.<sup>1</sup> The major trough of deposition, during the Jurassic was along the Indus Plain and thence to the east, where Grabau<sup>2</sup> assumed the existence of an old land undergoing erosion, and the geosyncline that was supposed to have migrated south probably never existed.

<sup>1</sup> Mushketov, The Tectonic Features of the East Ferghana and Alai Range, in Gregory, Structure of Asia, p. 165, (1929).

<sup>2</sup> Migration of Geosynclines, *Bull. Geol. Soc. China*, Vol. III, p. 157, (1924). From what has been said above and in Pt. VI of my Kachh work, it will be clear that I cannot accept either the Jurassic maps (Pl. VIII) or the account of the Cenomanian transgression given in Grabau's Stratigraphy of China, Vol. II, p. 519, (1928).

## ALPHABETICAL INDEX TO SPECIES.

	PAGE.
<i>Aulacosphinctes</i> sp. juv. cf. <i>proximus</i> (Steuer)	17
<i>Belemnopsis tanganensis</i> (Futterer)	21
<i>Berriasella?</i> sp. ind.	13
<i>Biplices</i> aff. <i>de-riazi</i> (Siemiradzki)	7
<i>Biplices</i> aff. <i>subrota</i> (Choffat)	7
<i>Biplices</i> sp. ind.	8
<i>Blanfordiceras</i> aff. <i>boehmi</i> (Uhlig)	16
<i>Blanfordiceras wallichi</i> (Gray)	15
<i>Dichotomosphinctes</i> aff. <i>grossouvrei</i> (Siemiradzki)	11
<i>Dichotomosphinctes</i> cf. <i>orbigny</i> (de Loriol)	9
<i>Dichotomosphinctes</i> sp. ind.	10
<i>Dichotomosphinctes</i> sp. nov. ? aff. <i>waehneri</i> (Siemiradzki)	11
<i>Epimayaites</i> aff. <i>lemoini</i> , Spath.	3
<i>Epimayaites polyphemus</i> (Waagen)	2
<i>Hibolites budhaicus</i> (Stoliczka)	22
<i>Hibolites tibeticus</i> (Stoliczka)	23
<i>Hibolites</i> aff. <i>windhoweri</i> , Stolley	24
<i>Hibolites</i> sp. nov. ? cf. <i>planohastatus</i> (Roemer)	25
<i>Hibolites</i> ( <i>Hastites</i> ?) cf. <i>claviger</i> (Waagen)	25
<i>Oxytropidoceras</i> cf. <i>acutocarinaratum</i> (Shumard)	20
<i>Oxytropidoceras</i> aff. <i>roissyanum</i> (d'Orbigny)	18
<i>Pachyplanulites pralairi</i> (Favre)	8
<i>Perisphinctes</i> cf. <i>indogermanus</i> , Waagen	5
<i>Perisphinctes jelskii</i> , Siemiradzki	6
<i>Perisphinctes orientalis</i> , Siemiradzki	4
<i>Prososphinctes virguloides</i> (Waagen)	12
<i>Rhopaloteuthis</i> sp. nov. aff. <i>spissa</i> (Gilliéron)	26
<i>Spiticeras</i> sp. ind.	17

