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JURASSIC CEPHALOPODA FROM MADAGASCAR

By L. F. SPATH, D. Sc., (Lond.), F. G. S.

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Harris Co.
Cornell University, Ithaca, N. Y.
U. S. A.

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INTRODUCTION

The collection of Madagascan cephalopods described in the following pages consists of some forty ammonites, two nautili, and two indeterminable belemnites, and the writer is indebted to Prof. J. Stansfield of the University of Illinois,[1] for entrusting him with the description of the material he collected.[2] The fossils evidently come from two sets of Upper Jurassic beds, and include a Callovian assemblage, preserved partly in a yellowish-brown limestone, partly as limonitic casts; further a Kimmeridgian series, the matrix of which is a glauconitic, sandy limestone of a greenish-grey colour. Six localities are represented and the specimens collected at each are listed and discussed in the concluding chapter of the present paper. Some of the ammonites have already been referred to in connection with descriptions, by the writer, of Jurassic faunas of Kachh, India, and of Somaliland, and while it will not be necessary again to go into a detailed comparison of the Jurassic ammonites of Madagascar with those of the African continent and of India, a discussion of the Madagascan forms described by Lemoine[3] and Newton[4] may prove of interest.

[1] Now of Montana State School of Mines, Butte, Montana.

[2] See Amer. Jour. Sci., Fifth Ser., vol. X, 1925, p. 1.

[3] "Ammonites du Jurassique Supérieur du Cercle d'Analalava (Madagascar)." Paléontologie de Madagascar, VIII. Annales de Pal., vol. V, 1910, pp. 1–32, pls. I–V; vol. VI, 1911, pp. 33 52, pls. VI–VIII.

[4] "Notes on Fossils from Madagascar, &c." Appendix to Baron: "Notes on the Geology of Madagascar." Quart. Journ. Geol. Soc., vol. XLV, 1889, p. 334. Also: "On a Collection of Fossils from Madagascar, &c." Ibid., vol. LI, 1895, p. 78.

II

SPECIFIC DESCRIPTIONS

A. ORDER AMMONOIDEA

Family *PHYLLOCERATIDÆ*, Zittel

Genus *PHYLLOCERAS*, Suess

Phylloceras aff. **disputabile,** Zittel

1852. *Ammonites tatricus,* Kudernatsch (*non* Pusch): "Die Ammoniten von Swinitza." Abhand. K. K. Geol. Reichsanst., vol. I, part 2, pl. I, figs. 1–4.

1869. *Phylloceras disputabile,* Zittel: "Bemerkungen über *Phylloceras tatricum* Pusch sp. und einige andere *Phylloceras*-Arten." Jahrb. K. K. Geol. Reichsanstalt, vol. XIX, pt. 1, p. 63.

This species is represented by an example (No. 7) of only about 40 mm. in diameter, somewhat corroded, but showing the suture-line, striation, and characteristic constrictions. In whorl-shape the example agrees more with the Tanganyika specimen figured by Dacque [1] than with the Kenya form, recorded by the writer as *Phylloceras* cf. *disputabile.*[2] Of Waagen's [3] Kachh examples, in the synonymy of which erroneous reference is made to Kudernatsch's figs. 4–6 of pl. I (= *Phylloceras kudernatschi,* Zittel, pars.), probably only one specimen, namely the original of pl. VI, fig. 3, can be attached to the present species. Through the kindness of Dr. E. H. Pascoe, Director of the Geological Survey of India, I have been able to study not only Waagen's types but some well preserved additional Kachh *Phylloceras* of the group to which *Ph. disputabile* belongs. Pending detailed description of these it may be briefly mentioned that the species represented by Waagen's figs. 1–2 differs from the typical *Ph. disputabile* in showing greater compression and more numerous constrictions which in the not very successfully drawn original of fig. 1 are wider than in the example of fig. 2. The constrictions are also more conspicuous across the venter in this flattened form than in the original of Waagen's fig. 3, and

[1] "Dogger und Malm aus Ostafrika." Betr. z. Pal. & Geol. Osterr.-Ung., vol. XXIII, 1910, p. 34, pl. V, figs. 3a–c.

[2] "On Jurassic Ammonites from East Africa, &c." Geol. Mag., vol. LVII, 1920, p. 318, pl. V, figs. 4a–d.

[3] "Jurassic Fauna of Kutch." I Cephalopoda. Mem. Geol. Survey India, Pal. Indica, Ser. IX, No. 2, 1875, p. 31, pl. VI, figs. 1–3.

the striation is finer. There are transitional forms, however, including the two *Phylloceras disputabile* recorded by myself [1] from bed No. 4 (of the Lower Chari Group) at Khera, Kachh, and it seems inadvisable at the present stage, to separate the two forms.

A second specimen (No. 1) in the present collection, rather poorly preserved, probably belonging to the flattened and more finely costate type above referred to, may be identical with the Madagascan form described by Lemoine [2] as *Phylloceras lodaense,* Waagen. In the Indian types of the latter species, the course of the radial line is far more sigmoidal.

Localities and Horizon. Ankidabé (localities I and II), Callovian, *macrocephalus* zone.

Phylloceras, sp. ind.

1910. *Phylloceras* sp. du groupe de *Ph. mediterraneum,* Neumayr; Lemoine: "Ammonites Jurassiques d'Analalava." *Loc. cit.,* p. 4, pl. I, fig. 4.

A small fragment of a cast (No. 28) without striation but a typical, deep rursiradiate constriction, probably belongs to the "Upper Oxfordian" form described by Lemoine as being extremely close to *Ph. mediterraneum* of the Callovian. Waagen's Indian examples [3] which are before me, together with other Kachh specimens, are probably not identical with the later species here discussed, as stated already by Lemoine. On previous occasions [4] I expressed

[1] "On the Blake Collection of Ammonites from Kachh, India." Mem. Geol. Survey India, Pal. Indica, New Series, vol. IX, No. 1, 1924, p. 22.

[2] "Ammonites du Jurassique Supér. d'Analalava." Pal. de Madagascar, VIII. Annales de Pal., vol. V, fasc. 4, 1910, p. 5, pl. I, fig. 2.

[3] Loc. cit. (1875), p. 34, pl. V, figs. 1a, b; pl. VII, figs. 3a–c.

[4] "Jurassic Ammonites from Jebel Zaghuan (Tunisia)." Quart. Journ. Geol. Soc., vol. LXIX, 1913, p. 561. Also: Geol. Mag. (loc. cit. 1920), p. 320.

doubt whether *Ph. mediterraneum* really persisted from the *macrocephalus* zone to the uppermost Jurassic, as is generally assumed. The present material, however, is insufficient for comparison with the Argovian forms recorded by de Riaz [1] and myself and the Kimmeridgian fragment described and figured by Canavari.[2]

Locality and Horizon. Antsalova, Kimmeridgian.

