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HIMALAYAN FOSSILS.

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THE FAUNA OF THE SPITI SHALES.

FASCICULUS 2.

PAGES 133 TO 306 AND PLATES XIX TO XLVIIIA AND LXXVII TO XCI.

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HIMALAYITES, Uhlig.[1]

Amidst the ammonites of the Spiti fauna, a well-defined group of closely allied species is constituted by *Ammonites Seideli*, *Amm. hyphasis*, *Amm. umbo* and some other forms. With his usual perspicacity, F. Stoliczka had already recognised the close relationship of these forms ; but whilst, in accordance with the views prevalent at his time, he included them all within the narrow limits of a single species—*Amm. hyphasis* Blanford—they constitute, for us, a new genus, HIMALAYITES, including the following species from the Spiti Shales :—

Himalayites Seideli Oppel sp.
„ *kutianus* n. sp.
„ *Schlagintweiti* n. sp.
„ n. sp. indet.
„ *Hollandi* n. sp.
„ *ventricosus* n. sp.
„ *Stoliczkai* n. sp.
„ *umbo* Strachey-Blanford.
„ *depressus* n. sp.
„ *hyphasis* Blanford sp.
„ n. sp. indet.
„ *hoplitiformis* n. sp.

All the species of *Himalayites* are characterised by a widely umbilicated shell consisting of rounded, frequently broadly depressed, and only slightly overlapping volutions. The mode of coiling, particularly that of *H. Seideli*, recalls the genus *Lytoceras ;* the umbilical wall of all the species is rounded and slopes down rather obliquely towards the umbilicus ; in the adolescent and full-grown stages the height of the volutions is invariably less than their breadth.

In the adolescent and adult stages the sculpture possesses a very characteristic feature : at about half the height of the flanks, individual ribs swell up into strong knobs from which originate bundles of three to five branch-ribs. Between each two successive tubercle-bearing ribs there are intercalated from one to three simple ribs. In the majority of forms main and branch-ribs are disposed radially and take a straight course ; it is only in isolated species that the ribs are slightly deflected forward or show a slight sigmoidal curvature. On the other hand, the branch-ribs exhibit a fan-like disposition, the anterior ribs of each bundle being deflected forward, whilst the posterior ones assume a radial direction or even a slight backward inclination. The ribs extend across the ventral face forming transverse or slightly arched, prominent ridges. Along the median line they are slightly, although usually only just perceptibly, reduced ; this reduction

[1] Pages 1 to 132 of Professor Uhlig's Memoir, originally written in German, have been translated into English by Mr. L. L. Belinfante. The English translation of the remainder is from a rough draft by Professor P. Brühl, carefully revised and largely re-written by Mr. E. Vredenburg.

constitutes the last trace of the ventral furrow existing on the innermost whorls. Now and then two ribs proceeding from the umbilical suture coalesce into a tubercle, or an intercalated rib shows a tendency to run into a neighbouring tubercle. The tubercles increase rapidly in thickness and are remarkable for their stoutness and massiveness and their somewhat rounded outline. Where the shell itself is preserved, it can be seen that the tubercles were produced into acute spines. They were probably not hollow, but consisted of a compact mass of calcium carbonate.

The suture line consists of a siphonal (ventral) lobe, an antisiphonal (dorsal) lobe, two principal lateral lobes and three smaller auxiliary lobes which latter rapidly diminish in size. The external auxiliary lobes considered in conjunction with three internal auxiliary lobes constitute together one slightly depressed umbilical lobe. The lobes are slender; the saddles are broader than the lobes and they are to a varying extent constricted by secondary lobes and lateral branchlets of lateral lobes. The first lateral lobe is nearly as long as, or only a little shorter than, the external lobe; the second lateral lobe is much shorter and usually disposed obliquely. The umbilical lobe is situated at about the same level as the second lateral. The antisiphonal lobe is as long as the first lateral or somewhat shorter. In various forms, as for instance in *H. Seideli, H. Hollandi* (plate XXXIX, fig. 1 *c*), the two main saddles are subsymmetrically divided, each by a long and slender secondary lobe; in *H. ventricosus* (plate XXXVIII, fig. 4) two nearly equal secondary lobes cut into the lateral saddle; and in *H. depressus* the external saddle is incised by three slender secondary lobes of equal length. Hence it is principally the two principal saddles, and only to a lesser extent the lobes, which supply the specific differences of the suture line.

The relative length of the body chamber and the shape of the aperture are unknown.

In order to arrive at a clear understanding of the genus *Himalayites*, a study of the individual ontogeny is of particular importance. As far as the shape of the shell is concerned, there exists a tendency towards a relative increase in the thickness with increasing age.

Whilst in many other genera, or sub-genera, such as *Stephanoceras, Sphæroceras, Macrocephalites, Spiticeras, Reineckia*, the inner whorls are comparatively thick, growing relatively higher later and becoming still narrower in full-grown aged specimens, the opposite tendency is observable in the present genus. This is most pronounced in *Himalayites ventricosus*. Here the inner volutions are somewhat higher than broad, but the whorls soon become broader than high. In other species the volutions are at first as high as they are broad, but further on they increase more and more in breadth. The innermost volutions of several species are not known; it is, however, possible to ascertain that growth in thickness predominates, and even the middle portion of the body-chamber does not decrease in relative breadth. Although, as already mentioned, we have no knowledge of the foremost part of the body-chamber and consequently are unable to ascertain whether after all a contraction of the cross-section may not take place

there, we are certainly in a position to declare that the predominant increase in the thickness of the volutions characterises the main phase of ontogenic development.

Simultaneously with the changes in the cross-section of the volutions there occur changes in the ornamentation. The innermost volutions do not yet possess the sculpture described above, but are ornamented with fine and sharp ribs which run for some distance across the flanks either in a radial direction with a slight anterior deflection, or else in a somewhat sigmoidal curve, and which, after having formed a swelling, split up into two branch-ribs which terminate each in a fine, pointed, small tubercle on either side of a sharp median ventral groove. At this stage the sculpture recalls that of *Parkinsonia* as well as the immature forms of the group of *Hoplites Callisto* and *Hoplites Wallichi*. As the shell grows in size, the ribs become gradually differentiated into tuberculiferous ribs and simple non-tuberculate ridges. The point at which the ribs divide and which in the immature stage is situated near the external margin of the volution shifts its position to about the middle of the flanks, and the knots at the point of bifurcation increase very rapidly in size. In the full-grown stage the tubercle-bearing ribs are somewhat stronger than the non-tuberculate ones. It is only when two ribs unite to form a tubercle that this strengthening of the ribs does not take place. The median furrow of the immature stage is soon lost; when the diameter has reached 25 to 35 mm., the ribs, where they cross the median line of the ventral face, are intersected by a very shallow groove or only slightly reduced, and finally only a trace of this reduction remains visible.

This course of development is followed by different species to a different extent and is passed through more or less rapidly or slowly. *Him. hyphasis* Blanford (*non* Stoliczka) represents a primitive type: it is a small species with relatively high volutions in which development proceeds up to the differentiation into tuberculate and non-tuberculate ribs, but does not reach the stage where trichotomy of the ribs sets in. Only in one place does a specimen show trifurcation of a costa, and tubercle formation is yet little pronounced. Whilst, therefore, *Him. hyphasis* proceeds only slightly beyond the *Parkinsonia* stage and retains its primitive features nearly throughout life, the opposite is the case with *Him. Stoliczkai*: here the *Parkinsonia* stage is rapidly traversed; already at an early age tubercles make their appearance at the branching-points of the ribs, and trichotomy sets in as soon as the diameter has reached 15 mm. With a diameter of 42 mm. the same species exhibits a division of a rib into five branch-ribs. When of a diameter of 35 mm. *Him. ventricosus* is yet in the *Parkinsonia* stage, but suddenly and practically without passing through a transitional stage it develops strong tubercles and the breadth of its volutions increases at a rapid rate. In *Him. Schlagintweiti*, also, the *Parkinsonia* stage is only abandoned when the diameter has reached 43 mm., but with a diameter of 29 mm. isolated trichotomous ribs already make their appearance. *Him. kutianus* is yet in the *Parkinsonia* stage when measuring 22 to 30 mm. in diameter, but at 35 to 40 mm. it develops a sculpture which corresponds approximately to the developmental phase of *Him. hyphasis;* it is only

when the diameter attains more than 40 mm. that the typical *Himalayites* sculpture establishes itself.

In *Himalayites depressus* the thickness of the volutions reaches its maximum, whilst it is least in *Him. hyphasis, Him. Seideli* and *Him. Schlagintweiti.* Somewhat apart from the majority of the forms stands *Him. hoplitiformis* with its characteristic cross-section and its sigmoidal ribs part of which are still merely dichotomous even on the body-chamber.

The genus *Himalayites* forms a sharply defined group of the Spiti fauna, without transition to any inter-related and similarly constructed forms. We cannot fail to recognise in the adult stage a considerable resemblance to certain Reineckias, especially to *Reineckia Brancoi* Steinm., as well as to certain forms which have been hitherto looked upon as members of the genus *Hoplites*, such as *Hop. microcanthus* and *Hop. Sömeringi* Oppel. The immature forms, on the other hand, recall the species of *Hoplites* which constitute the *Wallichi* group, further those Parkinsonias which are more closely related to the Reineckias, and perhaps also the species of *Perisphinctes* with ventral furrow, such as *Perisph. Mörickeanus* Oppel. Hence we have to look especially to *Reineckia* and *Hoplites* for points of contact with the new genus *Himalayites.*

The affinities of the latter to the *Wallichi* group are confined to certain resemblances between their respective immature stages: in both groups the innermost volutions are ornamented with fine ribs which are slightly sigmoidal; they are branched close to the ventral margin and interrupted on the ventral face. But the fully grown forms are quite different: in the *Wallichi* group, the ribs always exhibit a strong sigmoidal curvature, no differentiation is observable into tuberculiferous and non-tuberculate ribs, and no real tubercles or still less thorns are developed at the branching-points of the ribs, and one merely notices some swellings drawn out lengthwise along the ribs. The ventral furrow is broader than in *Himalayites* and remains distinct even in the largest-sized specimens. The suture-line possesses broad and stout lobal phylla which contrast vividly with the slender lobes of *Himalayites.* Hence, notwithstanding the resemblance between the immature forms, the great difference in the sum total of the development during the later stages prevents us from considering their relationship to be close enough for including them under the same generic designation. Although we cannot but concede that a certain degree of relationship actually exists, we have nevertheless to deal with two widely divergent branches; and the superficial resemblance which individual stouter representatives of the *Wallichi* group, such as *Hoplites rotundidomus* and *Hopl. rotundatus*, exhibit with *Himalayites depressus* must be regarded as a case of convergence.

Similar is the relationship to other *Hoplites* groups, such as *Hopl. Theodori* Oppel and *Hopl. Sömmeringi* Oppel as well as to the forms of *Perisphinctes* with a ventral furrow. Although the immature forms may exhibit a certain degree of resemblance, the later course of development differs greatly in *Hoplites* as well as in *Perisphinctes. Hoplites* again shows a pronounced tendency towards a fusion of the ribs along the umbilical suture and towards the formation of

umbilical tubercles as well as prominent external nodes. The ribs are always sigmoidally curved or deflected forward; one scarcely ever observes more than two branch-ribs originating from one and the same tubercle. The whole of these characters together with the strong ventral furrow impart to *Hoplites* an aspect so fundamentally different from that of *Himalayites* that a separation of *Himalayites* from the typical *Hoplites* becomes unavoidable. The difference between the two is not only a difference in single, isolated characters, but a difference in the impression which each of them produces as a whole.

It is exactly in this respect that the genus *Himalayites* forcibly recalls the *anceps*-group of *Reineckia*, more especially *Reineckia Brancoi* Steinm. and *Reineckia anceps carinata* Quenst. The ribs of these ammonites have the same radial disposition as those of *Himalayites;* there is a great similarity of form, size, disposition, and number of tubercles, and, as regards especially the form and disposition of the bundles of branch-ribs, there is so striking an agreement between *Reineckia* and *Himalayites* that the probability of the existence of a closer relationship between these two form-groups has to be seriously taken into consideration.

The generic name *Reineckia* was first introduced by Bayle.[1] Although this investigator did not furnish a detailed description of the genus, his choice of types proves clearly that by *Reineckia* he understood the group of *Ammonites anceps* in its wider conception. D. Steinmann was the first who actually established the genus *Reineckia* in that sense.[2]

Steinmann[3] distinguished two main sub-divisions—the series of *Reineckia anceps* and that of *Reineckia Greppini*. In the forms which constitute the latter group the cross-section of the volutions is already higher than broad at an early stage, the tubercles approach the umbilical suture, become feebler or may even disappear entirely. The forms of this series already acquire during the middle stages of development certain characters which fail to suggest a close relationship with the cycle of *Himalayites*.

The two species of *Reineckia* referred to above—*R. Brancoi* and *R. anceps carinata*—which so closely resemble *Himalayites*, belong to the *anceps*-group of Steinmann. Of the members of that group it is probably only the two just mentioned by name which possess such a striking resemblance with *Himalayites*. The majority of the forms appear to differ appreciably. For instance, intercalary ribs are usually entirely absent. The tubercles are feebler, more numerous and placed closer to the umbilical suture, and the ribs are more delicate. Further one observes numerous deep constrictions not known to exist in *Himalayites*, and the ventral furrow is retained even at the full-grown stage. The suture differs

[1] Explication de la Carte Géol. de France, IV, pl. LVI.

[2] Steuer, in his monograph on the Tithonian of Argentina, has considerably extended the confines of the genus *Reineckia* by the addition of numerous forms. The forms in question being, however, evidently of considerable diversity, it seems advisable to adhere to the original conception of the genus, at least for the present. (*Paläontol. Abhandlungen*, VII, Heft 3.)

[3] Zur Kenntniss der Juraformation von Caracoles (Bolivia). *Neues Jahrbuch f. Mineralogie*, etc., supplementary volume I (1881), p. 283.

in the feebler development of the second lateral lobe. Finally considerable differences exist as regards the mode of growth of the shell.

According to Steinmann the immature shells of *Reineckia* pass through a "Coronati" stage which is said to be permanent amongst the members of the *anceps*-group even when full-grown. This probably means that the volutions are broader than high and tuberculiferous, not only in the immature, but also in the full-grown stages. The development of *Himalayites*, however, takes a different course: it is precisely in youth that the volutions are higher than broad and only later that they become broader than high. Further, individual species show only a slight tendency towards the development of the tubercles during the earlier stages; and although we are ignorant of the developmental history of several species of *Himalayites*, yet we know with certainty that in some of the species of this genus the development follows a course which is not in satisfactory agreement with that taken by genuine Reineckias.