## PLATE I.

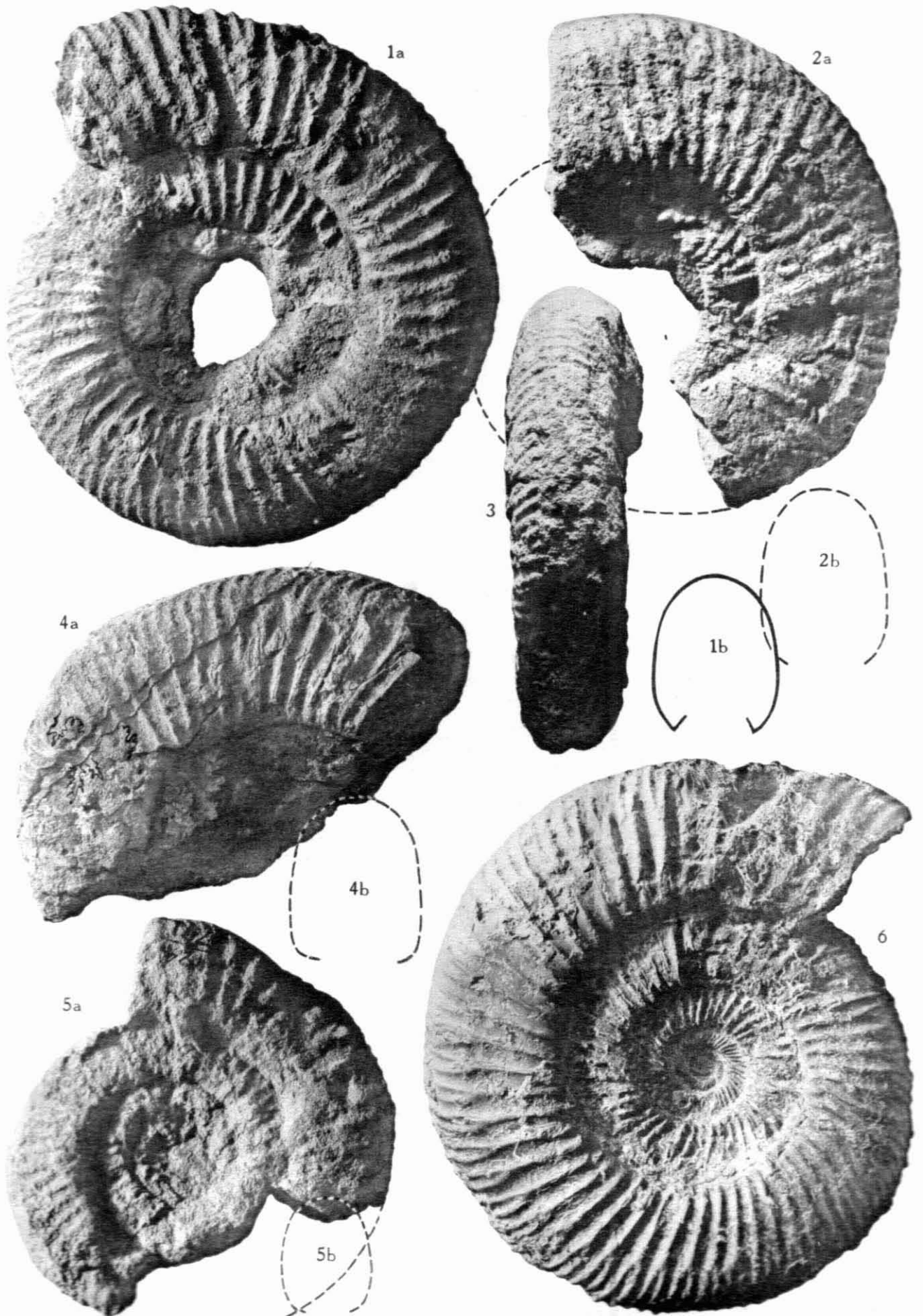
- Figs. 1a, b.** *DICHOTOMOSPINCTES* sp. nov. ? aff. *WAEHNERI* (Siemiradzki). Side view and outline whorl-section. Argovian, near Burjianwala Laman (Loc. 1). K. 23-690. Page 11.
- Figs. 2a, b.** *DICHOTOMOSPINCTES* sp. ind. Side view and outline whorl-section. Same horizon and locality (Loc. 1) K. 23-695a. Page 10.
- Fig. 3.** *PROSOSPINCTES* aff. *VIGULOIDES* (Waagen). Peripheral view of a poorly preserved example. Same horizon and locality (Loc. 5). K. 24-742a. Page 12.
- Figs. 4a, b.** *PROSOSPINCTES* aff. *VIRGULOIDES* (Waagen). Side view and outline whorl-section of a more involute variety. Same horizon and locality (Loc. 1). K. 23-697b. Page 12.
- Figs. 5a, b.** *BIPLICES* sp. ind. Side view and outline whorl-section. Argovian, near Talidhok (Loc. 7). K. 24-751a. Page 8.
- Fig. 6.** *PROSOSPINCTES VIRGULOIDES* (Waagen). Side view of Waagen's holotype (1875, Pl. XLIX, fig. 1) from the Argovian of Gangta Bét, Kachh. For peripheral view see Plate II, fig. 3. G. S. I., No. 2-71. Page 12.