Family *HECTICOCERATIDÆ,* Spath [3]

This family is taken to include the genera *Hecticoceras,* Bonarelli (genotype: *Ammonites hecticus,* Reinecke, 1818, Mar. Prot. Naut. et Argon., &c., pl. IV, fig. 37) and *Lunuloceras,* Bonarelli (genotype: *Ammonites lunula,* Zieten, 1830, Verst. Würt., pl. X, fig. 11). The latter is earlier than *Hecticoceras* and cannot therefore be considered to be a subgenus of *Hecticoceras.* The genus *Brightia,* Rollier (genotype: *B. nodosa,* Quenstedt sp. = *Ammonites hecticus nodosus* Quenstedt: Amm. d. Schwäb. Jura, 1887, pl. LXXXII, fig. 10) also belongs to this family, further *Hecticoceratoides,* Spath (genotype: *H. suborientalis,* Spath = *Oppelia orientalis,* Waagen, *non* d'Orbigny sp.; Pal. Indica, 1875, pl. XI, fig. 5). This was described as probably a development of the "*subpunctata* [4] group of *Hecticoceras*" and since the latter genus must now be restricted to the group of evolute forms with typical *hecticus* ornamentation, it is necessary to separate with a new name: KHERAITES gen. nov.,[5]

[1] "Description des Ammonites des Couches à *Peltoceras transversarium* de Trept (Isère)." 1898, p. 40, pl. XVI, figs. 9, 10.

[2] "Fauna degli Strati con *Aspidoceras acanthicum* del Mte. Serra." Pal. Ital., vol. II, 1896, p. 38.

[3] "The Ammonites." Part VII of J. W. Gregory's: "Somaliland." Monographs of the Hunterian Museum, Glasgow, 1924, p. 114.

[4] This name was used in error without being marked as new and explained.

[5] Genotype: *Harpoceras crassefalcatum,* Waagen, loc. cit. 1875, pl. XII, figs. 6, 6a.

the forms grouping themselves round "*Harpoceras*" *crassefalcatum*, Waagen, and K. SUBPUNCTATUS, sp. nov. (= "*Harpoceras*" *punctatum*, Waagen *non* Stahl sp., *loc. cit.* pl. XII, fig. 9). These latter forms, however, never lose the keel entirely, whereas *Hecticoceratoides* develops an almost subconcave periphery, with costation continuous across it, in the form of forwardly directed chevrons. The genus *Putealiceras* S. S. Buckman (genotype: *Ammonites putealis*, Leckenby, 1859, Quart. Journ. Geol. Soc., vol. XV, pl. II, fig. 3; S. S. Buckman: Type Ammonites, vol. IV, 1922, pl. CCXCVII) which includes such rectiradiate Kachh species as "*Harpoceras*" *trilineatum* Waagen,[1]

Genus *LUNULOCERAS* Bonarelli

Lunuloceras cf. **lunuloides** (Kilian)

1887. *Ammonites hecticus compressus*, Quenstedt: "Ammon. d. Schwäb. Jura," pl. LXXXII, figs. 31–32.
1911. *Hecticoceras lunuloides* (Kilian) Tsytovitch: "*Hecticoceras* du Callovien de Chézery." Mém. Soc. Pal. Suisse, vol. XXXVII, p. 70, pl. VIII, fig. 7 ?

Four immature examples (Nos. 19, 21–23) with smooth inner areas and fine and close crescents on the outer half of the sides may be tentatively referred to this species though it is very doubtful whether they are identical. The largest of the specimens has a diameter of only 16 mm.

Localities and Horizon. Ankidabé (localities III and IV), *anceps* zone ?

Genus *HECTICOCERAS*, Bonarelli

Hecticoceras, sp. juv. ind.

A small ammonite (No. 17) and the fragment of another (No. 17a) represent the inner whorls of forms like *Hecticoceras svevum* Bonarelli, as figured by Mlle. Tsytovitch.[2] The ventral area is still rounded and the keel is

[1] Loc. cit. (1875), p. 71, pl. XIII, figs. 2a, b.
also belongs to this family *Hecticoceratidæ*.
[2] Loc. cit. (1911), p. 51, pl. V, fig. 7.

hardly visible at the diameter of 14 mm., but the umbilicus is perhaps less open in the Madagascan examples than in the Württemberg types figured by Quenstedt.[1]

Locality and Horizon. Ankirihitra (locality V), Callovian, *anceps* zone ?

Family *BONARELLIDÆ*, Spath [2]

This family includes the genera *Bonarellia*, Cossmann (= *Distichoceras*, Munier-Chalmas; genotype: *B. bicostata* Stahl. sp. Corresp. Blatt. Württ. Landw. Ver., vol. VI, 1824, p. 49, fig. 9), *Horioceras*, Munier-Chalmas (genotype: *Amm. baugieri*, d'Orbigny, 1846, Pal. Franç., Terr. Jurass., p. 445, pl. CLVIII, figs. 5–7) and *Chanasia*, Rollier (genotype: *Hecticoceras chanasiense*, Parona and Bonarelli, "Faune du Callov. Inférieur de Savoie," Mém. Acad. Sci. Savoie (4), vol. VI, 1897, p. 134, pl. IV, fig. 2), also the new genus SINDEITES, gen. nov., proposed for a stock that has affinities with *Chanasia* as well as with *Hecticoceratoides*. Its resemblance to the latter is indicated by the inclusion, by Waagen, in his *Oppelia orientalis* (*non* Sowerby) of a doubtful, small, Kachh example (Waagen's fig. 6 of pl. XI, and figs. 8, 8a, b of pl. XII) which is distinguished from a new species of *Sindeites* before me, from Jessulmir, Sinde, India (B. M. No. C. 23545), chiefly by its rounded whorl-shape and retention of a keel. From *Bonarellia* and *Chanasia* the new genus differs in having more recticostate ornamentation and in not showing a subdivision of the lateral area into distinct inner and outer halves. The costation of the new form (and genotype) of *Sindeites* described below as *S. madagascariensis*, nov., almost resembles that of the outer whorl of *Peltoceratoides semirugosum* (Waagen).[3] In *Hecticoceratoides* also the

[1] Loc. cit. (1887), pl. LXXXII, figs. 3–5.

[2] Loc. cit. (Somaliland, 1924), p. 114. If it is considered that there was no need to change *Distichoceras* into *Bonarellia* (on account of supposed preoccupation by *Distichocera*, Kirby) the names *Distichoceratidæ* and *Distichoceras* will have to be substituted for *Bonarellidæ* and *Bonarellia* respectively.

[3] Loc. cit. (1875), p. 83, pl. XIV, fig. 1.

ribs are not rectiradiate and on the outer whorl at least they are not flattened as in the genera of the family *Bonarellidæ*.