These facts render the generic union of *Himalayites* with *Reineckia* a matter of doubtful policy notwithstanding the great resemblance of the species of *Himalayites* to *Reineckia Brancoi*. Since therefore the direct fusion of our group with the genus *Hoplites* is shown to be impossible, the establishment of a new genus *Himalayites* appears to be completely justified.

It only remains for us to decide what branch of the Ammonoids is the one to which the new genus should be attached. Are we to consider our genus to represent the continuation of the developmental series of *Reineckia*, or are we to conceive it to be a branch grown out of the *Hoplites*-stock?

We are not at present in possession of sufficient material to satisfactorily answer that question. We have to be content with stating that the early stages of development and the simultaneous appearance of the genera *Himalayites* and *Hoplites* in the Tithonian are circumstances favouring of the latter alternative. In favour of the former alternative we may point to similarity in the features which the two form-groups present in their totality. In this respect we must not forget that certain characters which distinguish the various forms of *Himalayites* from the Tithonian and those of *Reineckia* from the Kellaways—for instance the absence of constrictions and the early disappearance of the ventral furrow—are of very unequal value in different forms of *Himalayites*. For it is a well-established fact that as regards the ventral furrow and the constrictions, even closely allied forms may differ considerably. The immature stage of *Himalayites* with its sculpture which recalls *Parkinsonia* does not preclude the existence of a natural relationship with the *Reineckia* stock; for the Reineckias of the Callovian are undoubtedly very closely related to *Parkinsonia*. The only argument which appears to militate against the close union of *Reineckia* and *Himalayites* is their geological position in so far as *Reineckia* is found in the Kellaways, whilst *Himalayites* belong chiefly to the Tithonian. There exists, therefore, a chronological gap of considerable magnitude between *Reineckia* and *Himalayites*. We find, however, on closer examination that this gap is bridged over to a certain extent.

It is especially Quenstedt as well as Oppel who have described forms from the lower and middle Malm—forms like *Amm. anceps albus* Quenst., *Amm. bifurcatus* Quenst., *Amm. bifurcatus pinguis* Quenst., *Amm. stephanoides* Oppel— which appear to belong to the form-cycle of *Reineckia* and which, if better known and better appreciated, will probably establish the close connection between the Callovian and Tithonian forms. It must, however, be left to future investigations to gather sufficient material for the purpose of solving the problem of the natural affinities of the genus *Himalayites*.

The genus *Himalayites* does not appear to be well represented in Europe. The small number of species belonging to this genus described from that continent constitute forms isolated to such an extent that it was impossible to sufficiently estimate their importance.

Zittel described under the name of *Ammonites* cf. *athleta* a form from the Tithonian of Stramberg which appears to belong with certainty to *Himalayites*. Later on W. Kilian united this form with a species from Andalusia under the name of *Peltoceras Cartazari*. *Himalayites Cartazari* is exceedingly near *Himalayites Stoliczkai* n. sp. (*Amm. hyphasis* Stol., *non* Blanf.) and occurs not only at Fuente de los Frailes in Andalusia, but according to Retowsky, also at Theodosia in the Crimea and, on the authority of Kilian, in the south of France. In the region including Southern France, Andalusia, and North Africa the genus *Himalayites* appears to be comparatively well developed; for in Andalusia there is found, besides *Amm. Cartazari*, a second species which Kilian has described under the name of *Hoplites Malbosi* (*non Amm. Malbosi* Pict.). Further, the forms described by Pomel from Lamoricière in Algeria as *Amm. Breveti*, *Amm. Aulisuæ* and *Amm. kasdensis* appear to belong to *Himalayites*. Finally we have to add *Amm. microcanthus* Opp. Although this species is usually placed in the genus *Hoplites* its essential characteristics are those of a *Himalayites* and not those of a *Hoplites*. This is especially true of that species from Stramberg which Zittel has figured in his monograph on the Cephalopods of the "Stramberger Schichten" (pl. 17, fig. 3), and holds good also with respect to the form described and figured by F. Roman (in "Recherches stratigr. et pal. sur le Bas Languedoc," *Annales de l'Université de Lyon*, Paris, 1897, pl. I, fig. 10, p. 284). *Himalayites microcanthus* is widely distributed in the Tithonian of the Mediterranean Region. It occurs not only at Stramberg and in the Bas Languedoc, but also in Andalusia, the Tirol, the Veronesian, near Sisteron, at the Montagne de Lure, and at Chomerac. Larger specimens of *H. microcanthus* exhibit, according to Zittel, a development which differs not inconsiderably from that of the *Himalayites* of the Spiti Shales. It may be surmised that *H. microcanthus* represents a particular, independent mutational tendency of *Himalayites*, a tendency the significance of which it is not at present possible to grasp completely. Some species from the Tithonian of Argentina which Steuer has described under the generic name of *Reineckia* appear to be linked to the mutational series represented by *Himalayites microcanthus*. Whether some other species from Argentina, especially *Reineckia egregia* Steuer, *R. Steinmanni* Steuer, and *R. latior* Steuer, are more closely

related to the *Himalayites* of the Spiti Shales can only be decided after a fresh examination of the material from that country.[1]

HIMALAYITES SEIDELI, Oppel sp.

(Plate XXXIX, fig. 2 *a*, *b*; Plate XL, fig. 1.)

1865. *Ammonites Seideli* Oppel, *Palaeontologische Mittheilungen*, IV, Pl. 80, fig. 3 *a*, *b*, p. 283.

We commence the description of the species of *Himalayites* with *H. Seideli*, because the diagnostic characters of the genus are particularly well marked in the present species.

H. Seideli is distinguished by rounded volutions which at the anterior end are only slightly thicker than high. The volutions embrace one another to such a slight extent that Oppel was able to compare the mode of involution of this species with that of the "Fimbriati." Umbilicus wide; flanks and umbilical wall rounded; shell with strongly developed sculpture. One to three non-tuberculate roundish ribs are intercalated between the tubercle-bearing ribs the number of which amounts to twelve on the last volution of Oppel's specimen. The tubercles are situated near the middle of the flanks and are very strong or even exceedingly stout, as in the specimen depicted in figure 1 of plate XL. One of the specimens, which is partly imbedded in the rocky matrix, enables us to ascertain that the coarse tubercles were originally produced into acute spines after the same manner as in the original type specimen figure by Oppel. The tuberculate ribs are somewhat stronger than the non-tuberculate ones, especially on the most anterior portion of the shell. Here and there two main ribs unite in a tubercle. On the last volution there originate three or four branch-ribs from each tubercle. The ribs are strongly developed where they cross the external margin; here they form an arch which is slightly convex towards the front, and it is only at the mesal line that a slight reduction is just perceptible. On the inner volutions the tubercles are rather feebly developed and are placed at a slightly higher level.

The septal suture exhibits remarkably long, slender and copiously branched lobes. The first lateral lobe is as long as the external lobe; the second lateral lobe is shorter and only slightly oblique. The saddles are strongly laciniated, and they are encroached upon by long secondary lobes and the lateral branches of the main-lobes. The external as well as the first lateral saddle possesses each only a single secondary lobe.

[1] Two forms very closely related to those from the Spiti Shales have been described from the Sula Islands by G. Boehm under the names of *Himalayites Treubi* and *Him. Nederburghi* (Palaeontographica, Supplement IV, 1904, p. 38). [E. V.]

Besides Oppel's type specimen we place here two specimens from Lochambel-kichak which differ in some subordinate characters from the type, but not to such an extent that they could be looked upon as distinct species. We must, however, keep in view the possibility of a richer and better preserved material supplying us with new and distinct characters which may necessitate the separation of these forms as good species. The last volution of the specimen depicted in figure 1 of plate 39 is exactly as high as broad; the specimen is consequently somewhat flatter than Oppel's type. Further, the intercalated ribs run a somewhat less straight course and show a certain tendency towards uniting with neighbouring tubercles or at least towards approaching the latter. As far as can be made out, the lobes are copiously branched. The second specimen (plate XL, fig. 1 *a—d*) approaches the type by reason of its greater thickness, but differs owing to the ribs being more densely crowded and the cross-section apparently more rectangular. This rectangular form of the cross-section comes, however, into evidence only where the left flank shows signs of being injured so that the discrepancy in the shape of the cross-section as well as the flattening of the left flank are most probably to be ascribed to the injury referred to.

Closest allied to *H. Seideli* are *H. kutianus*, *H. Schlagintweiti* and *H. Stoliczkai*. The distinguishing characters are enumerated in the descriptions of these species. A striking resemblance to *Himalayites Seideli* is exhibited by *Reineckia Brancoi* Steinmann from the Callovian of Caracoles. As far as can be judged from the figure of *R. Brancoi*, the broad ventral furrow and the less frequent appearance of intermediate ribs in *R. Brancoi* are the only characters which render possible a discrimination of the latter species from *H. Seideli*. But it is very probable that differences exist in the structure of the suture and the development of the inner volutions, differences the significance of which it is at present impossible to gauge, since *Reineckia Brancoi* is not sufficiently well known in those respects.

As already noticed by Steuer, the characters of *H. Seideli* taken in their totality recall *Reineckia egregia* Steuer from the Tithonian of Argentine. The absence of intermediate ribs, the presence of isolated umbilical tubercles and the greater number of tubercles on the flanks of *Reineckia egregia* render its discrimination from *H. Seideli* an easy task. Whether *Ammonites egregius* has its proper place [redacted] *Himalayites* cannot be determined with certainty.

[redacted] ee specimens from Spiti under *Ammonites Seideli*, but in reality only two appear to belong there. Two specimens are from Lochambel-kichak (Coll. Diener-Griesbach).

Himalayites kutianus, n. sp.

Of this species, which is closely related to *H. Seideli* Oppel, yet specifically distinct from it, only a fragment is at our disposal. But exhibiting, as it does,

the most important characters sufficiently clearly, the latter can be employed for the establishment of a new species.

The diameter of the specimen, of which part of the living-chamber is preserved, appears to have been 84 mm. approximately, whilst the width of umbilicus must have been about 38·5 mm. Measured between the tubercles the height of volution is 24 mm. at the anterior end and the breadth 33 mm. The outer volution is strongly depressed and flattened on the external margin; the flanks are rounded and have a steep slope towards the umbilicus. The maximum thickness lies at about the middle of the volution. The next inner volution has somewhat flatter flanks and the umbilical wall is less steeply inclined towards the umbilicus. The height of volution is here as great or nearly as great as the breadth, and the same proportion of volution-height to breadth seems to have been the rule with the third-inner volution.

On the outer volution the sculpture consists of strong main-ribs which swell out into stout tubercles at the middle of the flanks and give rise to three secondary ribs, and of one or two simple intercalary ribs. On the umbilical region of the flanks the ribs are disposed radially, whilst on the outer part they are slightly inclined forward; on the ventral face they form an arch which is slightly convex anteriorly. On the next-inner volution the tubercles are developed comparatively feebly; similarly to what is observed in the case of *H. hyphasis* Blanford, in the majority of instances only two secondary ribs originate in each tubercle. On the third-inner volution, at a diameter of about 20 mm. the difference between main-ribs and intercalary ribs disappear. All the ribs are here bifurcate after the manner of *Parkinsonia*, and the point of bifurcation is marked by a slight swelling. At the same stage the ventral furrow is very distinct and deep and the ribs terminate against it suddenly with a slight swelling. On the next volution the ventral furrow grows gradually more and more feeble with the result that it is indicated on the body-chamber only by a slight weakening of the strong ribs and almost entirely disappears at the anterior end.

Of the suture-line only the two lateral lobes, the auxiliary lobes and portions of the dorsal lobes are known. The first lateral lobe is rather long, somewhat that of *H. Seideli*, but distinctly broader and less ramified. The lateral saddle is symmetrically divided by one large and [redacted] lobes. The inner half of the lateral saddle projects beyond [redacted] second lateral lobe somewhat smaller than the first lateral.

The length of the body-chamber and the oral margin are not known.

Himalayites kutianus has broader and more strongly depressed volutions than *H. Seideli*, but the volutions are less broad than those of *H. depressus* and *H. Hollandi*. The sculpture recalls vividly that of *H. Seideli*, but the union of *H. kutianus* and *H. Seideli* is precluded by the greater thickness of the volutions of the former and more especially by the much simpler structure of its suture line.

H. kutianus has been reported from the Upper and Middle Spiti Shales near Kuti (Coll. Krafft).

Himalayites Schlagintweiti, n. sp.

1865. *Ammonites Seideli*, Oppel (pars), *Palæontologische Mittheilungen* IV, p. 283.

Dimensions :—

Diameter	51 mm.
Thickness at the tubercles	23·5 „
Thickness between the tubercles	20 „
Height of the last volution above the umbilical suture	19 „
Width of umbilicus	19 „

The specimen on which the present species is founded and which, unfortunately is rather small, was referred by Oppel to *Ammonites Seideli*, but to all appearance represents an independent species which differs from *H. Seideli* by its much narrower umbilicus, a more rapid increase in size, and volutions which are less rounded, but which are higher and somewhat more flattened on the flanks and ventral face. From the tubercles radiate outwards three to four secondary ribs which are somewhat more strongly inclined forward than in *H. Seideli*. The intercalary ridges which occur between the tuberculiferous ribs are partly simple, partly divided into two subsidiary ribs. Along the median line of the external margin a slight weakening of the ribs is noticeable. The specimen is chambered up to its anterior extremity, but the septal sutures are unfortunately not visible.

Closely allied to *H. Schlagintweiti* appears to be a form from the Tithonian of Cabra which W. Kilian[1] has described under the name of *Hoplites Malbosi* Pictet. In both species the volutions are rather slender, and the umbilicus is comparatively narrow; but the intercalary ribs of the Andalusian species are much more numerous than those of our species, so that the two are not likely to be specifically identical.

The specimen is from Spiti and is preserved in the Palæontological State Collection in Munich.

Himalayites, sp. ind.

A specimen from Kuti which measures 60 mm. and is somewhat distorted by compression (Coll. F. H. Smith) represents a new species, but is too badly preserved for accurate definition. The shape of the volutions and the sculpture are similar to those of *H. Seideli*, but it differs by its decidedly narrower umbilicus. We have to content ourselves with this short notice and postpone the characterization of the new species to a time when new finds have been made.

1 Mission d'Andalousie, pl. XXXII, fig. 4, p. 670.

Himalayites Hollandi, n. sp.

(Plate XXXIX, fig. 1 *a—d.*)

The species which we are about to describe, but which is unfortunately represented only by an incomplete specimen, exceeds all other species of *Himalayites* by its size and by the width of its umbilicus. Although the available half of a volution is chambered right up to its extremity, the specimen nevertheless attains a diameter of approximately 125 mm. notwithstanding the absence of at least the whole of its body-chamber. In the stage represented by the specimen the width of umbilicus is about 63 mm. The volutions are broader than high; at the middle part of the available fragment of a volution the breadth measured across the tubercles is 43 mm. the height 29 mm.