AMMONITES AND BELEMNITES OF ATTOCK DISTRICT.

Geol. Surv. of India

Plate I.



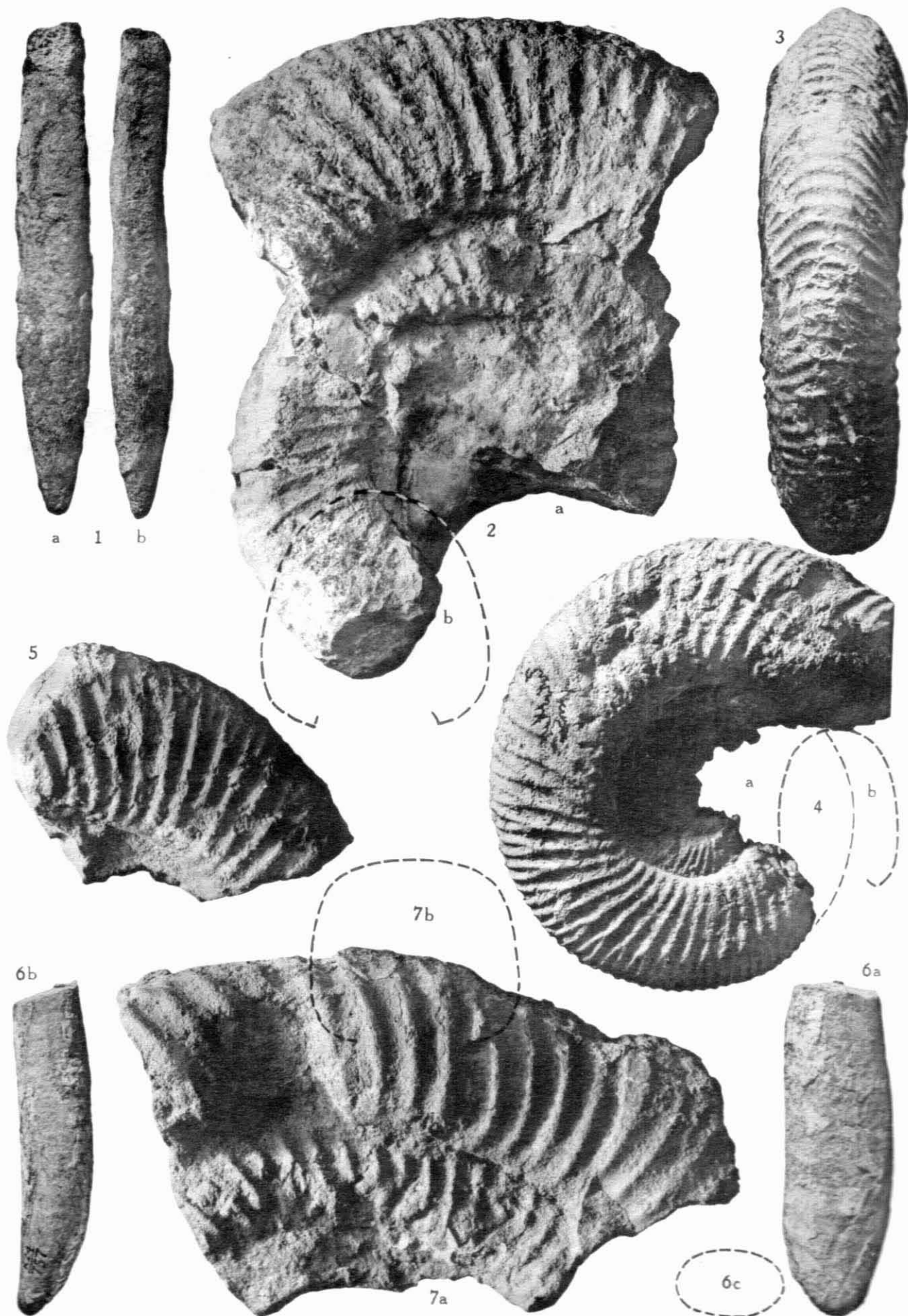
## PLATE II.