Rollier [1] separated *Bonarellia* (including *Horioceras* as its supposed male), as an Oppelid stock, from *Hecticoceras* and its allies (comprising *Chanasia*) which were considered to be offshoots of a "Ludwigian" group. It is true that at least some of the Kachh forms comprised in Waagen's "*Oppelia subcostaria*" [2] (which I included in the genus *Alcidia*), are very close to *Chanasia* and thence to *Bonarellia*, but it seems more probable that *Bonarellidæ* are offshoots of *Hecticoceratidæ* (e. g. *Lunuloceras*). It also appears advisable to restrict the family to those genera in which the costæ show that peculiar flattening which is found again in the Lower Albian genus *Leymeriella* and to exclude del Campana's genus *Taramelliceras* (comprising the typically Callovian "*flexuosi*"), which with *Phlycticeras*, Haug, may be grouped in a family PHLYCTICERATIDÆ, nov.

Genus *CHANASIA*, Rollier

Chanasia, sp. juv. ind.

A small example (No. 20), fragmentary but well preserved and resembling similar limonitic casts from European localities, e. g., the "Ornatenthon" of Gammelshausen, Württemberg, can be attached to this genus. As its diameter is only 18 mm., specific determination is difficult, but *Ch. chanasiensis*, Parona and Bonarelli, above referred to, from the Callovian of Chanaz, Savoy, France, appears to be very close, though it is considerably less compressed.

Locality and Horizon. Ankidabé (locality IV), Callovian, *anceps* zone ?

[1] "Phylogénie des Ammonites." Eclogæ Geol. Helvet., vol. XVII, 1922, pl. XXII (table).

[2] Loc. cit. (1875), p. 48, pl. X, fig. 2, *non* fig. 1.

Genus *SINDEITES*, gen. nov.

Sindeites madagascariensis, sp. nov.

This form is based on a fragment (No. 24) showing only a portion of a septate whorl of 8.5 mm. height and 7 mm. thickness (fig. 6c, pl. I, magnified × 2) and less well preserved remains of the almost smooth next inner whorl. The sides are compressed, flattened; the whorl-section is subhexagonal, the venter subtabulate, with the median line elevated but not actually keeled. The ribs are almost rectiradiate, with distinct inner and outer tubercles and a median bulla, as indicated in fig. 6a, (pl. I). They are alternately long and short, the latter ending at the median tubercle. The outer portions of the ribs up to the peripheral clavus are flattened (see figs. 6a and 6d, pl. I). The suture-line is closely comparable to that of typical *Bonarellia* and of a new form of *Sindeites* (to be figured in the forthcoming Revision of the Jurassic Ammonites of Kachh) in which there is no trace of a keel, but costation across the ventral area as in *Kosmoceras* (pl. I, fig. 6b).

There is some resemblance to the form figured by Quenstedt [1] as *Ammonites* cf. *bipartitus*, Zieten, but its keel is distinct and the ribs have no median tubercle. On the other hand the vigorously ornamented *Hecticoceras fortocostatum*, Tsytovitch [2] from the Middle Callovian of the Hautes in the Jura, with a wide ventral area bearing three keels, appears to be a true *Hecticoceras*. The form referred by Petitclerc [3] as a variety *boginense* to *Hecticoceras hecticum* (Reinecke) also is not closely comparable to the form here described and, in any case, has a high keel.

Locality and Horizon. Ankidabé (locality IV), Callovian, *anceps* zone ?

[1] Loc. cit. (1887), pl. LXXXII, fig. 14.

[2] Loc. cit. (1911), p. 38, pl. II, figs. 10, 11.

[3] "Faune du Callovien du Department des Deux Sèvres." Contrib. à l'Etude des Terr. Jurass. dans. l'W. de la France, Vesoul, 1915, p. 26, pl. I, fig. 4, pl. XIII, fig. (4) 33.

Family *HAPLOCERATIDÆ* Zittel emend. Spath

Genus *HAPLOCERAS* Zittel

Haploceras elimatum (Oppel) Plate I, Figs. 1a–c

1868. *Ammonites elimatus*, Oppel; Zittel: "Cephalopoden der Stramberger Schichten," Pal. Mitteil. Mus. K. Bayer Staates, vol. II, pt. 1, p. 79, pl. XIII, figs. 1–7.
1924. *Haploceras deplanatum* (Lemoine, *non* Waagen) Spath: loc. cit., Pal. Indica, p. 6.
1924. *Haploceras elimatum* (Oppel) Spath: loc. cit. Monogr. Hunterian Museum, p. 160.

This form is represented by eight examples (Nos. 35–42) of which three are here figured. It seems probable that Lemoine's "*Lissoceras*" *deplanatum*[1] which was before him in a large number of specimens, is not identical with Waagen's Indian type. The latter is even more compressed than the figure,[2] whereas Lemoine considered the section of his Madagascan form to be very close to that of Uhlig's *Haploceras indicum*.[3] In the examples here described the umbilical border most decidedly marks the region of greatest whorl-thickness as in Zittel's Stramberg and Koniakau examples.

Locality and Horizon. Antsalova, Kimmeridgian.

Family *MACROCEPHALITIDÆ*, S. S. Buckman

Genus *MACROCEPHALITES* (Sutner MS.) Zittel

Macrocephalites aff. **madagascariensis,** Lemoine. Plate I, Fig. 7

1911. *Macrocephalites macrocephalus* (Rein.) race *noetlingi*, Lemoine, Ann. Pal. *loc. cit.*, p. 31, pl. III, fig. 3.
1911. *Macrocephalites madagascariense*, Lemoine, *ibid.*, p. 51.
1924. *Macrocephalites madagascariensis* (Lemoine) Spath: Pal. Indica, *loc. cit.*, p. 7.

The example (No. 2) of which the outline section is

[1] *Loc. cit.* (1911), p. 13, fig. 8 on p. 14.

[2] Waagen, loc. cit. (1875), pl. XI, fig. 9. (The inner whorl in fig. 9b is wrongly restored, i. e., too inflated.)

[3] "Fauna of the Spiti Shales." Mem. Geol. Surv. India, Pal. Indica, Ser. XV, Himalayan Fossils, vol. IV, fasc. 1 (1903), p. 21, pl. III, fig. 2.

here figured (pl. I, fig. 7) is completely septate and it is believed that the more rounded periphery shown in Lemoine's figure, as in all the Indian forms of the *formosus* group, characterises only the larger and outer whorls. In its whorl-section the present example closely resembles typical European examples of *M. macrocephalus* (Schlotheim), e. g. a Chanaz specimen in the British Museum (No. C. 10564).

Locality and Horizon. Ankidabé (locality I), Lower Callovian, *macrocephalus* zone.

Genus *PLEUROCEPHALITES*, S. S. Buckman

Pleurocephalites, sp. ind.

Five badly preserved examples (Nos. 3, 8, 12–14) seem to be referable to this genus, but exact identification is impossible. *Pleurocephalites folliformis,* S. S. Buckman [1] is more inflated. The largest of the Madagascan specimens has some resemblance to the Indian forms of the group of *Pl. ? grantanus* (Oppel) Waagen, and *Pl. ? chrysoolithicus* (Waagen),[2] but owing to its being crushed obliquely, and to its otherwise defective preservation, its identity with the other four examples must remain doubtful.