The ornamentation consists of somewhat stronger tuberculiferous main-ribs and weaker intercalary ribs. At the posterior end of the preserved fragment two to three intercalary ribs are inserted between each two successive main-ribs; on the anterior portion of the fragment two ribs unite in a tubercle, and consequently the intercalary ribs disappear here or are at least not clearly individualised. The blunt, strong tubercles are situated at about half the height of the volution; from each tubercle originate three branch-ribs. On the external margin the strong ribs form a shallow arch with slight convexity bulging forward, and along the median line they are scarcely weakened. In contradistinction with the majority of the other species, which are distinguished by their very prominent and sharp ribs, the ribs of the present species are broad and roundish-flat and are distinctly deflected forward.

The body-chamber and the inner volutions are not known.

The suture-line is characterised by its pronounced laciniation and the comparatively narrow and short lobes and saddles. The first lateral lobe is as long as the external lobe; the second lateral lobe is only slightly shorter and not disposed obliquely. The auxiliary lobes constitute a shallow umbilical lobe which extends backwards to the same level as the second lateral. The antisiphonal lobe is somewhat shorter than the second lateral lobe. It possesses a slender body and short and small sub-symmetrically disposed lateral branchlets. The antisiphonal lobe is succeeded by three inner auxiliary lobes, which correspond sub-symmetrically to the outer auxiliary lobes, but are somewhat smaller than the latter.

Long, narrow, non-deflected, secondary lobes subdivide each of the external and first lateral saddles into two parts which are again cut into on either side by still smaller subsidiary lobes. The two main saddles acquire thereby a regular sub-symmetrical structure which is emphasized by the fact that the points of the two large secondary lobes and the inner and outer lateral branches of the main-lobes approach each other rather closely and thus effect the sub-division

and constriction of the saddle. The septa succeed each other so closely that the whole shell appears to be covered with the sutural patterns.

Himalayites Hollandi cannot be confounded with any of the known species of our genus. *H. Seideli* has much higher volutions, finer ribs which are less distinctly deflected forward, weaker intercalary ribs and much longer lobe-bodies. *H. depressus* differs from the present species by its much broader and lower volutions, more acute ribs which are not deflected forward, less numerous intercalary ribs and the characters of the suture-line, which differs especially by its broad external saddle cut into by three secondary lobes of equal length. *Himalayites kutianus* is distinguished by the much simpler structure of its suture-line and by its sharper, not forwardly inclined ribs.

Himalayites Hollandi has been found in Spiti.

HIMALAYITES VENTRICOSUS, n. sp.

(Plate XXXVIII, fig. 4 *a*—*d*.)

Dimensions :—

Diameter	54 mm.
Width of umbilicus	23·5 „
Thickness measured between the tubercles	24 „
Height of the last volution	19·8 „
Thickness of the penultimate volution	11 „
Height of the penultimate volution	12 „

The inner volutions have flat flanks which descend by a rounded umbilical wall to the umbilicus and which pass outwards into the flattened ventral face. The height of these volutions is somewhat greater than their breadth. The flanks of the last volution become gradually rounder and increase so rapidly in breadth that at the commencement of the body-chamber the breadth of the volution noticeably exceeds its height. This rapid rate of increase in the thickness of the last volution in contradistinction to the flat and relatively high volutions which form the inner portion of the shell gives to *Himalayites ventricosus* a striking and remarkable appearance.

The ornamentation of the inner volutions consists of fine, subsigmoidal ribs slightly deflected forward which on the outer part of the flanks split up into two secondary ribs; only a few of the ribs appear to remain undivided. On the inner volutions the point of bifurcation is scarcely thickened, and with continued growth it approaches more and more the middle of the flanks. It is only just before the commencement of the body-chamber that distinct tubercles arise from the point of bifurcation of the ribs, these swellings increasing rapidly in size. From the tubercles start three to four branch-ribs, and two to four long intercalary ribs are inserted between each two successive main-ribs. On the external margin the ribs form a very gentle anteriorly convex arch. At the commencement of the last volution the median interruption of the ribs on the

external margin is still quite pronounced; and although it becomes less distinct as growth proceeds, it remains more clearly visible than in most of the other species. The oblique disposition of some of the ribs on the ventral face is probably due to a slight distortion of the specimen.

The suture-line is only slightly ramified. The lobe-bodies are pretty strongly developed; the first lateral lobe is as long as the external lobe, the second lateral lobe is much shorter and only slightly inclined. The external saddle is divided symmetrically by a long secondary lobe; the first lateral saddle is broader than the external saddle and cut into by two narrow secondary lobes of which the inner one is placed at a somewhat higher level than the outer one.

In no other species besides *H. ventricosus* does the immature stage with its high and non-tuberculate volutions pass so rapidly into the broad and tuberculate full-grown stage of development. For this reason and because of the peculiar structure of the lateral saddle *H. ventricosus* cannot be confounded with any of the species known at present.

Himalayites ventricosus occurs at Lochambelkichak (Coll. Diener-Griesbach). Only one specimen is at present available.

HIMALAYITES STOLICZKAI, n. sp.

(Plate XXXVIII, fig. 1 *a—d.*)

1866. *Ammonites hyphasis* Stoliczka, *Mem. Geol. Survey of India*; Calcutta, Vol. V, p. 97, plate X, fig. 2 (*non Ammonites hyphasis* Blanford).

Only one specimen of the present species is available the same which Stoliczka figured under the name of *Ammonites hyphasis* in the year 1866. But since Stoliczka's figure is not quite a faithful representation, especially with respect to the inner volutions, the specimen is figured here a second time.

With a diameter of 50 mm. the shell is chambered right up to the anterior end; at this stage the umbilical width is 21·2 mm., the height of the last volution above the umbilical suture is 15·4 mm., the breadth at the tubercles is 22·7 mm. and between the tubercles 18·6 mm. At the anterior end of the shell the cross-section is transversely rounded-oblong, and the external margin is slightly flattened. The flanks are strongly arched and slope evenly towards the umbilical wall. The maximum of thickness occurs at about the middle of the volution.

The type of the sculpture is the same as that of the other species of *Himalayites*. Characteristic, however, for *H. Stoliczkai* is the early appearance of small but distinct tubercles at the branching-points of the ribs and also the fact that as many as five branch-ribs may go to form a fan-shaped bundle. Even where the diameter is only 8·5 mm., small but distinct tubercles can be recognised at the branching-points of the ribs, and, where the diameter is no more than 15 mm., a bundle consisting of three branch-ribs is observable.

On the inner volutions the ribs have a slightly sigmoidal form, and the branching-point of the ribs lies at a somewhat higher level than on the outer volutions. On the innermost whorls the majority of the ribs are bifurcate, the number of simple ribs being very small. On the outer volution the ribs take a radial course, and they traverse the ventral face in the shape of exceedingly sharp ridges.

The main-ribs swell up into strong tubercles, and each gives rise to three to five branch-ribs. Between the main ribs are inserted two to three simple, more rarely branching intercalary ribs. Along the median line of the external margin the ribs are slightly grooved.

The suture-line has a fairly simple structure. The first lateral lobe is only slightly shorter than the external lobe, the second lateral lobe is disposed slightly obliquely. The two main saddles are cut into by a rather short secondary lobe, their bodies are broad and only slightly encroached upon by secondary lobes and the lateral branches of the primary lobes.

The full-grown stage and body-chamber are not known.

H. Stoliczkai is distinguished from *H. kutianus* particularly by a much earlier appearance of the tubercle sculpture and by the greater number of branch-ribs which go to form a bundle; from *H. Seideli* it differs by the same characteristics as well as by its greater thickness and less ramified lobes; from *H. ventricosus* it is distinguished by its slower rate of increase in thickness, the development of much stronger tubercles on the inner volutions, the smaller number of intercalary ribs and the greater number of branch-ribs and finally by the different structure of its suture-line.

Amongst European species *H. Cortazari* Kilian sp. resembles *H. Stoliczkai* in such a degree that the two might be united, if we adopted a wider conception of species. But differences do exist. *H. Cortazari* has somewhat thicker volutions; the number of branch-ribs forming a bundle is somewhat smaller and the ribs are somewhat less curved than in *H. Stoliczkai*. As long as no marked transitions between the two species have been discovered, it will be advisable to keep them separate.

The relationship of *H. umbo* Strachey-Blanford to the present species cannot be stated with certainty, because of *H. umbo* only a small fragment of one of the larger volutions is known.

H. Stoliczkai was found near Gieumal.

Himalayites umbo, Strachey et Blanford sp.

1865. *Ammonites umbo*, Palæontology of Niti, p. 78, plate 17, fig. 2.

The fragment which is 50 mm. long and which Blanford described under the name of *Ammonites umbo* from the Spiti Shales of Niti, although representing an independent species, is not such as to permit of a satisfactory specific diagnosis. *H. umbo* differs from *H. Seideli* by its greater thickness, from

H. kutianus by the less steep slope of its umbilical wall, the feeble development of those portions of the ribs which lie between the tubercles and the umbilical suture, and by the more distinct ventral furrow. The latter characters distinguish *H. umbo* also from *H. Hollandi*. The suture-line agrees in its main features with that of the last-named species.

The species most closely allied to *H. umbo* are apparently *H. kutianus* and *H. Hollandi*. A more precise characterisation of the present species will be possible only after the discovery of more perfect specimens.

HIMALAYITES DEPRESSUS, n. sp.

(Plate XL, fig. 2 *a—d.*)

Of this species we are in possession of only a short fragment with the two last septa and the commencement of the body-chamber. Since, however, we have to deal here with an extreme form and since, notwithstanding the fragmentary state of preservation of the specimen, some of the most important characters are easily recognisable, it seems best not to postpone the establishment of this new species.

H. depressus represents a form exceeding even *H. Hollandi* in the breadth of its volutions. At the anterior margin the breadth is 47 mm. measured at the tubercles and 37 mm. measured between the tubercles; the height of the volution above the umbilical suture is 27·4 mm.; the volution is broadly flattened on the external margin, and strongly arched at the flanks. The latter descend into the umbilicus as a rounded umbilical wall with a rather steep slope. From each of the strong, stout tubercles proceed three to four secondary ribs which form a radially disposed bundle; even the most anterior branch-rib of each bundle is only slightly deflected forward. Between the tuberculiferous ribs is inserted a somewhat weaker non-tuberculate intercalary rib. The ribs assume a radial course across the flanks and traverse squarely the external margin. A reduction of the ribs on the ventral face is scarcely discernible. Judging from the nature of the dorsal face and the impression which the external margin of the preceding whorl has left on it, the ribs of the preceding volutions can likewise have been only slightly reduced on the respective external margin, but the weakening must have affected a remarkably broad median band.

The nature of the inner whorls is not known, neither is the anterior part of the body-chamber.

The characteristics of the group are, on the whole, well developed in the suture. Its specific peculiarity consists in the remarkable breadth of the external saddle which is cut into by three equally long, narrow, non-deflected, and parallel secondary lobes, a peculiarity which does not occur in any other species. The first lateral saddle is divided into two sub-symmetric halves by a rather broad secondary lobe. The anterior lateral branch of the first lateral lobe is

particularly copiously ramified. The second lateral lobe is placed somewhat obliquely. The sub-symmetrically branched slender dorsal lobe is as long as the first lateral lobe.

Himalayites depressus is distinguished from *H. Seideli* by its much more depressed volutions, its less numerous intercalary ribs and the structure of its suture-line; from *H. kutianus* by its much greater thickness, the structure of its suture-line, the more radially disposed ribs and the less numerous intercalary ribs. The characters which distinguish it from *H. Hollandi* are stated under the latter species.

Himalayites depressus occurs in Spiti.

HIMALAYITES HYPHASIS, Blanford sp.

(Plate XXXVIII, figs. 2 *a*, *b*, 3 *a*—*d*.)

1863. *Ammonites hyphasis* Blanford, *Journ. Asiatic Society of Bengal*, Calcutta, XXXII, plate IV, figs. 2, 2*a*, 2*b*, p. 132 (*non Ammonites hyphasis* Stoliczka).

Dimensions :—

	of fig. 3.	of fig. 2.
Diameter	49 mm.	45·6 mm.
Width of umbilicus	21 „	20 „
Height of last volution measured above umbilical suture	14·8 „	15 „
Thickness of last volution measured over the ribs	17·5 „	18 „

The shell of this small species consists of roundish volutions which overlap one another only slightly, are gently arched at the flanks, somewhat depressed on the ventral face and descend by the rounded umbilical wall to the wide umbilicus. The breadth of volution on the anterior part of the shell is only slightly greater than the height. Straight, sharp and high ribs traverse the flanks in a radial direction and pass right across the external margin. Some of the ribs split up into two secondary ribs at about the middle of the flanks, whilst others remain undivided. In Blanford's type specimen (fig. 3) simple and branched ribs alternate fairly regularly. Only at three places two bifid ribs follow each other directly, whilst near the front end of the shell on a part of the latter belonging to the body-chamber four simple ribs are developed one after the other. The point of bifurcation may be slightly thickened, this swelling even having developed into a spine-like protuberance near the anterior edge of the specimen depicted in fig. 2. Along the median line of the external margin, the ribs are not completely interrupted but only slightly weakened or furrowed. On either side of the median line, a feeble, just noticeable swelling affects the ridge-like ribs. On the last whorl occur 28 to 30 main-ribs.

The suture-line corresponds in its main outline to the generic type, but is only scantily ramified. The saddle-bodies are very broad and cut into by short secondary lobes. On the external saddle, two secondary lobes are especially prominent, as is also one secondary lobe on the lateral saddle. The first lateral

lobe is somewhat shorter than the external lobe; the second lateral lobe is much shorter than the first one. The second lateral lobe, as also the auxiliary lobe situated at the umbilical suture, occupy a somewhat lower position. The anterior part of the last volution of Blanford and Strachey's type specimen (fig. 3) belongs with certainty to the body-chamber; this probably holds good also with respect to the second specimen (fig. 2). Since here certain changes in the ornamentation become noticeable and since the ventral furrow disappears, the existing body-chamber probably represents the definite body-chamber. If this is correct, *H. hyphasis* is a species which grew only to a small size.

Most closely allied to *H. hyphasis* appears to be *Himalayites n. sp. ind.* (plate XXXVIII, fig. 5 *a—d*), provided that the fragment which is described under the latter name belongs in reality to a smaller-sized species instead of to one of the inner whorls of a larger-sized shell, a question which cannot be decided with certainty by the aid of the available material. *Himalayites n. sp. ind.* differs from *H. hyphasis* by its broader cross-section, stouter tubercles and the knot-like thickening of individual intercalary ribs on either side of the ventral furrow.

From all the other species *H. hyphasis* is distinguished by its smaller size, the feeble development of tubercles and the simple structure of its suture-line. From those smaller sized specimens which Zittel figures under the name of *Ammonites microcanthus*, *Himalayites hyphasis* differs by its much weaker ventral furrow and by more closely packed, higher and sharper ribs. Steuer[1] placed *H. hyphasis* among the species of *Hoplites*, but the structure of the suture-line, the ornamentation, and the conditions of growth prove without doubt that the present species does not bear any close relationship to *Hoplites*, but has to be considered a member of the group of which *Ammonites Seideli* is a representative and which constitutes our genus *Himalayites*.