- FIGS. 1a, b.** *HIBOLITES BUDHAICUS*, Stoliczka. Ventro-dorsal and lateral views of a greatly corroded example. Argovian, near Bagh Nilab (Loc. 8). K. 24-757b. Page 22.
- FIGS. 2a, b.** *BIPLICES* aff. *DE-RIAZI* (Siemiradzki). Side view and outline whorl-section (restored, but probably too rounded peripherally). Argovian, near Burjianwala Laman (Loc. 1). K. 23-697i. Page 7.
- FIG. 3.** *PROSOPHINCTES VIRGULOIDES* (Waagen). Peripheral view of holotype; figured in Plate I, fig. 6. Page 12.
- FIGS. 4a, b.** *PROSOPHINCTES VIRGULOIDES* (Waagen). Side view and outline whorl-section of an example from near Burjianwala Laman (Loc. 1). Argovian. K. 23-693. Page 12.
- FIG. 5.** *DICHTOMOSPINCTES* cf. *ORBIGNYI* (P. de Loriol). Side-view of a doubtful fragment. Whorl-section similar to Plate I, fig. 4b. Argovian, near Talidhok (Loc. 7). K. 24-750b. Page 9.
- FIGS. 6a, b.** *HIBOLITES* sp. nov. ? cf. *PLANOHASTATUS* (Roemer). Ventro-dorsal and lateral aspects of a deformed guard, with sectional outline. Argovian, near Bagh Nilab (Loc. 8). K. 24-757a. Page 25.
- FIGS. 7a, b.** *BIPLICES* aff. *SUBROTA* (Choffat). Side view and outline whorl-section of a fragment from near Talidhok (Loc. 7). K. 24-750a. Page 7.

AMMONITES AND BELEMNITES OF ATTOCK DISTRICT.