Localities and Horizon. Ankidabé (localities I [No. 3] and II [No. 8]) and Ankirihitra (Nos. 12–14). Lower Callovian, *macrocephalus* zone.

Genus *CATACEPHALITES*, S. S. Buckman

Catacephalites, sp. ind. Plate I, Figs. 3, 4

An example (No. 4) of which the whorl section is here figured (pl. I, fig. 4), unfortunately not well preserved, has costation resembling that of *Macrocephalites colcanapi* Lemoine [3] or of *Catacephalites durus,* S. S. Buckman.[4]

[1] Type Ammonites, vol. IV, 1922, pl. CCCXLVIII.
[2] Loc. cit. (1875), pls. XXXVI, fig. 6, and pl. XXX, fig. 1.
[3] Loc. cit. (1911), p. 33, pl. II, figs. 1, 2.
[4] Type Ammonites, vol. IV, 1922, pl. CCLXXXIII.

The suture-line represented in fig. 3, pl. I, was taken from a small example (No. 9) of only 13 mm. diameter, which has a similar whorl-section, but may not belong to the same species, and a third specimen (No. 11) is only a doubtful fragment.

Localities and Horizon. Ankidabé (localities I [No. 4] and II [No. 9]) and Ankirihitra (No. 11). Lower Callovian, *macrocephalus* zone.

Genus *KHERAICERAS*, Spath

Kheraiceras ? stansfieldi, sp. nov. Plate I, Figs. 2a, b

This species is based on a completely septate cast (No. 5) which may belong to a new genus, but is here attached to *Kheraiceras,* created [1] for the scaphitoid *Macrocephalites,* i. e. the so-called *bullati* of the Callovian. The type of *Kheraiceras* is *K. cosmopolita,* Parona and Bonarelli [2] (= *Stephanoceras bullatum,* Waagen *non* d'Orbigny sp.) and as the original example is now before me, it may be mentioned that Waagen's Indian form is even more depressed that Quenstedt's figures 21–23 of pl. LXXVIII ("*Ammonites platystoma,*" pars, *non* Reinecke) included in *K. cosmopolita* by Parona and Bonarelli, but that it has similar rectiradiate costation. In the Madagascan form, on the other hand, the ribs are very strongly prorsiradiate, the umbilical border is merely rounded, and the suture-line is extremely complex, finely divided, and interlocking, so that probably several distinct stocks within the *Macrocephalitidæ* produced these scaphitoid endforms that may eventually have to be separated. If the present form is now left in *Kheraiceras,* it is partly on account of insufficiency of comparable European material and partly because forms like *Kheraiceras ? platystomum* (Reinecke) [3] and *Kh. ? globulatum* (Quenstedt) [4] bridge the gap between the type of *Kheraiceras* and the present form.

[1] In Pal. Indica, loc. cit. (1924), p. 7.
[2] Loc. cit. (1897), p. 146.
[3] In Quenstedt, loc. cit. (1887), pl. LXXVIII, fig. 25.
[4] Ibid., fig. 2.

On the side of the Madagascan form *not* figured the remains of the umbilical suture of the (missing) outer whorl are visible, as indicated in fig. 2a, pl. I, by the white line. This is comparable to that shown in Quenstedt's fig. 1, pl. LXXVIII, but is even more eccentric. The suture-line is considerably more complex than that of *Kh. ? platystomum* (Reinecke) Quenstedt (pl. LXXVIII, fig. 25) and the saddles are deeply divided, whilst the second lateral lobe is less wide and the whole of the suture-line closely interlocking with the preceding and succeeding lines.

Kh. ? QUENSTEDTI, sp. nov. (= *Ammonites bullatus* Quenstedt *non* d'Orbigny [1]) also has a wider second lateral lobe and less individualized auxiliary elements of the suture-line, and a less strongly prorsiradiate costation, but comes close to the present species in whorl-shape. *Kh. ? globulatum* (Quenstedt) is much more inflated and differs in ribbing.

Excentrumbilicate shells somewhat similar to *Kheraiceras* were successively produced by *Sphæroceratidæ* and *Morphoceratidæ* in the Bajocian, and by *Tulitidæ* in the Bathonian (including the true *Ammonites bullatus* d'Orbigny) and correct identification of incomplete specimens is very difficult. The apertures of *Kheraiceras cosmopolita* and *Kh. ? quenstedt* have neither collar nor lip.

I have much pleasure in dedicating this species to Prof. J. Stansfield, its discoverer.

Locality and Horizon. Ankidabé (locality I), Lower Callovian, *macrocephalus* zone.

Family *PROPLANULITIDÆ*, S. S. Buckman, emend. Spath

Genus *GROSSOUVRIA*, Siemiradzki

Grossouvria, sp. ind. cf. **anomala** (Loczy)

? 1875. *Perisphinctes curvicosta* (Oppel) Waagen: Pal. Indica, *loc. cit.*, pl. XXXIX, fig. 5 (*non* 4–6).

1915. *Perisphinctes anomalus*, Loczy: "A Villanyi Callovien-Ammonitesek Monografiaja." Geol. Hungar., vol. I, p. 347, pl. VIII, figs. 8–11, pl. XIV, fig. 5.

A fragment (No. 10) is doubtfully referred to this

[1] Quenstedt, loc. cit. (1887), pl. LXXVII, figs. 7 and 8, as represented by a Neuffen specimen in the British Museum (No. 22366).

Lower Callovian form, but its mode of preservation is unsatisfactory. The rursiradiate character of the secondary costæ is pronounced but there are more single costæ than in Waagen's original of his fig. 5. It may be added that Loczy was misled by the incorrect drawings of Waagen's types. The three Indian forms are all different and only fig. 5 shows a peripheral aspect comparable to that of Loczy's fig. 10 (pl. VIII). The other two forms also differ considerably in whorl-section from the compressed form figured by Loczy (text—fig. 92, p. 346) as *Perisphinctes curvicosta.*

Locality and Horizon. Ankidabé (locality II), Callovian, *macrocephalus* zone?

Grossouvria ? cf. **waageni** (Teisseyre) Loczy sp.

? 1915. *Perisphinctes waageni,* Teisseyre; Loczy: Geol. Hungar., loc. cit., p. 356, pl. XIII, fig. 4.

A fragmentary example (No. 15), the whorl-section of which is figured (pl. I, fig. 10), may be tentatively attached to Loczy's *P. waageni* (*non* Teisseyre ?). Its umbilicus, however, may have been smaller since the outer whorl appears to have increased in thickness comparatively more rapidly. *Perisphinctes recuperoi* (Gemmellaro) Waagen [1] has finer secondary costation, also *P. waageni,* Teisseyre in Petitclerc.[2] The latter author's *P. cardoti,*[3] however, in coarseness of costation, resembles the form here discussed, but is too evolute and far too rounded-whorled.