H. hyphasis is represented by only two specimens which do not completely agree with each other. In the specimen depicted in fig. 2 the volutions are more rounded, the ribs are rather more distantly spaced and show a greater tendency to the formation of tubercles; further one of the ribs splits up into three secondary ribs and in one place the costation is rather irregular. On the whole, however, these differences appear too unimportant to justify the separation of this specimen from Blanford's type of *H. hyphasis*.

Himalayites hyphasis occurs at Gieumal, Spiti Valley.

Himalayites, n. sp. ind.

(Plate XXXVIII, fig. 5 *a—d*.)

A small-sized fragment of an inner volution indicates the existence of a species which cannot be identified with any other known species, but which

[1] Argentinische Jura Ablagerungen, *Palaeont. Abh. von Dames und Kayser*, VII, part 3, p. 25.

the imperfection of the fragment prevents from being sufficiently well characterised. The fragment in question is, however, interesting enough to deserve a brief reference.

It corresponds to that early stage of development in which there still subsists a shallow ventral furrow and the tuberculiferous ribs divide only into two branch-ribs. The number of intercalary non-tuberculate ribs fluctuates between one and three. Remarkable is the fact that every one of the posterior branch-ribs undergoes a slight thickening at the ventral furrow, which creates a certain resemblance with *Hoplites*, a resemblance which is further accentuated by the rounded-oblong cross-section and the flattened flanks. The generic position cannot be ascertained with complete certainty owing to the small size of the fragment, and its place among the species of *Himalayites* has been assigned only provisionally.

The thickness of the volution is 17 mm. at its anterior end, its height is 9·5 mm.

The suture-line is constructed according to the *Himalayites* type. The intermediate and final stages of growth are unknown. Supposing that the specimen belongs to a species of comparatively small size, then *H. hyphasis* must be considered its closest ally. The differences are enumerated in the description of *H. hyphasis*. The present species is distinguished from *Ammonites microcanthus* Oppel by its greater breadth of volution and by the swellings of individual ribs on the ventral face.

The specimen was found in the Spiti Shales.

HIMALAYITES HOPLITIFORMIS, n. sp.

(Plate XLII, fig. 2 *a*—*c*.)

This species deserves our special attention, because it is the only one which represents a mutational tendency, the direction of which deviates considerably from that indicated by any of the other forms constituting the genus *Himalayites*. This is the reason which has prompted us to bestow a name on the present species, although the available material is very scanty and permits only a partial diagnosis. The specimen consists only of a fragment of a body-chamber at the posterior end of which one can recognise the presence of a slender second lateral lobe, placed at a comparatively high level, and traces of a broad lateral saddle and a retrograde umbilical lobe. The cross-section has a rounded-trapezoidal form; the flanks are flattened towards the external margin and descend at rather a steep slope towards the umbilicus. The maximum thickness lies below the middle of the volution. The ribs are strongly developed and slightly falciform; they traverse the external margin either normally or in a gentle arch, and are slightly weakened along the median line. Individual ribs swell up into a tubercle just below the middle of the volution and two branch-ribs originate

in the tubercle. Between the tuberculiferous ribs is inserted a simple or bifurcate intercalary rib. In one place there appears to exist a constriction, unless we are deceived by the state of preservation of the shell. On the dorsal side traces of the external region of the preceding whorl are preserved, indicating that the ribs of that whorl were rounded and very strongly developed. The ribs are more strongly curved than in any other form of the genus *Himalayites*; the tubercles are comparatively weak and the cross-section is somewhat different. As far as can be recognised, the lobes also possess a structure different from those of other species of *Himalayites*. The falciform course of the ribs might induce us to place the present species in the genus *Hoplites*. The fact, however, that the totality of its characters points to the *Himalayites* group compels us to assign to it a place in the latter, where it represents a remarkable and peculiar mutational tendency. The exact position of the present species relatively to the main mass of the forms which constitute the genus *Himalayites* cannot be determined until we are acquainted with the inner volutions.

The specimen described above was found in Spiti.

HOPLITES, Neumayr.

The complex of strata constituting the Spiti Shales has yielded an extraordinary wealth of forms belonging to the genus *Hoplites* of Neumayr. Not less than fifty-four species could be named, and to these are to be added another sixteen species which it was possible to describe although it was not practicable to define them specifically. In reality the number of extant species is decidedly greater; for several small fragments which certainly represent new species could not be dealt with on account of their too deficient state of preservation. Only two species are represented by numerous specimens—*Hoplites* (*Blanfordia*) *Wallichi* Gray and *Hoplites* (*Acanthodiscus*) *octagonus* Strachey sp.; of all the others only a few specimens are available, and of the majority of species only one specimen. This fact probably indicates that the wealth of the Spiti Shales in *Hoplites* forms have not at all been exhausted by the collections made up to the present.

Whilst, in the case of many genera of ammonites, the absence of close relationship of the Spiti Shales fauna with that of Europe constitutes rather a noticeable anomaly, we meet among the species of the genus *Hoplites* quite a series of well-known European types. Although even here indications of a separate individual development are not wanting, the larger number of points of contact of the Indian *Hoplites* with the fauna of Europe and even that of America constitute a striking and suggestive fact.

Another important fact is the Lower Cretaceous character of the majority of the Indian species of *Hoplites*. We meet here not only forms of the Upper Tithonian and the Berrias-Stage, but also types which in Europe are unhesitatingly assigned to the Lower Neocomian (Valanginian), and even to *the lowest zone of the Middle Neocomian*. We shall, however, not enter here into a discussion of

the geological age of our species of *Hoplites*, this subject being reserved to the concluding chapter of this monograph. For the present we confine ourselves to the discussion of the morphological features of the forms of *Hoplites*.

Since Neumayr founded the genus *Hoplites*,[1] several form-groups have been detached from it as separate genera, such as *Sonneratia* Bayle,[2] *Pulchellia* Uhlig,[3] *Parahoplites* Anthula,[4] and *Aulacostephanus* Pompeckj and Sutner. On the other hand a great number of new forms has been described and the form-circle constituting the genus *Hoplites* has been susbstantially extended by Bayle, Neumayr, and other investigators.

This multitude of forms has rendered the genus *Hoplites* so unwieldy that it has become exceedingly difficult to deal with it in a comprehensive manner. In the course of the present investigation the impossibility of maintaining the genus *Hoplites* as originally conceived by Neumayr has impressed itself on us more and more forcibly. If the limits of this genus are allowed to remain as wide as they are drawn at present, systematic science misses its principal aim to facilitate our obtaining a closer general view of the existing multitude of forms. It also became evident that several of the groups of forms at present placed in the genus *Hoplites* are distinguished by their relative independence and definiteness and therefore may claim to be raised to the rank of sub-genera or perhaps preferably to that of genera. The rich material gathered from the Spiti Shales has therefore prompted us to make the genus *Hoplites* in Neumayr's sense the subject of a more comprehensive investigation which, as a matter of course, was directed chiefly to the group of forms represented in the Spiti Shales, but which has to be extended to allied European groups.[5]

As known, Neumayr assigned the first appearance of the genus *Hoplites* to the Kimeridgian and connected it with the small cycle of *Ammonites Eudoxus* and *Ammonites pseudomutabilis*. He supposed that the so-called "Dentati" of the Neocomian and the Gault were the derivatives of that group, and especially of *Ammonites progenitor* Oppel.[6] As ancestors of the *Eudoxus* group Neumayr indicated the forms related to *Perisphinctes involutus* and thus declared the genus *Hoplites* to be a lateral offshoot of the *Perisphinctes* stock. Later on Neumayr placed *Ammonites involutus* at the commencement of the *Holcostephanus* series and consequently conceived the forms intermediate between *Perisphinctes* and *Holcostephanus* to have been the origin of the genus *Hoplites*.[7]

[1] *Zeitschrift der deutschen geologischen Gesellschaft*, 1875, p. 925.

[2] *Bull. Soc. géol. France*, 13 Janvier 1879.

[3] Die Cephalopoden der Wernsdorfer Schichten, *Denkschrift der k. Akademie*, Wien, Vol. XLVI, 1883, p. 246.

[4] Ueber die Kreidefossilien des Kaukasus, *Beiträge zur Paläontologie Oesterreich-Ungarns und des Orients*, XII, 1900, p. 109.

[5] Our investigation did not derive much benefit from American and African species, these species being for the most part very imperfectly known and frequently badly figured.

[6] *Zeitschrift der deutschen geologischen Gesellschaft*, 1875, p. 927.

[7] Hilsammonitiden, p. 34.

As a matter of fact, the *Eudoxus* group with its ribs, which are interrupted on the ventral face and provided with tubercle-like swellings on the lower part of the flanks, bears a decided general resemblance to *Hoplites*. On closer investigation, however, we recognise that the essential feature of the sculpture of the *Eudoxus* group consists in the deeply cleft and only slightly curved ribs which originate in the tubercles of the umbilical wall.

Very different is the sculpture of the vast majority of the Neocomian species of *Hoplites* in which the ribs are more decidedly sigmoidal and usually have their branching-points situated on the upper part of the flanks. The branching-points frequently give rise to tubercles or spines, which are entirely absent from the *Eudoxus* group. These two types of ornamentation are entirely unconnected; no transition leads from one type to the other, and no continuity can be said to exist between the two.

By discriminating between these two types of ornamentation we are able to distinguish, instead of a single *Hoplites* phylum as understood by Neumayr, two separate off-shoots which develop in the Upper Jurassic and Lower Cretaceous as bearers of those two types of ornamentation. One of them constitutes the group of the Neocomian *Hoplites*, the other makes up the group of *Aulacostephanus*.

We are able to discern the different nature of these groups from their very origin and their respective development can readily be followed, especially during the first period. But in the Neocomian and Gault the position of certain individual forms is difficult to determine. Among them are unfortunately the "Dentati" of the Gault, just those types, to which several authors appear to be inclined to restrict Neumayr's name *Hoplites*. Should we feel eventually justified in definitely referring the Gault *Hoplites* to the *Aulacostephanus* group, the large majority of the Neocomian forms which we have been accustomed to consider as belonging to *Hoplites* would have to forfeit their claim to such a designation. The fact that at the present day it is impossible to formulate definite views on that point prevents us not only from drawing a clear picture of the course of development of the forms we are dealing with, but creates also formal difficulties for the systematic part of our science. We have therefore to confess that the designations adopted in the following have in part at least only a provisional character.

I.—The Aulacostephanus Group.

J. Pompeckj and L. v. Sutner were the first to emphasize the independent position of the *Eudoxus*-group by establishing for it the genus *Aulacostephanus*.[1] The extent of the genus is approximately indicated by stating that it comprises the species *Aulacostephanus eudoxus* d'Orb., *Aul. mutabilis* Sowerby, *Aul. pseudomutabilis* Lor., *Aul. phorus* Dum. et Font., *Aul. autissi-dorensis* Cott., *Aul. Undoræ*

[1] Zittel, *Grundzüge der Palāontologie*, 1903, p. 460.

Pavl., *Aul. subundoræ* Pavl., *Aul. Syrti* Pavl., *Aul. jasonoides* Pavl., *Aul. karpinsensis* d'Orb., *Aul. Stuckenbergi* Pavl., *Aul. progenitor* Oppel.

Neumayr's theory concerning the origin of the *Eudoxus*-group, the present genus *Aulacostephanus*, received deeper and more precise significance from Würtenberger; in a highly interesting memoir[1] Würtenberger shows that not only *Ammonites involutus*, but also *Amm. biplex bifurcatus* (*Amm. Witteanus* Oppel), *Amm. stephanoides* Oppel, and *Amm. Strauchianus* Oppel formed starting points for the *mutabilis*-ammonitoids, and moreover that these forms are connected, not with *Perisphinctes*, but with the *anceps*-group of the Callovian—that is to say with the present genus *Reineckia*. All the above-mentioned transitional forms, to which *Amm. trimerus* Oppel, *Amm. trifurcatus* Quenstedt, and *Amm. anceps albus* Quenst. have to be added, are characterised by deeply cleft ribs whose origin, along the umbilical margin, swells into tubercles; on the inner volutions tripartite or multiple ribs frequently predominate, whilst on the outer whorls bifurcate ribs are the rule.

This type of ornamentation is so characteristic and agrees so well with *Reineckia* that there cannot be any doubt as to the close relationship of the types in question with *Reineckia*. Consequently a more detailed and specialised investigation of these forms is all the more desirable and would prove particularly interesting as they must be considered to have formed the starting-point not only of the *Aulacostephanus* series, but also that of *Himalayites*.

Würtenberger's views concerning the connection of *Aulacostephanus* with *Reineckia* were adopted subsequently by Zittel,[2] Steinmann,[3] Nikitin,[4] and others, and may be considered as generally accepted. It is not nearly so difficult to solve the problem of the origin of *Aulacostephanus* as it is to trace the subsequent course of its development in Lower Cretaceous times.

The Neocomian species which may be looked upon as members of the *Aulacostephanus* stock include the small group of allied forms consisting of *Hoplites ambiguus* Uhlig, *Hopl. himalayanus* Uhlig nov. sp., *Hopl. Cautleyi* Oppel sp. and *Hopl. hystrix* (Bean) Neum.-Uhlig. In *Hopl. ambiguus* and its relatives, deeply cleft rib-bundles make their appearance only near the anterior end of the shell; since the rib-bundles are preceded, during the earliest and middle stages of development by the typical sculpture of the Neocomian forms of *Hoplites*, there can be no doubt that the *Aulacostephanus*-like bundle-sculpture of the species referred to above represents an independent acquisition of the final stage, and that consequently those forms do not stand in any phylogenetic relationship with *Aulacostephanus*. As will be noticed later on we are much less certain on this point

1 *Studien über die Stammesgeschichte der Ammoniten*, Leipzig, 1880, pp. 81—87, and genealogical table.

2 *Handbuch der Paläontologie.*

3 *Elemente der Paläontologie.*

4 Vestiges de la periode crétacée dans la Russie meridionale. *Mem. Com. géol.*, V., St. Petersbur 1888, p. 172.

in the case of *Hoplites Cautleyi* Oppel sp.,[1] *Hoplites himalayanus* Uhlig n. sp. and *Hoplites hystrix*.

In the Gault, the type of sculpture which characterises *Aulacostephanus* is found again in the large group of the coarse-tubercled species of *Hoplites* of that formation. As it is extremely difficult to come to a final decision with regard to the phylogenetic relations of these forms, we have to allow the question to remain open, but nevertheless we must declare ourselves in favour of the hypothesis that the Gault *Hoplites* should be grouped not with *Aulacostephanus*, but with the *Hoplites* proper of the Neocomian.