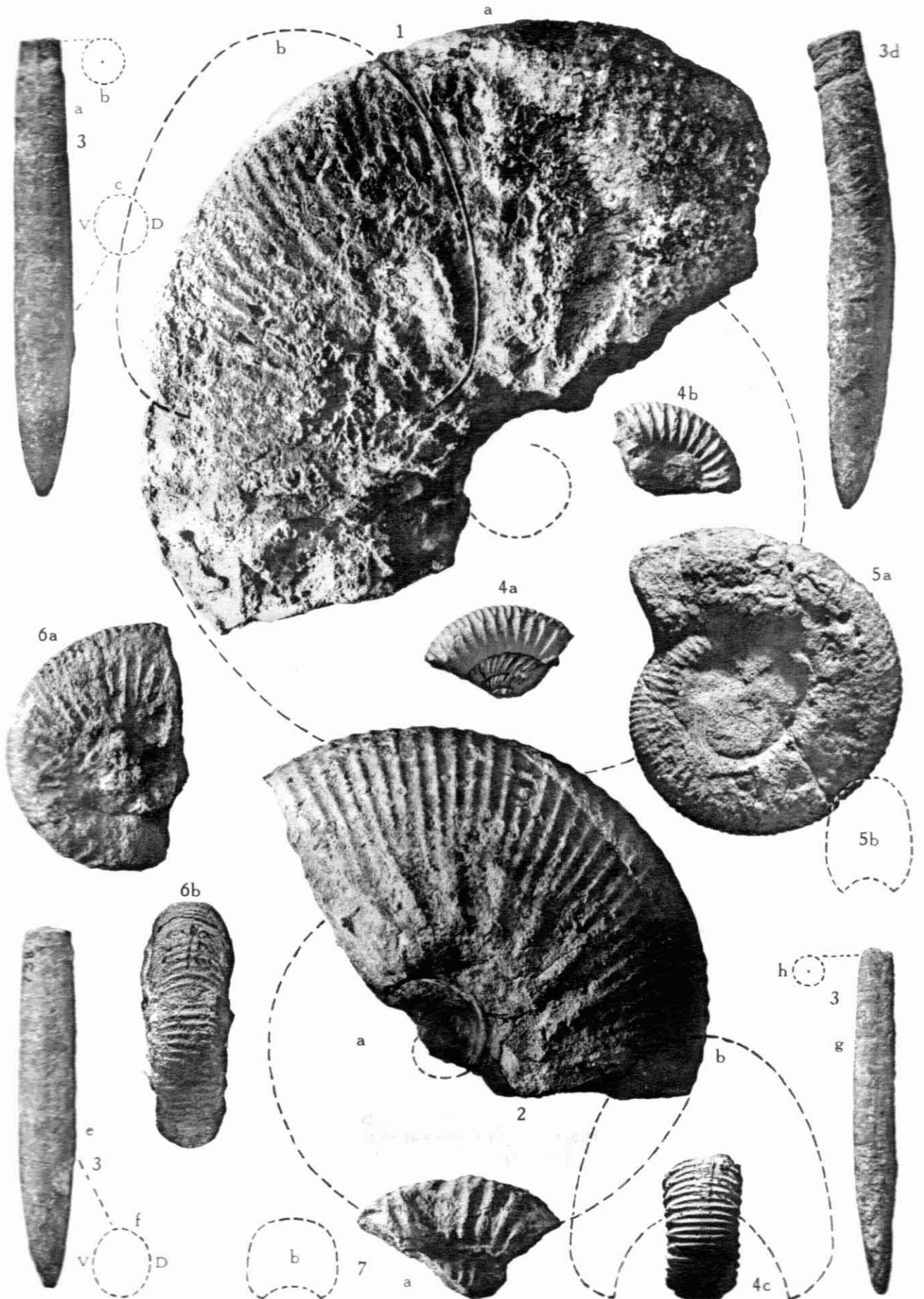
Geol. Surv. of India

Plate II.



### PLATE III.

- FIGS. 1a, b.** EPIMAYAITES aff. LEMOINI, Spath. Side view and outline whorl-section of a corroded fragment. Argovian, near Burjianwala Laman (Loc. 1). K. 23-694. Page 3.
- FIGS. 2a, b.** EPIMAYAITES POLYPHEMUS (Waagen). Side view and outline whorl-section of a fragment from the same horizon and locality (1). K. 23-698. Page 2.
- FIGS. 3a-h.** HIBOLITES BUDHAICUS (Stoliczka). Lateral views of four examples, corroded and partly deformed, with sectional outlines, showing ventro-dorsal flattening of thickest part. Argovian, near Burjianwala Laman (Loc. 3). K. 24-732a-d. Page 22.
- FIGS. 4a-c.** PACHYPLANULITES PRALAIRES (Favre). Two side and peripheral views of small fragment. Same horizon and locality (1). K. 23-695e. Page 8.
- FIGS. 5a, b.** DICHOTOMOSPHINCTES aff. GROSSOUVREI (Siemiradzki). Side view and outline whorl-section. Same horizon and locality (1). K. 23-692a. Page 11.
- FIGS. 6a, b.** DICHOTOMOSPHINCTES cf. ORBIGNYI (P. de Loziol). Side and peripheral views of a doubtful, small, example from the same horizon and locality (1). K. 23-695-h. Page 9.
- FIGS. 7a, b.** BIPLICES aff. SUBROTA (Choffat). Doubtful fragment from the Argovian of Bagh Nilab (Loc. 9). K. 24-759a. Page 7.



## PLATE IV.

- FIGS. 1a, b. PERISPINCTES ORIENTALIS, Siemiradzki. Side view and outline whorl-section.  
Argovian, near Burjianwala Laman (Loc. 1). K. 23-692b. Page 4.
- FIGS. 2a, b; 3a, b. PERISPINCTES aff. JELSKII, Siemiradzki. Side and peripheral views of two  
doubtful, immature examples. Same horizon and locality (1). K. 23-695c,  
f. Page 6.
- FIG. 4. PERISPINCTES JELSKII, Siemiradzki. Side view and restored outline whorl-  
section of a crushed fragment. Argovian, near Talidhok (Loc. 7). K.  
24-751c. Page 6.
- FIGS. 5a, b. PROSOSPINCTES VIRGULOIDES (Waagen). Side view and restored outline whorl-  
section of a crushed fragment. Same horizon and locality (7). K. 24-751b  
Page 12.