Locality and Horizon. Ankirihitra. Callovian, *macrocephalus* zone ?

Grossouvria, sp. juv. ind.

1887. *Ammonites convolutus dilatatus,* Quenstedt: "Amm. des Schwäb. Jura," pl. LXXXI, figs. 1–9.

Three immature specimens (Nos. 18, 26, 27) probably

[1] Loc. cit. (1875), p. 172, pl. XLIII, fig. 1.
[2] Callovien des Deux Sèvres. II, 1915, pl. IX, fig. 1.
[3] Ibid., p. 64, pl. V, fig. 2, pl. XIII, fig. 2 (62).

belonged to forms of *Grossouvria* comparable to Quenstedt's species, but specific identification is impossible. The largest example has a diameter of only 16 mm. and is slightly more compressed and more closely costate than the smaller examples.

Localities and Horizon. Ankidabé (localities III and IV) Callovian.

Family *ATAXIOCERATIDÆ*, S. S. Buckman emend. Spath

Genus *TORQUATISPHINCTES*, Spath

Torquatisphinctes ? cf. bangei (Burckhardt) Plate I, Fig. 5

1921. *Perisphinctes* (*Aulacosphinctes*) *bangei*, Burckhardt: Faunas Juras. de Symon, &c. Bol. Inst. Geol. Mexico, No. 33, vol. II (Atlas), pl. IX, figs. 5–9.
1924. *Torquatisphinctes bangei* (Burckhardt) Spath: Pal. Indica, loc. cit., p. 15.

Four fragments of Perisphinctoid ammonites (Nos. 29–32), the whorl-section of one of which is here figured (pl. I, fig. 5), show great resemblance to the Mexican form from the Middle Kimmeridgian. Their reference to *Torquatisphinctes*, however, must remain uncertain. Some fragmentary *Lithacoceras*, another Middle Kimmeridgian genus, probably belonging to *L. ? andranosamontæ*, Lemoine, in the British Museum and included (with other forms) in Newton's *Perisphinctes polygyratus* (Reinecke),[1] are distinguished from the examples here described by their finer and tri- or multiplicate ribbing. Lemoine's "*Perisphinctes*" *colcanapi*,[2] with numerous constrictions, differs from the typical *Torquatisphinctes* and should perhaps be referred to *Subplanites* or to *Lithacoceras*, but is represented only by worn fragments (B. M. C. 3587a, C. 3580f).

Locality and Horizon. Antsalova, Kimmeridgian.

[1] Loc. cit. (Q. J. G. S., 1889), p. 334.
[2] Loc. cit., (1911), p. 43, pl. VIII, figs. 2a, b.

Family *PELTOCERATIDÆ*, Spath

Genus *PELTOCERAS*, Waagen

Peltoceras, sp. juv. ind.

A small fragment of a limonitic cast (No. 25) probably belongs to a form of *Peltoceras* but cannot be attached to any described species. The inner whorls of *Peltoceratoides,* at the same diameter are very finely costate. *P. madagascariense* Lemoine [1] does not belong to this genus, but is apparently an immature *Subdichotomoceras.* The fine and close costation of other small examples mentioned by the same writer and compared to *Amm. arduennensis,* d'Orbigny, and *A. eugenii,* Raspail, points rather to species of *Peltoceratoides.* On the other hand the same author's *Peltoceras* cf. *syriacum,* Noetling [2] may be close to the present form, though not Noetling's Argovian type [3] which like G. Boehm's *P. tjapalului* [4] is probably a *Peltoceratoides.* In the absence of outer whorls Peltoceratids are often difficult to distinguish.

Locality and Horizon. Ankidabé (locality IV), Callovian?

Family *SIMOCERATIDÆ*, Spath

Genus *HEMISIMOCERAS*, gen. nov.

This genus is established for the two Madagascan forms described below, *H. semistriatum,* nov. to be genotype. On a previous occasion [5] I referred to these forms as "peculiar (undescribed) Aspidocerates," but their resemblance to *Aspidoceratidæ* is probably quite superficial and based on the resemblances of the cross-section to that of typical

[1] Loc. cit. (1911), p. 14, pl. VII, fig. 2 (*non* 1!).
[2] Ibid., p. 15, pl. V, figs. 3a, b.
[3] "Der Jura am Hermon." 1875, p. 31, pl. V, fig. 3 only. The external saddle of this form is extremely wide and the suture-line differs also in the umbilical elements.
[4] "Beitr. z. Geol. v. Niederländ.-Indien." Pal. Suppl. (1904–7), pl. XXIX, figs. 2a–b, 3.
[5] Loc. cit. (Pal. Indica, 1924), p. 6.

forms of *Aspidoceras,* although there is also similarity in suture-line. *Sutneria,* another somewhat similar genus, though having a reduced suture-line, shows a change in ornamentation comparable to that noticed in the new forms here described, namely from merely costate or striate to tuberculate. Comparison with this genus is difficult, because both the Madagascan species are septate casts and there is no indication of a modified body-chamber. It seems possible, of course, that like *Sutneria* the new genus is an abnormal offshoot of some regular, perisphinctoid, stock, though here the resemblance ends. Both the new forms show peculiar, deep, prorsiradiate constrictions, especially where the striate ornamentation definitely changes to a tuberculate one. At the same time the whorl-thickness increases abruptly (after the deep constrictions). This points to affinity with *Simoceratidæ,* especially those early forms like *Pseudosimoceras,* Spath, which were at one time included in *Holcostephanus.* In a specimen of *Simoceras volanense* (Oppel) from Catria, Apennines (B. M. No. C. 8365) agreeing with the inner whorls of Zittel's [1] type-figure but in a better state of preservation, there can be seen the perisphinctoid inner whorls, resembling in ornamentation and whorl shape such a *Pseudosimoceras ?* as e. g. *"Perisphinctes acer"* (Neumayr). Peripheral tubercles, however, soon appear on the ribs and at a diameter of 15 mm. already, these become more blunt and distant, until finally (at 35 mm.) only very indistinct ribs but strong outer tubercles remain. The inner tubercles appear only at still larger diameters. The suture-line of *Simoceras volanense* does not show a dependent umbilical lobe, but other Simoceratids and especially *Pseudosimoceras* have suture-lines closely comparable to those of the forms here described. Since the present species, however, are quite unlike any forms previously described and so far are known

[1] "Fauna d. Alt. Cephalopoden-führenden Tithonbildungen." Palæontgr. Suppl. 1870, pl. XXXII, fig. 7.

in only two entirely septate specimens, the reference of the new genus to the family *Simoceratidæ* must remain tentative. For the same reason a Middle Kimmeridgian age is assigned to these forms merely on the strength of the associated ammonites.