This view, if correct, must lead us to admit that the *Aulacostephanus* group died out in Tithonian times after having flourished for only a short period and without a very abundant development. If, on the other hand, the forms from the Neocomian and the species of *Hoplites* from the Gault, referred to above, were after all to be considered as issued from the *Aulacostephanus* stock, we would have to suppose that this group, after having flourished for a first time during the Kimeridgian age and languished during Tithotian and Neocomian times, passed through a second period of vigorous development in the Gault.

To judge from the discoveries made up to the present, the genus *Aulacostephanus* developed chiefly in the Extra-Alpine and Russian Kimeridgian. The Spiti fauna has hitherto furnished no representative of this genus. On the other hand, allied forms appear to occur in Argentina; they have been described by Steuer under the generic name of *Odontoceras* (*Steueroceras* Cossmann) and connected with a form from the Kimeridgian of Weymouth (*Steueroceras anglicum* Steuer)[2]. Although the ribs of these species exhibit a much more pronounced sigmoidal curvature than is usual with *Aulacostephanus*, and although, in the case of *Steueroceras anglicum* and *St. transgrediens*, they are much more densely crowded, yet they originate as bundles from small umbilical tubercles, a disposition which constitutes a very important feature bearing evidence to the close relationship which must exist between *Steueroceras* and *Aulacostephanus*.

Steuer connects these species not with *Aulacostephanus*, but with *Cosmoceras*, and we cannot but admit the existence of a certain amount of superficial resemblance with certain forms of *Cosmoceras*, particularly with *Cosmoceras Jason*. On the basis, however, of an examination of the original type specimen of *Steueroceras transgrediens*, the opportunity for which I owe to the kindness of Professor A. von Koenen, I feel compelled to declare this species to be in all probability

[1] Nikitin referred *Hoplites Cautleyi* to the group of *Hopl. mutabilis*, and therefore to *Aulacostephanus*.

[2] Cossmann substituted the generic name *Steueroceras* for *Odontoceras* which was already pre-occupied. Steuer refers to this genus a great number of species from Argentina described by him, but the majority of them have evidently nothing to do with *Steueroceras anglicum* and *Steueroceras transgrediens*, but belong to various other genera. Although Steuer does not explicitly state which of the various species he considers as the type of his genus, he nevertheless bases the whole of his description on *Ammonites anglicus* and *Amm. transgrediens*, and also applies the name *Odontoceras* to these species; the name *Odontoceras* and therefore also the name *Steueroceras* has consequently to be reserved for those two species. This view has already been expressed by Cossmann (*Revue critique de Paléozoologie*, 1898, p. 115).

more closely related to *Aulacostephanus*. Whether the genus *Steueroceras* should be maintained or whether it should be united with *Aulacostephanus* has to be left undecided, at least for the present. To decide this question definitely will require more copious material. If it could be ascertained that *Aulacostephanus* is provided with a body-chamber analogous to that of *Steueroceras transgrediens*, similarly ornamented with ribs which originating independently and remaining simple, such an observation would constitute a weighty argument in favour of the union of both groups into one genus.[1]

II.—The Neocomian Hoplites Group.

It is the ornamentation of the shell that constitutes the safest guide in attempting to classify the countless forms derived from the group of the Neocomian *Hoplites*. By this means we may distinguish forms provided with rather straight ribs bifurcating rather high up, others with rather straight ribs bearing tubercles, and finally forms with sigmoidal ribs and a feeble development of tubercles. For the sake of simplicity we shall call the first group Perisphinctoid, the second one Trituberculate, and the third group Costate. The ornamentation of the trituberculate forms consists of strong main-ribs, each with an umbilical, lateral and external spine and of weaker branch-ribs which are tuberculiferous only on the external margin. In the costate forms all the ribs are approximately uniform in their development, and it is only on the umbilical wall and on the external margin that they swell into tubercles.

The cross-section of the volutions of the perisphinctoid forms has a tall elliptic shape, somewhat flattened externally. The cross-section of the costate forms is rounded-trapezoidal or less frequently elliptical, that of the trituberculate forms is frequently octagonal.

The external lobe is invariably only slightly shorter than the first lateral lobe; the external saddle is always very broad and sub-divided by a secondary lobe. Similarly there is little variation as regards the second lateral and the auxiliary lobes. The first lateral lobe, on the other hand, is variable. In the majority of species it possesses a long and stout trunk bearing sub-symmetrical lateral branches and a long terminal branch. But in other instances the trunk of the first lateral lobe may experience a shortening (*Neocomites*) or may even become funnel-shaped. In this case the lateral branches are developed unsymmetrically and the ramification is copious (group of *Neocomites amblygonius*). In several species of *Acanthodiscus* the trunk of the first lateral lobe is much

[1] The specimen from the Kimeridgian of Weymouth which Steuer described under the name of *Odontoceras anglicum* has been sent to the author by Professor A. Pavlow as *Amm. pseudomutabilis*. From this it follows that Professor Pavlow, or whoever labelled the specimen, recognised its relationship to *Aulacostephanus*. It is not without interest to note here that in the original specimen of *Steueroceras transgrediens* a fine calcite lamella extends between the external denticles of the air-chambers, which connects the individual denticles with each other, a feature which, to my knowledge, has not been observed hitherto in Ammonitoids.

narrower. In the group of *Hoplites Leopoldi* the lobes become reduced, the first lateral lobe being stout and unsymmetrically divided.

A.—PERISPHINCTOID FORMS.

The perisphinctoid forms are undoubtedly the most primitive forms amongst the Neocomian *Hoplites*. The origin of the forms is so intimately connected with certain species of *Perisphinctes* that it is not an easy task to trace the boundary line between them. Zittel and Pictet[1] appear to have been the first to discriminate more precisely between these apparently so uniform Ammonitoids, and they pointed out particularly three types, namely *Ammonites transitorius* Oppel, *Ammonites Callisto* d'Orbigny, and *Ammonites privasensis* Pictet.

Of these three types *Ammonites transitorius* is evidently closely connected with the *Perisphinctes* stock. The ventral furrow is yet narrow, the rib completely resemble those of *Perisphinctes*, and the suture-line with its narrow first lateral lobe, its obliquely disposed second lateral lobe, its deeply depressed umbilical lobe and its long external lobe exhibits essentially the characters of *Perisphinctes*. We shall therefore attach *Ammonites transitorius* and its relatives to the genus *Perisphinctes* in the wide sense of this term.

In *Ammonites privasensis* the ribs are fairly straight and their branching-point lies above the middle of the flanks, but the ventral furrow is broader and deeper than that of *Ammonites transitorius*, and the rib-terminations show a clear tendency towards becoming thickened on either side of the furrow, a feature which presents the first indication of a mutational tendency characteristic of *Hoplites*, but foreign to *Perisphinctes*. Moreover, the branching point of the ribs exhibits slight traces of swellings in accordance with the *Hoplites* type of sculpture.

It is therefore *Ammonites privasensis* which amongst the derivatives of *Perisphinctes* shows slightly, but quite clearly, the first signs of a fresh mutational tendency towards the genus *Hoplites;* this fact compels us to draw a sharp systematic division-line between *Ammonites privasensis* and *Ammonites transitorius* and to place *Ammonites privasensis* in the neighbourhood of the genus *Hoplites*, however closely allied those two species may otherwise prove to be. *Ammonites Callisto* d'Orbigny stands already nearer to the bulk of the *Hoplites* forms by reason of its ribs being more strongly sigmoidal and more deeply cleft and its rib-terminations being somewhat more distinctly thickened on either side of the ventral furrow. Moreover, the structure of the suture-line of this species clearly exhibits the *Hoplites* character.

Several other forms of the Upper Tithonian and of the Berriasian behave similarly to *Ammonites privasensis* and *Ammonites Callisto.*

Several other *Hoplites* features are for the first time feebly, though distinctly, indicated amongst some of these species, for instance the tubercle-shaped swelling

[1] *Mélanges paléontologiques*, p. 245.

of the ribs on the umbilical wall in *Amm. abscissus* Oppel, the thickening of the points of ramification in *Amm. obtusenodosus* Ret., the formation of isolated rib-bundles in *Amm. n. sp. aff. privasensis* Pictet.

These features appear to constitute an evident link between the perisphinctoid forms of *Hoplites* and the bulk of the remaining and more advanced forms of this genus. A number of these forms pass through an immature stage during which the sculpture completely corresponds with that of the perisphinctoid types; we only need mention here such forms as *Hoplites Michaelis* Uhlig, *Hopl. hystricoides* and *Hopl. Ruprechti* Oppel sp.

Notwithstanding, however, the relationship of the perisphinctoid types with the advanced *Hoplites* forms from the Neocomian, it is impossible to overlook the fact that the two groups are separated from each other by a wide gap. Systematic palæontology ought to take this fact into account, and this consideration induces me to propose uniting the perisphinctoid forms into a new genus under the name of *Berriasella*.

The following species find their place in *Berriasella* :—

Berriasella *privasensis* Pictet sp.
„ *Callisto* d'Orbigny sp.
„ cf. *privasensis* Bogoslowsky.
„ *Oppeli* Kilian (= *H. Callisto* Zittel *non* d'Orb.).
„ *carpathica* Oppel sp.
„ *abscissa* Oppel sp.
„ *delphinensis* Kilian sp.
„ *subcallisto* Toucas sp.
„ *Callisto*, var. *Berthei* Toucas.
„ *consanguinea* Retowsky sp.
„ *oltusenodosa* Retowsky sp.
„ *Janus* Retowsky sp.
„ *pontica* Retowsky sp. (Simionieseu).
„ *Kokeni* Behrendsen sp.
„ *mendozana* Behrendsen sp.
„ *rjasanensis* Lahusen sp. (Nikitin).
„ *subrjasanensis* Nikitin.
„ *swistowiana* Nikitin.
„ *vetusta* Steuer sp. (?)
„ *peregrina* Burckhardt sp.
„ *australis* Burckhardt sp.
„ *molinensis* Burckhardt sp.
„ cf. *Theodorii* Burckhardt (*non* Oppel).

H. Tenochi Felix[1] and *H. Xipei* Felix may also belong to *Berriasella*.

The genus *Berriasella* is represented in the New as well as in the Old World and is distinguished by its wide distribution. Its chief homes are the horizons

[1] *Mexicanische Kreide*, Pl. 38, fig. 3 (*non* Pl. 39).

of Stramberg, of Berrias, and of Rjazan, that is to say, the passage beds between the Jurassic and the Cretaceous Systems. In the Lower Neocomian *Berriasella* gives way to more advanced types, while in the underlying beds it is the genus *Perisphinctes* that predominates. Notwithstanding the correctness of this statement, we do not ignore the fact that in those very junction beds where *Berriasella* is so abundant, it is already associated with the earliest of the more advanced types, a point to which we shall recur later on.

In the fauna of the Spiti Shales the genus *Berriasella* is represented by only two species, and they are incompletely preserved. These are *Berriasella privasensis* Pictet sp. and *Berriasella nov. sp. ind. aff. privasensis* Pictet. The incompleteness of these remains is all the more regrettable as the Spiti Shales harbour a richly developed and well-defined group of forms which are apparently closely related to *Berriasella Callisto* d'Orbigny. *Ammonites Wallichi* Gray constitutes the well-known type of this group for which we propose the new generic name of *Blanfordia*.

BLANFORDIA, nov. gen.

All the forms of the genus *Blanfordia* pass during their ontogenetic course of development through a common early stage characterized by a type of ornamentation which is essentially that of *Berriasella Callisto* d'Orb. sp. At this stage the shell is beset with slightly sigmoidal ribs which are simple at their point of origin along the umbilical margin, which bifurcate into two secondary ribs somewhat above the middle of the flanks and which on the ventral margin are interrupted by a furrow or by a smooth band on either side of which they are thickened into tubercles. In isolated forms, such as *Blanfordia Wallichi*, *Blanf. subquadrata*, and *Blanf. applanata*, this primitive stage of development continues up to a later age, and only after the shell has attained a considerable size a slight change sets in just before the commencement of the body-chamber in so far as the previously close connection of the secondary with the primary ribs becomes looser and intercalary ribs make their appearance. In other forms the secondary ribs increase in number with the result that corresponding to each main-rib we count three secondary ribs in *Blanf. curvata* and *Blanf. Boehmi*, four, five, or even six secondary ribs in *Blanf. Middlemissi* and *Blanf. Celebrant*. At the same time the connection of the secondary ribs with the main-ribs may either remain distinct enough to give rise to the formation of rib-bundles or else intercalary ribs are inserted between the other secondary ribs. This change is accompanied by a tubercle-like swelling of the branching-point of the ribs, which in the most extreme case, that of *Blanf. Celebrant*, leads to the formation of massive conically projecting knots. In *Blanf. Celebrant* these knots already make their appearance at an early age; in *Blanf. Boehmi* they commence forming somewhat later. This development of knots must not be confounded with the occurrence of fine small tubercles on the early volutions, such tubercles appearing in a specimen of *Blanf. rotundidoma* when its diameter has reached only

7 mm. and again becoming gradually obsolete, after the diameter has exceeded 23 mm.

Amongst the species which are immediately allied to *Blanf. Wallichi* the ventral furrow remains distinct as far as the neighbourhood of the body-chamber, and only at that stage does the furrow flatten out and become indistinct, allowing the ribs to traverse the external margin uninterruptedly, although more or less reduced. In other forms the furrow becomes obliterated at a somewhat earlier age, but even in the largest-size specimens it is indicated by the swelling of the ribs on the external margin. The external tubercles are distinctly developed in only a few forms, such as *Blanf. acuticosta*, nevertheless their presence is suggested by the occurrence of slight rib-swellings which can be observed even in large specimens.

Umbilical tubercles are not developed in any of the forms belonging to the present group, nor is it possible to discover, even in a single case, a distinct union of two main-ribs at the umbilicus.

In all forms of the genus *Blanfordia* the relation of thickness to height of volution changes in the course of ontogenetic development in this sense that with increasing size the thickness increases comparatively more rapidly than the height. This statement is not only applicable to the species from the Spiti Shales, but according to G. Boehm holds good also with respect to the forms from the Dutch East Indies. It is true that the relatively more rapid increase in thickness is, as a rule, not very considerable, not, for instance, as considerable as in the genus *Himalayites;* it is indeed only slight in some species, but nevertheless noticeable. The cross-section of the volutions of many species is elliptic, at least during the earlier stage, but starting from this as the primitive form the cross-section may become now trapezoidal, now subquadratic, now roundish-depressed in outline. The most strongly inflated species, such as *Blanf. Celebrant and Blanf. Middlemissi*, possess fairly thick volutions even when quite young. The umbilical wall is that part of the shell which is least affected by those changes; in all the various forms it is slightly rounded, and it is never distinctly marked off from the flanks, whilst its slope towards the wide, often funnel-shaped umbilicus is almost always more or less oblique, seldom steep.