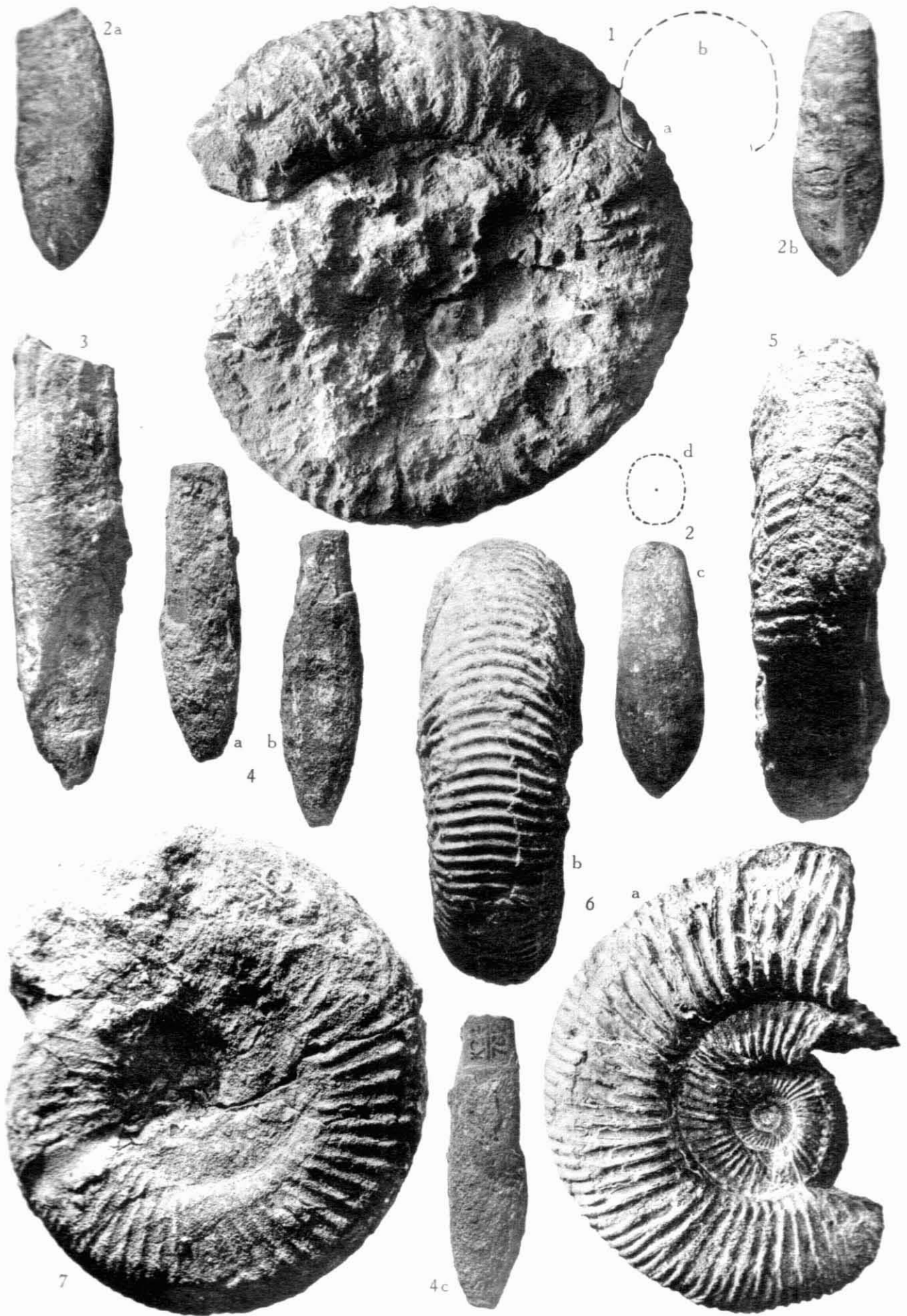




## PLATE V.

- FIGS. 1a, b. *PERISPINCTES* cf. *INDOGERMANUS* (Waagen). Side view and outline whorl-section of a worn example. Argovian, near Burjianwala Laman (Loc. 1). K. 23-695c. Page 5.
- FIGS. 2a-d. *RHOPALOTEUTHIS* sp. nov. ? aff. *spissa* (Gillieron). Three views and sectional outline of a deformed example. Argovian, near Burjianwala, Laman (Loc. 3). K. 24-737. Page 26.
- FIG. 3. *HIBOLITES TIBETICUS*, Stoliczka. Corroded fragment. Argovian, near Bagh Niaz (Loc. 9). K. 24-761a. Page 23.
- FIGS. 4a-c. *HIBOLITES* (*HASTITES* ?) cf. *CLAVIGER* (Waagen). Three views of a corroded guard. Argovian, near Bata (Loc. 10). K. 24-762a. Page 25.
- FIG. 5. *PERISPINCTES* cf. *INDOGERMANUS* (Waagen). Peripheral view of a badly corroded, doubtful, example. Argovian, near Burjianwala Laman (Loc. 1). K. 23-695d. Page 5.
- FIGS. 6a, b. *PERISPINCTES JELSKII* (Siemiradzki). Side and peripheral views of holotype [original of *P. martelli*, non Oppel: Waagen, Pl. LV, fig. 3, (1875)]. Argovian, Gangta Bét, Kachh. G. S. I., No. 2-89. Page 6.
- FIG. 7. *PROSOSPINCTES VIRGULOIDES* (Waagen). Corroded example from the Argovian near Burjianwala Laman (Loc. 1). K. 23-697a. Page 12.





## PLATE VI.

- FIGS. 1a, b.** *OXYTROPIDOCERAS* aff. *ROISSYANUM* (d'Orbigny). Side view and outline whorl-section of one, and part of external suture-line of a second, worn, fragment. Middle Albian, near Sujhanda (Loc. 12). K. 24-775a, b. Page 18.