Hemisimoceras semistriatum, sp. nov. Plate I, Figs. 8, b, text—Fig. 1

The holotype has dimensions 42–.30–.36–.45.[1] The inner whorls are depressed, subcoronate, with subtuberculate primary ribs and very faint and fine secondary ribbing across the broad and almost flat ventral area. Later the whorl-section becomes less depressed, with wider sides and longer primaries bearing a faint tubercle at the point of involution. Then the whorls become rounder, though remaining wider than high, the primary costæ almost disappear and only uniform single striæ remain, somewhat lytoceratid, with only at intervals a single tubercle near the ventral part of the lateral area (only developed on the side not figured). These tubercles remain and become increasingly conspicuous, whilst all striation disappears. The primary ribs, leading from the tubercles towards the umbilical suture, tend to reappear on the outer whorl.

The suture-line is characterized by its trifid lateral lobe and dependent umbilical lobe. Its saddles are less slender than those of the comparable suture-line of "*Perisphinctes*" *acer* Neumayr.[2]

[1] Diameter in mm.; whorl-height, thickness and umbilicus in percentages of the diameter.

[2] As figured in Canavari's: "Fauna d. str. con *Aspidoceras acanthicum* di Mte. Serra." Pal. Ital., vol. III (1897), p. 209, text—figs. 17, 18.

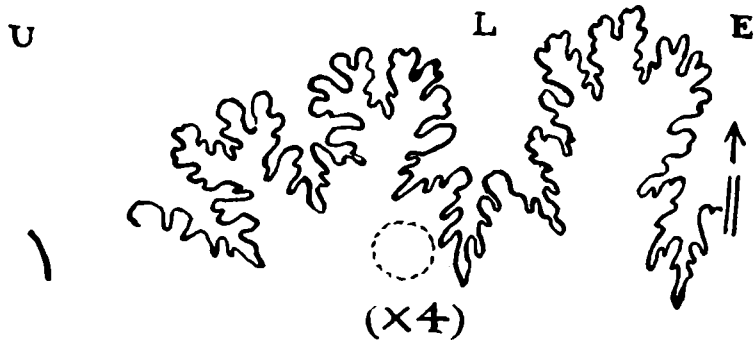


FIG. 1. *Hemisimoceras semistriatum*, gen. et sp. nov. Middle Kimmeridgian, Antsalova. Suture-line (× 4) near end of outer whorl. E = external lobe; L = lateral lobe; U = umbilical suture. (Compare fig. 8a, pl. I.)

Locality and Horizon. Antsalova, Kimmeridgian.

Hemisimoceras nodulosum sp. nov. Plate I, Figs. 9a, b

This species is closely allied to that last described but cannot be included with it. While whorl-shape and suture-line are very similar, the present species differs from *H. semistriatum* in showing a perisphinctoid type of ribbing to a diameter of 30 mm. where there is a deep constriction. The primary ribs then become distant and nodate at the outer ends, with four or five very faint secondaries to each, crossing the evenly rounded venter. The siphonal line is smooth on the last half-whorl. The costation of the earlier whorls resembles that of the forms of the *acanthicus* beds, figured by Canavari.[1]

Sutneria evoluta (Quenstedt) [2] had a flattened venter and if it is as close to *S. reineckeiana* as Quenstedt thought, its suture-line would be quite different from that of the present form. Costate forms of *Sutneria* like *S. galar*

[1] Loc. cit. (1897), pls. VII, VIII.
[2] Loc. cit. (1888), pl. CXII, fig. 19.

(Oppel), *S. cyclodorsata* (Moesch) de Loriol,[1] and *S. nusplingensis* Fischer[2] suggest that the stock here described is derived from quite a different branch of perisphinctoids.

Locality and Horizon. Antsalova, Kimmeridgian.

B. ORDER NAUTILOIDEA

Genus *NAUTILUS*, Breyn

Nautilus cf. **calloviensis,** Oppel.

1875. *Nautilus calloviensis* Oppel. Waagen: Pal. Indica, loc. cit., p. 18, pl. III, fig. 2.

A poorly preserved specimen (No. 6) seems to agree with this species which was described as the "most common of all the Kachh nautili." Waagen's type is now before me and shows a similar whorl-shape.

Locality and Horizon. Ankidabé (locality I), Callovian.

Nautilus cf. **kumagunensis** Waagen.

1875. *Nautilus Kumagunensis*, Waagen, Pal. Indica, loc. cit., p. 19, pl. III, fig. 1.

A small and fragmentary specimen (No. 16) has a subsulcate periphery and the high umbilical wall of this species. *Nautilus hexagonus*, Sowerby, with a similar whorl-shape, has a wider umbilicus.

Locality and Horizon. Ankirihitra, Callovian.

C. ORDER BELEMNOIDEA

Genus *BELEMNOPSIS* Bayle

Belemnopsis, sp. ind.

1895. *Belemnites hastatus*, Blainville. R. B. Newton: "Fossils from Madagascar." Quart. Journ. Geol. Soc., vol. LI, p. 78 (pars.).

1921 ?. *Belemnites tanganensis* (non Futterer ?) Morand: Bull. Soc. Géol. France (4), vol. XX (1920), p. 158.

[1] "Monogr. Paléont. des Couches de la Zone à *A. tenuilobatus* de Baden." Mém. Soc. Pal. Suisse, vol. V, 1878, pp. 90–93, pl. XV, figs. 3–5.

[2] "Ueber einige neue oder in Schwaben bisher unbekannte Versteinerungen d. Weiss. & Braun. Jura." Jahresb. Ver. Vat. Vaturk. Württemb., vol. LXIX (1913), p. 54, pl. V, fig. 23.

Two fragmentary examples (Nos. 43, 44) are comparable to the majority of the specimens recorded by Newton (e. g. B. M. No. C 4925–6) but specific determination is probably impossible. Mlle. Morand recorded *Belemnopsis* cf. *semisulcatus* (Mstr.), *Bel tanganensis;* Futterer and *Hastites claviger* (Waagen), from blue shales at Andranosomonta, and mentioned that *B. tanganensis* occurred already at the horizon of the sandy limestones associated with lamellibranchs of the Inferior Oolite. The identifications undoubtedly require revision, and there may be no need to invoke the aid of faults to explain apparently anomalous superposition.

Locality and Horizon. Antsalova, Kimmeridgian.

III

CONCLUSIONS

The cephalopods described in the foregoing pages may be arranged in the following assemblages:

I. From "Hill approaching hollow west of and before reaching Ankidabé":

Phylloceras aff. *disputabile,* Zittel.
Macrocephalites aff. *madagascariensis,* Lemoine.
Pleurocephalites sp. ind.
Catacephalites sp. ind.
Kheraiceras ? stansfieldi sp. nov.
Nautilus cf. *calloviensis,* Oppel.

This is clearly a Lower Callovian fauna, from the *macrocephalus* beds (sensu lato).

II. From: "Coming down the Hill from Ankidabé, going towards Maevatanana":

Phylloceras aff. *disputabile,* Zittel.
Pleurocephalites, sp. ind.

Catacephalites sp. juv. ind.
Grossouvria cf. anomala (Loczy).