The suture-line exhibits none but unimportant variations. The external and the first lateral lobe are of about equal length. The first lateral lobe has a massive trunk which ramifies sub-symmetrically giving origin to a slender terminal branch and to two principal as well as to several secondary lateral branches. The second lateral lobe is much shorter than the first one; in the more slender forms of the genus its disposition is somewhat more oblique and its conformation is somewhat more unsymmetrical than in the strongly inflated species. In the thick forms—*Blanf. Celebrant* and *Blanf.* sp. ind. G. Boehm—the second lateral lobe possesses a short and broad trunk and a remarkably long and narrow terminal branch. In almost all forms the external saddle is divided into two parts by a long secondary lobe. These two parts of the external saddle are of

about the same size in some forms such as *Blanf. Celebrant*, *Blanf. Cricki*, *Blanf. curvata*; in others, especially in *Blanf. Wallichi*, the inner portion is smaller than the outer one. As a rule the first lateral saddle is somewhat more slender than the external saddle. In the majority of forms a secondary lobe penetrates obliquely into the saddle and subdivides it into a smaller and lower outer and a larger and more highly placed inner segment. Two secondary lobes are developed in the first lateral saddle of *Blanf. applanata* and in the ventral saddle of *Blanf. Asseni* Boehm. The first lateral saddle of *Blanf. Rooseboomi* Boehm is exceedingly broad. It is scarcely possible to trace any definite law regulating the variations of the suture-line, excepting that a greater thickness of the volutions usually seems to coincide with a greater breadth of the saddles and to allow a more perfect development of the second lateral lobe.

The genus *Blanfordia* is represented in the Spiti Shales by the following species:—

Blanfordia Wallichi Gray sp.
" *rotundidoma* n. sp.
" sp. ind. aff. *Wallichi* Gray sp.
" aff. *rotundidoma* n. sp.
" n. sp. ind.
" *Cricki* n. sp.
" *subquadrata* n. sp.
" *applanata* n. sp.
" *latidoma* n. sp.
" *Boehmi* n. sp.
" *Middlemissi* n. sp.
" *Celebrant* n. sp.
" *curvata* n. sp.
" *acuticosta* n. sp.
" 2 n. sp. aff. *acuticosta* n. sp.

Connected with these species by the closest ties of affinity are the following forms described by G. Boehm from the Dutch East Indies—*Hoplites Wallichi*, *Hoplites Rooseboomi* G. Boehm, *Hoplites Asseni* G. Boehm, and *Hoplites* n. sp.

All these forms can be arranged in three groups. The first of these groups comprises *Blanfordia Wallichi*, *Blanf. rotundidoma*, *Blanf.* sp. ind. aff. *Wallichi*, *Blanf. subquadrata*, *Blanf. applanata*, and *Blanf. Cricki*. In this group the primitive forked rib sculpture is retained up to the final stage; the volutions are comparatively flat, and with advancing age their cross-section assumes a trapezoidal or subquadrate shape.

The second group consists solely of *Blanf. acuticosta* n. sp. and two new not sufficiently well characterised forms, and is distinguished by the sharp, ridge-like ribs, the deep ventral furrow, the strong external tubercles, and the comparatively steep umbilical wall.

The third tgroup includes thick, inflated forms with coarse ribs, the branching-points of which are swollen into nodes, while there are numerous

secondary ribs disposed in bundles of three to six. *Blanf. latidoma* and *Blanf. Cricki* constitute somewhat of a transition between the third and first groups.

The third group is especially of morphological interest. Here we meet forms such as *Blanf. Celebrant* and *Blanf. Middlemissi* in which the characteristic mutational tendency has been carried to such extreme limits that they have developed into types which have an entirely foreign aspect and, instead of presenting the characteristic features of *Hoplites*, rather recall certain forms of *Holcostephanus*, of *Perisphinctes* (especially *Perisphinctes Pottingeri* Waagen and Futterer) or of *Himalayites* or certain *Reineckias*. Indeed, it requires some care not to overlook the connection of these extreme types with the more primitive forms. Certain branches of the *Holcostephanus* stock acquire a certain degree of resemblance to Blanfordia: thus amongst the species of *Spiticeras* we notice especially *Spiticeras Stanleyi* Opp. sp. (pl. XVI), amongst those of *Polyptiches*, *Polypt. Keyserlingi* Neumayr et Uhlig, *Polypt. marginatus* Roemer, *Polypt. polyptychus* Keys., while amongst *Simbirskites*, there is *Simb. coronula* Koenen. Although *Himalayites* differs by its long intermediate ribs which reach down to the umbilicus, its resemblance to the extreme forms of *Blanfordia* may become exceedingly close, as is also the case with *Reineckia*, especially *Reineckia latior* Steuer. We have here to deal with an instructive instance of the convergence of several branches of Ammonoids, the starting points of which are certainly located at considerable distances from each other.

Much more formidable than these cases of convergence are the difficulties encountered in the attempt to elucidate the relation of the Asiatic genus *Blanfordia* to the genus *Berriasella*, as previously defined. *Berriasella* as compared with *Blanfordia*, consists of forms of smaller growth, with finer and more numerous ribs, steeper umbilical walls and less ramified lobes. Moreover, the ribs of *Berriasella* are somewhat less sigmoidally curved and here and there exhibit a tendency to become thicker at their points of origin, whilst the ribs of *Blanfordia* are very inconspicuous at their umbilical origin and increase in thickness up to the middle of the flanks.

These differences would hardly deserve being noticed, were it not for the fact that *Blanfordia* constitutes an exceedingly homogeneous group, whose evolution proceeds along lines not at all noticeable in *Berriasella*. Those strongly divergent forms with inflated volutions, thickened tuberculiferous main-ribs and numerous secondary ribs which stamp the Asiatic section of *Blanfordia* as so characteristically distinct, are entirely wanting within the form-circle of *Berriasella*. In any case the fact that *Blanfordia* is related to *Berriasella* cannot be established without a certain amount of detailed investigation. On the other hand, the generic identity of the British Indian species of *Blanfordia* with those from the Dutch East Indies is evident at first sight. This fact appears to be of the greatest possible significance in connection with the direction in which the development of *Blanfordia* has proceeded and speaks strongly in favour of the unity and well-defined position of the group besides assisting us to form a

correct conception of its relation to *Berriasella*. We have to take cognisance of the fact that *Blanfordia* has developed along lines of its own as a well-defined phylogenetic unit. Considering its relationship to *Berriasella* we might treat it as a separate peculiarly modified branch of *Berriasella*. It appears to me, however, that the purpose of a natural system is to give expression to evolutional phenomena of this nature, and consequently I feel constrained to deal with *Blanfordia* as a separate sub-genus. It would be of the highest interest to know the exact geographical distribution of *Blanfordia*. As far as our present knowledge goes, *Blanfordia* is a group characteristic of the Indian province, a group whose vertical distribution coincides with the passage-beds between the Jurassic and Cretaceous Systems.

B.—TRITUBERCULATE FORMS.

ACANTHODISCUS, nov. genus.

The general type of sculpture of these forms, which play a most important part in the Neocomian and which we unite under the new name of *Acanthodiscus*, has been so frequently described that we may dispense with reproducing that description in this place.

Acanthodiscus passes through a primitive costate stage, which, in some forms, is continued into the middle stages of growth, whilst in other forms it is replaced at an early stage by the tituberculate type of sculpture. In some of the more extreme forms, such as *Acanthodiscus subradiatus* n. sp. and *Acanthodiscus hexagonus*, the costate type of sculpture seems to be entirely eliminated from the course of development, the forms referred to exhibiting tituberculate ornamentation when only 6 mm. in diameter. Whether the primitive costate stage is of the same type in all forms of *Acanthodiscus* is a question which can hardly be decided on the basis of the available but deficient material, nor has it been investigated with sufficient accuracy. The costate stage of *Acanthodiscus Ruprechti* Oppel sp., *Ac. spitiensis* n. sp., *Ac. asiaticus* n. sp., *Ac. Michaelis* Uhlig, and *Ac. hystricoides* Uhlig is precisely of the same character as *Berriasella*. Since all the species or *Acanthodiscus* exhibit an intimate relation to one another after having reached the full-grown stage, whatever may have been the course of their development during the younger stages of growth, it appears that in the discussion of phylogenetic problems too much weight should not be given to variations observable in the earlier stages. Primitive stages with discrepant features are met with in those forms in which the course of ontogenetic development is considerably shortened and which exhibit an extreme type of tituberculate sculpture. One would naturally expect that those forms which, from their earliest stages of growth, already exhibit certain adult features are the very ones which, as has frequently been said, "falsify the developmental record."

The marked prominence of the tubercles imparts to the cross-section of the volutions of the majority of the species of *Acanthodiscus* a more or less angular,

often octagonal shape. It also produces a certain amount of distortion of the interior space of the shell, producing peculiar variations in the structure of the suture-line. In any case, distortions of the suture-line, such as occur in *Acanthodiscus octagonus* (see plate XXVII, fig. 3c), are caused by the formation of tubercles. In every form of which the suture-line is known, the number and usually, the disposition of the suture-line, as well as the number of the principal inflections, are constant, but the degree of ramification, the length of the branches and the breadth of their trunks are subject to considerable variations. *Ac. Hookeri* and *Ac. acanthoptychus* possses rather broad lobe-trunks, *Ac. subradiatus*, *Ac. Sömmeringi*, *Ac. octagonus*, and *Ac. asiaticus* rather narrow ones. The European *Acanthodiscus radiatus*[1] and the Indian *Acanthodiscus subradiatus* are exceedingly closely allied in every respect; and yet the lobe-trunks of the former are remarkably broad, those of the latter are very narrow.

Among the Indian forms of *Acanthodiscus* the group of *Acanthodiscus octagonus*, which besides the latter species includes *Ac. octagonoides* n. sp. and *Ac. polyacanthus*, exhibits the most extreme varieties of shape. The intercalary ribs disappear here completely or nearly completely, and the sculpture only consists of strong main-ribs which in the middle stages of growth resolve themselves into two anteriorly deflected branch-ribs. In the most extreme form, *Acanthodiscus octagonus*, one of these two branch-ribs is even suppressed with the consequence that the body-chamber only bears a few simple main-ribs, each with an umbonal, a lateral, and a ventral tubercle. The primitive costate stage is traversed exceedingly rapidly. The tubercles are produced into long massive spines which, on the chambered portion of the shell, are shut off by a lamella from the interior of the shell. The bodies of the lobes are narrow; in *Ac. octagonus* some of them are distorted. In the largest specimens the body-chamber shows signs of becoming disconnected from the inner whorls. In connection with this feature it is interesting to notice that there exist species of *Crioceras* closely related by their ornamentation to the group of *Acanthodiscus octagonus*, such as *Crioceras Roemeri* Neum. et Uhlig, *Crioceras varicosum* v. Koenen, and *Crioceras Strombecki* v. Koenen. Amongst the forms which are close-coiled according to the manner of normal ammonites it is only *Hoplites Sayni* Simionescu from the Berriasian of the south of France which can be placed here besides the Indian species already referred to.

The second group includes the following Indian species:—

Acanthodiscus subradiatus n. sp.
" *acanthinus* n. sp.
" *hundesianus* n. sp.
" *Sömmeringi* Oppel sp.
" n. sp. ind. aff. *subradiatus* n. sp.
" (?) *Medea* (Strachey) Blanf. sp.

[1] See Neumayr and Uhlig, *Hilsammoniliden*, Pl. 34, fig. 2b.

As in the *octagonus*-group, the species of the present group also show an early tendency to abandon the costate stage. Corresponding to each main-rib one observes at least two and frequently a greater number of branch-ribs or intercalary ribs. The ventral band is exceedingly broad, and the external tubercles change into thickened ribs traversing the ventral band. Only in the remarkable form *Acanthodiscus hundesianus* do the external parts of the ribs give rise to external tubercles at the anterior end of the shell. The lobes have small trunks.

The group of *Acanthodiscus subradiatus* is not sharply separated from the group of *Acanthodiscus octagonus*. *Ac. Sömmeringi* Oppel forms a connecting link: this species still approaches the *octagonus*-group very closely with regard to the sculpture of its flanks, but at the same time it possesses the broad ventral band traversed by ribs, of the *subradiatus*-group.

It is impossible to overlook the great resemblance of the Indian *Ac. subradiatus* with *Ac. radiatus* from the Neocomian of Europe. We might even suppose the specific identity of the two forms, if this supposition were not precluded by the very different disposition of their suture-line as has already been mentioned. Besides *Acanthodiscus radiatus* we can place in the present group various other European and American species of *Hoplites*, such as *Ac. Vaceki* Neum. et Uhlig, *Ac. Ottmeri* Neum. et Uhlig, *Ac. curelensis* Kilian, *Ac. asinensis* Canav., *Ac. malbosiformis* Steuer, *Ac. hospes* Bogosl., *Ac. micheicus* Bogosl., *Ac. Bonarellii* Canav., *Ac. Malbosi* Pictet, *Ac. Euthymi* Pictet, *Ac. Chaperi* Pictet. We have here enumerated together forms from the Berriasian, the lower Neocomian, and the lowest strata of the Middle Neocomian, but we have to remark that the relation of the geologically older of these forms to the geologically younger ones requires further elucidation and our enumeration can have only a provisional character.

The following Indian forms can be united into a third group:—

Acanthodiscus Hookeri (Strachey) Blanf. sp.
„ *La Touchei* n. sp.
„ *acanthoptychus* n. sp.
„ *Smithi* n. sp.
„ aff. *hystricoides* Uhlig sp.

In these forms there are developed regularly between each two successive main-ribs one or two, or even three weaker intermediate ribs, of which one takes its origin in the umbilical tubercle of the main-rib. The external tubercles are small and show a tendency towards a gradual reduction, and only the lateral tubercles grow out into spines. The ventral band is rather narrow. The lobes possess broad trunks, their branches being fairly well developed, but only slightly ramified.

It would be possible to draw a sharper division line between this group and the preceding one, if it were not for the occurrence, within the confines of these groups, of forms such as *Ac. octagonoides* and *Ac. Sömmeringi* in which the

intermediate ribs are not yet completely obliterated, being partly still visible as feeble traces. Consequently here also it is not possible to draw a rigid boundary line. Of European forms *Acanthodiscus perornatus* Retowski, *Ac. Rütimeyeri* Sarasin et Schondelmeyer (*non* Oster), *Ac. sub-Chaperi* Sar. et Schondelm., and *Ac. hystricoides* Uhlig appear to belong to the present group.

Still less sharply marked off is the fourth group including the following Indian species:—

Acanthodiscus spitiensis n. sp.
„ aff. *Michaelis* Uhlig sp.
„ *tibetanus* n. sp.
„ *asiaticus* n. sp.
„ aff. *asiaticus* n. sp.
„ n. sp. ind. aff. *spitiensis* n. sp.
„ *Ruprechti* Oppel sp.