- FIGS. 2a-c.** *OXYTROPIDOCERAS* cf. *ACUTOCARINATUM* (Shumard). Side view, outline whorl-section and external suture-line of a worn fragment. Same horizon and locality. K. 24-775-c. Page 20.
- FIGS. 3a-c.** *DICHTOMOSPHINCTES* aff. *GROSSOUVREI* (Siemiradzki). Two side and peripheral views of a deformed fragment. Argovian, near Talidhok (Loc. 7). K. 24-751g. Page 11.
- FIGS. 4a-d.** *HIBOLITES* aff. *WINDHOUWERI*, Stolley. Three views and sectional outline of a doubtful fragment. Argovian, near Bata (Loc. 10). K. 24-762c. Page 24.
- FIGS. 5a-d.** *HIBOLITES* *BUDHAICUS* (Stoliczka). Three views and sectional outline of a small example, with two lateral lines. Same horizon and locality. K. 24-762b. Page 22.
- FIGS. 6a, b.** *BLANFORDICERAS* *WALLICHI* (Gray). Side view and outline whorl-section. Uppermost Tithonian ?, near Burjianwala Laman (Loc. 1). K. 23-691. Page 15.
- FIGS. 7a-c.** *BLANFORDICERAS* aff. *BOEHMI* (Uhlig). Two side and peripheral views of a limonitic fragment. Lowest Infra-Valanginian ?, near Talidhok (Loc. 6). K. 24-749. Page 16.
- FIGS. 8a, b.** *SPITICERAS* sp. ind. Side view and outline whorl-section. Lowest Infra-Valanginian, near Burjianwala Laman (Loc. 1). K. 23-696. Page 17.
- FIGS. 9a, b.** *BERRIASSELLA* ? sp. ind. Side view and restored outline whorl-section. Uppermost Tithonian or lowest Cretaceous, near Bagh Nilah (Loc. 9). K. 24-760. Page 13.
- FIGS. 10a, b.** *AULACOSPHINCTS* sp. juv. cf. *PROXIMUS* (Steuer). Side and peripheral views. Uppermost Tithonian ?, near Burjianwala Laman (Loc. 1). K. 23-692d. Page 17.