This assemblage is apparently of the same age as that of Locality I.

III. From 1 Km. East of Ankidabé:
Grossouvria sp. juv. ind.
Lunuloceras cf. *lunuloides* (Kilian).

A middle Callovian age may be suggested for these forms but they are immature and no definite conclusions could be based on them.

IV. From "Approaching Ankidabé, on trail to Maevatanana":
Chanasia sp. juv. ind.
Lunuloceras cf. *lunuloides* (Kilian).
Sindeites madagascariensis sp. nov.
Peltoceras sp. juv. ind.
Grossouvria sp. juv. ind.

This assemblage also is probably of Middle Callovian age (*anceps* zone in the wider sense) but again consists merely of small and indefinite examples.

V. From "1 hr. East of Ankirihitra":
Pleurocephalites sp. ind.
Catacephalites ? sp. ind.
Grossouvria ? cf. *waageni* (Teisseyre) Loczy sp.
Nautilus cf. *kumagunensis,* Waagen.
Hecticoceras sp. juv. ind.

The first four forms are probably from the "*macrocephalus* beds," like those of localities I and II; the last, resembling the small limonitic casts from III and IV, may tentatively be grouped with the Middle Callovian (*anceps* zone).

VI. Near Antsalova:
Phylloceras sp. ind. (*mediterraneum* group).
Haploceras elimatum (Oppel).
Torquatisphinctes ? cf. *bangei* (Burckhardt).
Hemisimoceras semistriatum gen. et sp. nov.

Hemisimoceras nodulosum sp. nov.

Belemnopsis sp. ind.

This assemblage is probably of the Middle Kimmeridgian age, and would have been included in the "zone of *Amm. acanthicus*" or "Lower Tithonian" of the older authors. There is no evidence for definite reference of this fauna to one of the three corresponding zones previously listed for the Middle Kimmeridgian.[1] It is probable that it differs from Middle Kimmeridgian faunas of Kachh and Somaliland because the exact subzone or horizon to which the Madagascan forms belong is not represented in India or on the African continent; but Toucas's "Diphyakalk" of the South of France [2] which includes both *Haploceras elimatum* (the commonest ammonite in the present collection) and similar perisphinctoids may possibly comprise a corresponding and as yet undefined horizon. No zonal collecting, unfortunately, has been done in Mediterranean countries, and the more detailed subdivision of the geological time-scale given in previous papers [3] must remain somewhat speculative.

Considering, however, for the present only the larger zones, it is clear that the Jurassic sequence of Madagascar must be very incomplete.[4] Of Lemoine's list of Madagascan species, forms not already referred to above include notably *Reineckeia anceps, Obtusicostites,* and *Kinkeliniceras,* which were recorded by Waagen and myself from the Middle Callovian (*anceps* zone) of Kachh, India; further *Hildoglochiceras kobelli* (Oppel) which is an important Middle Kimmeridgian form, occurring in the Spiti shales as well as Kachh and Tanganyika. But Lemoine also re-

[1] Spath, loc. cit. (Somaliland, 1924), p. 158.

[2] See Spath: "Ammonites from New Zealand," Quart. Journ. Geol. Soc., vol. LXXIX (1923), p. 305, and loc. cit. (Somaliland, 1924), p. 160.

[3] Loc. cit. (New Zealand, 1923), p. 304 and Somaliland, 1924, p. 158.

[4] See also Spath, loc. cit. (Somaliland, 1924), p. 160.

cords a number of more doubtful forms, like "*Oppelia*," *Lytoceras rex*, and some *Phylloceras*, which may indicate the presence of Oxfordian beds, and above all some *Mayaites* ("*Macrocephalites*" of the group of "*M.*" *maya* and "*M.*" *transiens*, Waagen), and *Dhosaites* (including his "*Macrocephalites*" *elephantinus* Waagen). These indicate beds of Argovian age. Some comparable examples in the British Museum, recorded in two papers by Mr. R. B. Newton, have already been referred to on a previous occasion.[1] The example figured in Newton's pl. XIV, figs. 1–2 (loc. cit. 1889) collected by the Rev. J. Richardson, is not in the Baron Collection in the British Museum. The *Stephanoceras macrocephalus*, *St. herveyi*, and *St. calloviense*, are poorly preserved, in a peculiar reddish, soapy matrix, and are probably Argovian *Mayaites* and *Dhosaites*, and not Callovian Macrocephalitids. Another specimen, from North of Andranosamonta (B. M. No. C. 3586) preserved in a sandy limestone of a light colour, I have previously described as possibly a new globose form of *Dhosaites*, with the blunt ribs that characterise the (equally Argovian) genus *Tornquistes*.

An example of *Haploceras elimatum* (B. M. No. C. 3585b) and an indeterminable fragment of a *Phylloceras* (B. M. No. C. 3585a) were not referred to by Mr. Newton. Among his twelve fragments of "*Perisphinctes polygyratus* (Reinecke) those that can be determined are referable to *Lithacoceras ? andranosamontæ* (Lemoine) (B. M. Nos. C. 3588*a* and *c*), *L.?* cf. *colcanapi* (Lemoine) (B. M. No. C. 3587a, 3588f) and doubtful *Subdichotomoceras* (C. 3587*b*, 3588*e*). The "*Perisphinctes* sp. (probably allied to *P. polygyratus*, Rein.)" recorded by Mr. Newton in 1895[2] I have previously[3] described as a *Lithacoceras* of the group of *L. eystettense—fruticans* (Schneid).

[1] Spath, loc. cit. (Pal. Indica, 1924), p. 10.
[2] Loc. cit. (Q. J. G. S., 1895), p. 78.
[3] Loc. cit. (Somaliland, 1924), p. 160.

There is, then, nothing yet recorded that would definitely indicate the presence, in Madagascar, of the Upper Callovian, the Divisian, a good deal of the Argovian, the Lower and Upper Kimmeridgian, and, of course, the uppermost Jurassic (Portlandian and Tithonian). Whilst it is improbable that the Jurassic succession of Madagascar is more complete than that of other areas and some gaps are expected, it might yet be claimed that the absence of e. g. Callovian Cosmoceratids or Argovian Cardioceratids is due to differences of "province" and not to the non-representation of strata of those ages. The discovery recently of Virgatitids in Somaliland may justify the expectation that e. g. Cosmoceratids also may yet be found in more southern deposits if there are anywhere beds that contain the true *Peltoceras athleta* and its zonal associates.

Perisphinctoids, however, are still the commonest and often only representatives of Oxfordian faunas and offer great difficulty in specific identification. Reference also has already been made to some doubtful Oppelids, recorded by Lemoine, so that the probable gaps in the Madagascan sequence, in the present state of our knowledge, cannot be definitely indicated.