In these forms the rib-sculpture still further predominates over the tuberculation, which sinks to the position of a subordinate character. The number of intermediate ribs amounts to three or four. The volutions are higher and more slender than in the other groups, the lobe trunks more copiously ramified. In several species the general external appearance is determined by the ribs and not by the spines, and the latter appear to differ considerably from those of the preceding groups. But here again we meet with intermediate forms which establish a close connection with the other groups. Such species as *Acanthodiscus* aff. *hystricoides*, which has been enumerated in the preceding group, might just as well have been placed in the fourth group. In Europe the present group is represented by *Acanthodiscus Michaelis* Uhlig sp., *Ac. Hohennegeri* Uhlig sp., *Ac. Paquieri* Simionescu sp., *Ac. sub-Chaperi* Retowski (*non* Sarasin et Schondelm.), *Ac. pseudo-Malbosi* Saras. et Schondelm., *Ac. incompositus* Ret. sp., *Ac. incompositus discrepans* Ret. sp., *Ac. Rütimeyeri* Oost. p.p.

Notwithstanding considerable differences in details, the four groups which we have just discussed constitute a well circumscribed systematic unit. A single form, however, *Acanthodiscus himalayanus* n. sp., occupies a position apart from the others and cannot be united with any of the other groups. Its anterior extremity exhibits a trituberculate ornamentation, but the inner portion of the shell up to a diameter of 55 mm. is beset with bundles of unbranched ribs originating in the umbilical tubercles and exhibiting the typical *Aulacostephanus* sculpture. Only two of the species of *Hoplites* from the Neocomian of Europe, namely, *Hoplites hystrix* (Bean) Neum. et Uhlig and *Hoplites spiniger* v. Koenen from the Hils formation of Northern Germany, exhibit similar features.

With regard to these remarkable forms, we have to choose between two alternatives: either the *Aulacostephanus* sculpture of the inner whorls indicates the phylogeny, or the trituberculate ornamentation of the middle and final stages must be taken as a guide. On the former supposition, the trituberculate

ornamentation must be regarded as acquired during the middle stage of growth, causing a remarkable convergence of *Aulacostephanus* towards the Neocomian *Hoplites*. In the latter alternative we shall have to assume that the bundles of ribs are a "cænogenetic" acquisition of the immature stage, and the forms in question will have to be united with the Neocomian *Hoplites*.

The insufficiency of the material at our disposal renders it impossible to arrive at a definite conclusion. Remembering, however, that the forms in question agree with the Neocomian forms of *Hoplites* in many of their characters, and that the other species of *Acanthodiscus*, notwithstanding their evidently constituting a well-defined unit, exhibit differences in their immature characters, we are induced to group these forms with the Neocomian *Hoplites*. It is in this sense that we refer *Hoplites himalayanus* to *Acanthodiscus*. Whether the group of *Hoplites himalayanus* and *Hoplites hystrix* occupy within the form-circle of *Acanthodiscus* a sufficiently independent position to justify our assigning to them a separate generic name is a question the answer to which can only be supplied by future investigations.[1]

C.—COSTATE FORMS.

The costate form of the European *Hoplites* may be arranged in a number of smaller groups which stand side by side without any clear connecting links. We might have expected to discover, among the numerous Indian species, transitional forms which would have bridged over the gaps between those groups. Such, however, is not the case, for the Indian forms can either be readily identified with European species, or they exhibit the same group-characteristics, or else fall naturally into distinct groups of equal value as compared with the European ones. Not only, therefore, has the relative independence of the various costate *Hoplites* groups not suffered by the discovery of the numerous Indian forms, but, on the contrary, it has been accentuated and further confirmed. And, although there can be hardly any doubt about future finds bringing to light various transitional forms, the relative independence of the different costate *Hoplites* groups is a remarkable fact notwithstanding their close relationship, and this fact ought to find expression in the systematic treatment of the genus. This can be most suitably done by the establishment of a number of subgenera. Compared with the genera of the Triassic Ammonoids or those of the Upper Lias and Lower Oolite, founded by S. Buckmann, the size of our subgenera is very considerable indeed.

[1] A special generic name for *Hoplites hystrix* is already in existence. Its author is Hyatt, who performed the remarkable feat of bringing together, in the same family, the involute *Hoplites hystrix*, with its undoubted *Hoplites* suture, and the evolute *Pictetia* Uhlig, which has the suture of a *Lytoceras*. This is one amongst innumerable unfortunate instances in which Hyatt has created the utmost confusion in the systematic account of the Ammonitoids without assigning any reasons whatsoever for a mode of procedure so completely at variance with the judgment of all his predecessors.

The costate forms of the Neocomian *Hoplites* may be divided into the following groups and subgenera :—

1.—The Group of Hoplites pexiptychus.

Kilianella, nov. subgenus.

Small forms with a comparatively simple suture-line. There occur fairly distinct, and frequently even deep constrictions. The ribs are either slightly or decidedly falciform: starting from the umbilical wall they run in a straight radial direction up to about the middle of the volutions and then bend suddenly and decidedly backwards, and only close to the ventral face do they again assume a forward inclination. Certain ribs split up at half the volution-height, others run undivided from the umbilicus to the external margin. In some forms the simple ribs exceed the branching ones in number. The large majority of the ribs originate singly on the umbilical wall, and only a few ribs start as rib-pairs. In some forms a weak tubercle or a slight thickening marks the branching-points of the ribs. The external margin is smooth, and it is bordered on either side by the rib-terminations which are thickened and often also broadened and bear a small tubercle. The cross-section of the volutions is comparatively low, and is elliptical or rounded-octagonal in shape. The shell is rather flat and possesses a wide umbilicus.

The following Indian species belong to the subgenus *Kilianella* :—

Kilianella pexiptycha Uhlig (pl. LXXXII, fig. 2).
,, *constricta* n. sp. (pl. LXXXII, fig. 5).
,, n. sp. ind. aff. *epimeloides* Parona sp. (pl. LXXXVI, fig. 5).
,, n. sp. ind. (pl. LXXXII, fig. 4).
,, *leptosoma* n. sp. (pl. LXXXII, fig. 3).

Of these species *K. constricta* is distinguished mainly by its exceedingly deep constrictions, *K.* n. sp. aff. *epimeloides* by the pronounced backward inclination of its somewhat irregular ribs, *K.* sp. ind. by the distinctly falciform shape of its individual ribs.

The following European and African species may also find place in this group :—

Kilianella pexiptycha Uhlig (= *Hoplites Roubaudi* d'Orbigny, *teste* Kilian).
,, *asperrima* d'Orbigny sp.
,, cf. *asperrima* d'Orbigny (Uhlig).
,, *sinuosa* d'Orbigny sp.
,, *epimeloides* (Mgh.) Parona.
,, *Isaris.* Pomel sp.
,, *Roubaudi* Pavlow.

The French palæontologists place *Kilianella pexiptycha* in the group of *Hoplites neocomiensis*. According to Kilian the distinction between *Hoplites neocomiensis* with distantly spaced ribs and *Hoplites pexiptychus* with finer ribs is not always

easy to make out.[1] Ch. Sarasin also considers these forms as belonging to one and the same group, and P. Lory, who has devoted a special memoir to these forms, alludes even to direct transitions between *Hoplites pexiptychus* and *Hoplites neocomiensis*.

I myself have never been able to accept this view in its integrity, but believe in the distinction of a sharper dividing line between *Hoplites pexiptychus* and *Hoplites neocomiensis* notwithstanding their undoubted relationship.[2]

The new Indian types confirm my doubts. They exhibit the characteristic features of the *pexiptychus*-group to perfection without any tendency towards *Hoplites neocomiensis* or any other group of the costate *Hoplites*. This fact speaks strongly in favour of the relative independence of the *pexiptychus*-group in the sense of the present monograph. It is true that the constrictions are not equally strongly marked in all the forms, nor is the falciform curvature of the ribs as strongly developed everywhere as it is in forms such as *Kilianella* aff. *periptycha* and *Kilianella* n. sp.; and finally the number of unbranched and single ribs is somewhat variable; in any case, however, the general significance of these characters cannot be doubted.

Constrictions do not occur[3] in any other *Hoplites* group; in no other group are the ribs so distinctly falciform, nor do single and unbranched ribs play such an important part; in no other group do we find such small shells. These peculiar characters justify the establishment of a separate genus which, notwithstanding its small extent, will have to be maintained even in the case of future discoveries disclosing a closer relationship between the present group and other groups than can be assumed to exist at present. The large number of single ribs recalls the genus *Berriasella*; the Tithonian form which F. Roman figured under the name of *Hoplites pexiptychus* (non *Hopl. pexiptychus* Uhlig), and which we have referred to when dealing with the genus *Berriasella*, forms a connecting link between *Kilianella* and the primitive genus *Berriasella*.

2.—The Group of Hoplites Thurmanni.

Subgenus Thurmannia, Hyatt.[4]

This group also consists of only a few species. Amongst Indian species we place here only *Thurmannia Boissieri* Pictet sp., *Thurmannia Kingi* n. sp., and *Thurmannia* cf. *rarefurcata* Pictet, and of European forms of *Hoplites* we are at present able to enumerate only *Thurmannia Boissieri* Pictet, *Thurmannia Paquieri* Simionescu and *Thurmannia rarefurcata* Pictet. Probably, however, *Hoplites*

[1] Fossiles du crét. inf. de la Provence. *Bull. Soc. géol. France*, 3ème série, Vol. 16, p. 680.

[2] *Cephalopodenfauna der Teschener-und Grodischter Schichten*, p. 32.

[3] An exception is exhibited by the remarkable *Hoplites* n. sp. ind. aff. *perisphinctoides* Uhlig from the Valenginian of the Carpathian Mountains of Silesia (*Cephalopodenfauna der Teschener-und Grodischter Schichten*, Pl. VI, Fig. 1, p. 52.

[4] Zittel-Eastman, *Text-book of Palæontology*, 1903.

Storesi Stanton, *Hoplites angulatus* Stanton, and *Hoplites crassiplicatus* Stanton belong also to *Thurmannia* (*Bull. U. S. Geol. Survey*, 133).

W. Kilian[1] was the first to lay special stress on the characteristic features of *Hoplites Thurmanni*. He showed that in *Hoplites Thurmanni*, similarly to *Hoplites neocomiensis* and *Hoplites amblygonius*, there appear bundles of ribs which become branched on the flanks; whilst, however, the branching of the ribs of *Hoplites amblygonius* and *Hoplites neocomiensis* takes place at various heights now above, now below the middle of the flanks, the branching-points of the ribs of *Hoplites Thurmanni* lie uniformly at the same height above the middle of the flanks.

The situation of the branching-points of the ribs at the same height above the middle of the flanks is not only characteristic for *Hoplites Thurmanni*, but also for the remainder of the forms grouped under *Thurmannia*, and together with other characters secures to this group a certain degree of independence. On the flanks the ribs are slightly sigmoidal, almost after the manner of those of *Perisphinctes*, and only in the vicinity of the ventral face do they exhibit a slight forward curvature. In the earlier and middle stages of growth the ribs are interrupted on the external margin, but the rib-terminations are only slightly thickened and distinctly transverse. In the full-grown stage the external region becomes rounded and the ribs traverse it uninterruptedly with only a slight reduction. In certain forms, the number of single ribs is greater than that of the bundles of ribs. Single ribs appear to be especially numerous on the inner volutions; the sculpture then shows a considerable resemblance to that of *Berriasella* and to that of the non-tuberculate primitive stage of certain forms of *Acanthodiscus*, such as *Acanthodiscus Michaelis* Uhlig. This resemblance becomes accentuated by a tendency towards a thickening of the points of origin of the bundles of ribs on the umbilical wall and at the upper branching-points.

The suture-line is not known in any case: according to Kilian that of *Hoplites Thurmanni* approaches that of *Hoplites pexiptychus* and *Hoplites neocomiensis*.

The subgenus *Thurmannia* is certainly not so satisfactorily characterised and sharply defined as the subgenus *Kilianella*. Nevertheless we have to concede to it a certain degree of independence. The costation is of a more primitive character than that of *Hoplites neocomiensis* and *Hopl. amblygonius*, and notwithstanding a certain general resemblance it cannot be placed on a level with the species just mentioned. With regard to the costation, there is a somewhat greater resemblance to *Hoplites Theodorii* Oppel in so far as in the latter species frequent single ribs also make their appearance and their shape is slightly sigmoidal and perisphinctoid on the flanks. But the ribs of *Hoplites Theodorii* and its nearest allies are deeply cleft, constituting a feature connected with a somewhat different type of costation.

[1] *Sur quelques Céphalopodes nouveaux ou peu connus*. Grenoble 1892, p. 10.

Considering that the differentiation of the present group is not particularly pronounced, and that it is of only small extent, we should probably have abstained from raising it to the rank of a subgenus, if A. Hyatt[1] had not made the best known form of the group, *Hoplites Thurmanni*, the type of a separate genus.

It is to be hoped that future discoveries and a more detailed study of the European material will conduce to a more precise characterisation of the present subgenus than is at present possible.

3.—Group of Hoplites varians n. sp. and Hoplites Ambiguus, Uhlig.

Sarasinella, nov. subgenus.

The forms of this small group are provided on their inner volutions with a more or less strongly developed trituberculate sculpture, which disappears from the last volution and is replaced here by undivided, slightly sigmoidal bundles of ribs. The trituberculate stage recalls certain species of *Acanthodiscus;* whilst, however, the latter bear simple ribs on their inner volutions and only in their middle and full-grown stages assume the trituberculate ornamentation, in the present subgenus the opposite course of development is followed: the trituberculate sculpture is characteristic of the primitive stage and gives way to the costate ornamentation in the adult.

The external form of the shell does not present any particular characters. It is similar, on the whole, to that of *Thurmannia* and of the following subgenus. The suture-line is generally constructed also according to the same fundamental type as that of *Thurmannia* and *Neocomites;* but it should be noticed that the terminal branch of the first lateral lobe is in several species not strictly in the direction of the middle line of the trunk, but is bent slightly towards the inner side.

As has been noticed before, slight indications of tubercles can be observed in several species of *Thurmannia.* We might therefore feel inclined not to attach much importance to the usually feeble tuberculation of the group of *Hoplites varians* and to unite this group either with the preceding or in the following one. But against this view we have to reckon with the fact that, in the later stages of growth, the tuberculate sculpture gives place to simple, rarely cleft bundles of ribs, producing, in the adult, a type of ornamentation which, as already mentioned, reminds us of *Aulacostephanus.*

The only European representatives of the present group are *Hoplites* (*Sarasinella*) *ambiguus* Uhlig, *Hoplites* (*Sarasinella*) aff. *ambiguus* Uhlig, and probably also *Hoplites campylotoxus* Uhlig from the Lower Neocomian of the

[1] Zittel-Eastman, *Text-book of Palæontology*, p. 585.