In conclusion, it may be repeated that when only strictly contemporaneous formations are compared, the question as to whether there is affinity with forms of the Indian or Mediterranean Provinces ceases to have importance. Haug [1] pointed to the presence of the peculiar Sequenziceratid genus *Bouleiceras* in Madagascar as possibly indicating a separate zoölogical province. The discovery, by the writer,[2] of a specimen of *Bouleiceras nitescens,* Theve-

[1] Traité de Géologie, vol. II, fasc. 2 (1907), p. 995.

[2] "Cretaceous Cephalopoda from Zululand." Ann. South Afr. Museum, vol. XII, part VII, No. 16 (1921), p. 272.

nin, in a Domerian-Toarcian collection from the Valley of Kelat, Baluchistan, dealt the death-blow to this speculative "province," as the record of Virgatitids, from Somaliland throws doubt on the value of the "Ethiopian Province" of Neumayr, Uhlig, Dacqué, and Krenkel. Upon the analogy between the Jurassic faunas of India and Madagascar. insisted on by Boule and Lemoine, more will be said in connection with the forthcoming revision of the Ammonite Fauna of Kachh.

EXPLANATION OF PLATE

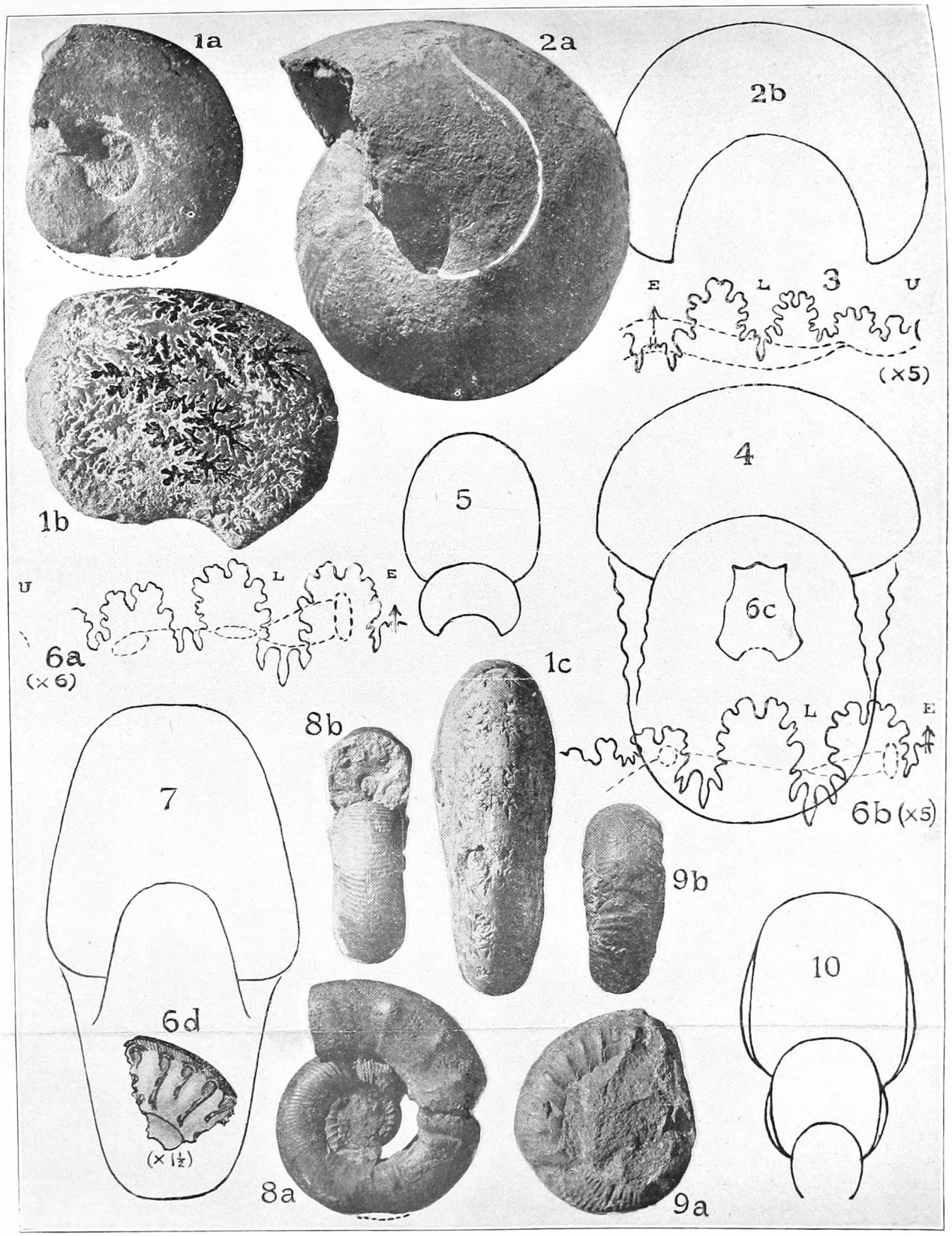
FIG. PAGE

1. *Haploceras elimatum* (Oppel). Middle Kimmeridgian, Antsalova. *a.* Side-view of a small example; *b.* septate fragment, showing suture-lines; *c.* peripheral view of another completely septate specimen 13
2. *Kheraiceras ? stansfieldi*, sp. nov. Lower Callovian, (*macrocephalus* beds) Ankidabé. *a.* side-view of holotype, with umbilical suture of (missing) outer whorl drawn in from traces on side not shown; *b.* sectional outline of outer whorl. 15
3. *Catacephalites* sp. ind. External suture-line (× 5) of a small specimen from near Ankidabé (*macrocephalus* beds). E = external lobe; L = lateral lobe; U = umbilical suture. The dotted lines represent the rib-curve. 14
4. *Catacephalites* sp. ind. Sectional outline of another example from the same bed. 14
5. *Torquatisphinctes ?* cf. *bangei* (Burckhardt). Middle Kimmeridgian, Antsalova. Sectional outline of a fragmentary example. 18

6*a*, *c*, *d*. *Sindeites madagascariensis* gen. et sp. nov. Callovian, Ankidabé. *a.* external suture-line (× 6); *c.* sectional outline (× 2); *d.* side view, diagrammatic (× 1½). . . . 10

6*b*. *Sindeites* sp. nov. Callovian, Jessulmir, Sinde, India. (British Museum, No. C. 23545.) External suture-line (× 5) for comparison with fig. 6*a*. 10

7. *Macrocephalites madagascariensis*, Lemoine. Lower Callovian, nr. Ankidabé. Sectional outline of a completely septate specimen. 13
8. *Hemisimoceras semistriatum* gen. et sp. nov. Middle Kimmeridgian, Antsalova. *a.* side-view; *b.* peripheral view of holotype (genotype). 21
9. *Hemisimoceras nodulosum* sp. nov. Same locality and bed. *a.* side-view; *b.* peripheral view of holotype. 22
10. *Grossouvria ?* cf. *waageni* (Teisseyre) Loczy sp. Callovian, Ankirihitra. Sectional outline of a fragmentary example. 17


1a
2a
2b
3
E
L
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5
4
6c
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6a
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6d
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