Carpathians in Silesia. To these scanty representatives we are able to add a somewhat greater number of species from the Himalaya, namely:—

Sarasinella varians n. sp.
,, *subspinosa* n. sp.
,, 2 n. sp. ind. aff. *subspinosa* n. sp.
,, n. sp. aff. *ambigua* Uhlig.

The Asiatic forms are closely related to the European ones, which leads us to the conclusion that we have to deal here with a well individualised branch of the genus *Hoplites*, whose evolutional direction deviates from that of the other *Hoplites* groups. This fact calls for the establishment of a separate subgenus, on which we bestow the name of *Sarasinella*.[1]

With this subgenus we may provisionally classify three forms whose ornamentation consists exclusively of forked ribs united into bundles, and amongst which a trituberculate stage has not yet been detected up to the present. These forms are *Hoplites Cautleyi* Oppel sp. (*non Spiticeras Cautleyi* Oppel sp.) from the Spiti Shales, *Hoplites teschenensis* from the Valanginian of the Carpathians of Silesia and *Hoplites fascicularis* d'Orbigny sp. Unfortunately these species are only imperfectly known, and consequently we are not able to arrive at a definite conclusion with regard to them. It is possible that they represent types which outgrow the trituberculate stage at an early period of their existence or have even eliminated it entirely from their ontogenetic development. *Hoplites campylotoxus* Uhlig may be looked upon as a transitional form, in so far as in this species traces of lateral tubercles are yet recognisable, which, in the forms referred to above, are entirely wanting. Or we may conceive that the forms in question are derived from *Aulacostephanus*, with some such form as *Aulacostephanus progenitor* Zittel as an intermediate link. Their resemblance to the full-grown stage of *Sarasinella* would then have to be regarded as a case of convergence. Considering the scantiness of the available material this question cannot be decided definitely for the present. We propose therefore to include these interesting forms provisionally in the subgenus *Sarasinella*.

Certain relations exist between this subgenus and a remarkable, large-sized form from the Lower Neocomian of Silesia, namely, *Hoplites austro-silesiacus* Uhlig. In this species also the primitive trituberculate sculpture is replaced on the last volution by a costate ornamentation. The ribs, however, which constitute the latter, are not gathered into bundles, but originate singly and subdivide into branches on the upper part of the flanks. It is probable that this form also represents a small lateral outgrowth, the evolution and significance of which cannot be clearly appreciated at present.

[1] Named in honour of Professor Ch. Sarasin of Geneva.

4.—NEOCOMITES, nov. subgenus.

Under this designation we unite the bulk of the Neocomian species of *Hoplites*.[1] On closer examination we find it possible in this form-circle also to differentiate a certain number of smaller groups, which, although distinguished by certain peculiarities, are, nevertheless, so intimately connected with one another that their generic separation would not be justifiable.

The Spiti Shales contain four of these smaller groups of *Neocomites*, namely :—

I. GROUP OF NEOCOMITES NEOCOMIENSIS d'Orbigny and NEOCOMITES NIVALIS n. sp. consisting of :—

Neocomites neocomiensis d'Orbigny sp.
" *nivalis* n. sp.
" *montanus* n. sp.
" *indomontanus* n. sp.

II. GROUP OF NEOCOMITES CALLIPTYCHUS n. sp. including:—

Neocomites calliptychus n. sp.
" *pycnoptychus* n. sp.
" *Walkeri* n. sp.
" *Nikitini* n. sp.
" aff. *Walkeri* n. sp.
" aff. *Nikitini* n. sp.

III. GROUP OF NEOCOMITES THEODORII Oppel sp. including :—

Neocomites Theodorii Oppel sp.
" *indicus* n. sp.

IV. GROUP OF NEOCOMITES ODONTODISCUS n. sp. including :—

Neocomites odontodiscus n. sp.
" n. sp. aff. *odontodiscus* n. sp.
" n. sp. aff. *odontodiscus* n. sp.
" n. sp. ind.

The ornamentation of the group of *Neocomites neocomiensis*, so far as is known, is characterised by an alternation of single and of double ribs. The single ribs are either simple or forked, whilst the double ribs consist, as a rule, of a simple and dichotomous rib. Bifurcation takes place usually on the middle of the flank, frequently also above the middle, more rarely below the latter. Thickenings and tubercles occur only at the origin of the ribs on the umbilical wall and also on the external margin. Lateral tubercles are not developed.

[1] The name *Lyticoceras* introduced by Hyatt cannot be adopted for this group, as it is impossible to ascertain what limits Hyatt intended to assign to his genus; moreover, the form—*Hoplites cryptoceras* d'Orb.—which he selected as the type of *Lyticoceras* belongs possibly to another group.

The nature of the external margin, the form of the shell and the suture-line have been described so often that it would be superfluous to enter here into details.

The sculpture of *Neocomites neocomiensis* and *Neocomites nivalis* n. sp. agrees exactly with the description outlined above, while *Neocomites montanus* and *Neocomites indomontanus* show slight deviations, in so far as all the ribs of the fascicles are branched, with the result that the number of ribs increases considerably on the outer portion of the volutions. This feature recalls *Hoplites cyptoceras* d'Orbigny, a species which cannot be referred to the present group in consequence of the discrepancy of its suture-line.

The group of *Neocomites calliptychus* consists principally of small forms with rounded flanks, oblique umbilical walls and somewhat strongly sigmoidal ribs, the points of bifurcation of which are situated at different heights. In one form, *Neocomites calliptychus*, there is a feeble indication of small tubercles. The suture-line is in general similar to that of the preceding group. It is, therefore, chiefly by the form of the shell, and of the more rounded or more elliptical cross-section, that the present group is distinguished from the preceding one.

Neocomites Theodorii Oppel sp. and *Neocomites indicus* also exhibit a close approach to the *neocomiensis* group. They possess sharp deeply cleft, nearly filiform ribs; the cross-section of their volutions is wedge-shaped and contracted outward, the ventral furrow is very narrow, and is traversed by the ribs in larger specimens.

The ornamentation and structure of the suture-line assign also to the fourth group, that of *Neocomites odontodiscus*, a place near *Neocomites neocomiensis*. The character which differentiates this group and gives it a remarkable appearance consists in the exceedingly broad, flattish and scanty ribs on the body-chamber. Unfortunately several species belonging to this group are so badly preserved that we have not ventured to define them specifically.

Of these closely related groups that of *Neocomites neocomiensis* d'Orbigny appears to have the widest distribution. In Europe it is represented not only by the well-known species whose name we have selected to designate the whole group, but also by *Neocomites castellanensis* d'Orbigny sp., *Neocomites heliacus* d'Orb. sp., *Neocomites vicarius* Vacek, *Neocomites scioptychus* Uhlig, *Hoplites* sp. (Uhlig, *Cephalopodenfauna der Teschener Schichten*, Pl. VI, fig. 7), and *Neocomites perisphinctoides* Uhlig. Amongst American species *Neocomites Tenochi* Felix and perhaps also *Neocomites Hyatti* Stanton may belong to this group. Very little can be said about the distribution of the remaining three groups.[1] Side by side with the remarkable *Neocomites odontodiscus* may be placed the American *Hoplites Burckhardti* Mayer-Eym., but nothing of the kind can be mentioned amidst the European material. At first sight, *Steueroceras transgrediens* appears to have a striking resemblance to *Neocomites odontodiscus*, but a closer examination discloses the fact that the type of sculpture as well as the structure

[1] The Fauna of the Knoxville beds. *Bull. U. S. Geol. Survey*, 133, 1895, part XVI, fig. 2, p. 79.

of the suture-line are different. No real relationship exists between these two forms, only an external resemblance based on similarity of shape and on the manner in which the fine costation of the inner volutions passes into the fold-like ribs of the living-chamber.

Neocomites Theodorii is possibly closely allied to *Hoplites volgensis* Uhlig nov. nomen (=*Hoplites amblygonius* Pavlow, *non Hoplites amblygonius* Neumayr et Uhlig), perhaps also to *Hoplites fallax* Steuer sp. *Neocomites Theodorii* presents also a certain degree of resemblance to *Hoplites perisphinctoides* Uhlig; this species, however, can be as well or even better referred to the *neocomiensis* group. Similarly it is not possible, on the basis of the available literature on the subject, to refer any European or American species to the group of *Neocomites calliptychus* notwithstanding the close affinity of the latter with the species of the *neocomiensis* group, especially with *Neocomites vicarius* Vacek.

Whilst, therefore, the fauna of the Indian Spiti Shales includes groups belonging to the costate division of *Hoplites* which do not have their equivalents in Europe, we are acquainted with some European groups of Neocomian origin which, as far as our knowledge goes, are wanting in the Spiti Shales: firstly, the GROUP OF HOPLITES AMBLYGONIUS, and, secondly, the GROUP OF HOPLITES LEOPOLDINUS. In Europe these groups belong chiefly to the Middle Neocomian. As to the true cause of these faunistic differences we are at present only able to offer conjectures: they may find their explanation in the palæontographical conditions of the Middle Neocomian epoch, or they may be referable to differences in geological age. As will be demonstrated later on, the Middle Neocomian is most probably represented in the Himalayan area, not by the richly fossiliferous Spiti Shales, but partly at least, and most probably entirely, by the Gieumal Sandstone, a formation poor in fossils; hence the absence from India of the above-mentioned Middle Neocomian form-groups admits of an easy explanation.

In order to complete our review of the Neocomian forms of *Hoplites* we propose to deal briefly with those European groups which are wanting in India.

The characteristic feature of the group of *Hoplites amblygonius* (=*Hoplites noricus* Schlotheim-Römer), to which, besides the latter species with its varieties *planicosta* v. Koenen and *euryomphalus* v. Koenen, we refer *Hoplites oxygonius* Neumayr et Uhlig, *Hoplites regalis* (Bean) Pavlow, *Hoplites paucinodus* Neumayr et Uhlig, and *Hoplites longinodus* Neumayr et Uhlig, consists in a peculiar development of the first lateral lobe: growing out of a short funnel-shaped trunk there is an excessively developed outer lateral branch, further a very feeble inner lateral branch and a very long terminal branch slightly displaced inwards. By reason of its occurrence in the Neocomian of England, Northern Germany, and Russia this group was first regarded as characteristic of the Neocomian fauna of Northern Europe. Subsequently it was shown that its supposed importance as characterising a zoological province had been somewhat overrated,

especially when W. Kilian was able to correctly point out the close relationship of the *amblygonius* group with *Hoplites neocomiensis*.

Indeed, there exists no essential difference as regards the shape and ornamentation of the shell between *Hoplites neocomiensis* and *Hoplites amblygonius*. It is only the suture-line which reveals any difference, the first lateral lobe of *Hoplites neocomiensis* being sub-symmetrically developed, with a uniformly broad trunk, nearly equally strong lateral branches and a terminal branch which is a direct continuation of the trunk, while the first lateral lobe of *Hoplites amblygonius* exhibits the asymmetrical structure already described.

Nothwithstanding the close relationship between *Hoplites neocomiensis* and *Hoplites amblygonius* the type of suture characterising the North German forms has not, so far as we know, been discovered in any of the Alpine species of *Neocomites* and *vice versâ*. This statement has been confirmed lately by the experience gained in Northern Germany as well as in the Carpathian region of Silesia. All the forms of *Neocomites* which have been described in the year 1901 from the Upper Teschener Slates of Silesia, which belong to the Alpine Province, exhibit, without exception, the Alpine type of lobes, whilst the Northern German forms of *Hoplites* with which v. Koenen acquainted us are as consistently characterised by the Northern European type.[1] We have, therefore, to reckon not only with the really existing relationship of the *amblygonius* group with *Hoplites neocomiensis*, but also with the divergence in the development of the lobes in the Alpine and Extra-Alpine regions of Europe. The recent advance in our knowledge has not altered any of the notions previously acquired: the *amblygonius* group remains restricted to the Northern European province, and the proof of a close relationship with *Neocomites neocomiensis* does not in any sense detract from its palæogeographical significance. It only remains to consider what is the most convenient way of emphasizing this fact in the classificatory system.

It is impossible to look at the divergent structure of the lobes of the group under discussion in the light of a variation in the ordinary sense of the term, for the divergence does not affect single individuals found in the same locality, but is characteristic of extensive groups belonging to distinct provinces. Neither have we to deal here with provincially vicarious variations, for we have also to reckon with a difference in the geological age which, although small, is by no means negligible, in so far as the group of *Neocomites neocomiensis* has its home in the Valanginian, whilst the group of *Hoplites amblygonius* belongs to the Lowest Hauterivian. It would be contrary, therefore, to the evidence of established facts to represent *Hoplites amblygonius* as a variety of *Neocomites neocomiensis*, and we cannot but adhere to our previous decision in regarding

1 Even the North German form which was designated as *H. neocomiensis* d'Orb. (?) by v. Koenen has an asymmetrical first lateral lobe; it differs, therefore, from *H. neocomiensis* in an important point, and for this reason cannot be identified with the later species. This appears to have been felt by A. v. Koenen, an undisputed authority on the Neocomian of Germany, as is shown by the query.

Neocomites neocomiensis and *Hoplites amblygonius* as distinct species. The only point which remains somewhat doubtful is whether the two species should be referred to the same genus or whether a separate subgenus should be created for the *amblygonius* group. The former alternative appears to be the more advisable as representing most correctly the present state of our knowledge, and we place, therefore, the whole of the *amblygonius* group in the subgenus *Neocomites*.

In the second of the two groups that are not represented in India, that of *Hoplites Leopoldinus*, the suture-line plays a decisive part: indeed, the suture-line of this group deviates so greatly from that of the remaining forms of *Hoplites*, that on repeated occasions stress has been laid on the desirability of creating a new genus for this group, a view with which we entirely concur. For the group of *Hoplites Leopoldinus*, which von Koenen included in his genus *Hoplitides*, Baumberger has established the generic, or, as we prefer to regard it, subgeneric division *Leopoldia* (*Abh. der Schweiz. pal. Ges.*, Vol. XXXII, 1905).[1]

We refer the following species to this subgenus[2]:—

Leopoldia Leopoldina d'Orbigny.
" *gibbosa* v. Koenen (=*Hoplites pronecostatus* Felix p.p.).
" *Leenhardti* Kilian (=*Hoplites neocomiensis* Pictet *non* d'Orbigny).
" *læviuscula* v. Koenen.
" *Brandesi* v. Koenen.
" cf. *cryptoceras* (d'Orb.) v. Koenen.
" *Bodei* v. Koenen.
" aff. *Arnoldi* (Pictet) v. Koenen.
" *paraplesia* Uhlig.
" *Zitteli* Uhlig.
" *biassalensis* Karakasch.
" *Inostranzewi* Karakasch.
" *Kurmischensis* Stschirowski.
" *menensis* Stschirowski (?).
" *cryptoceras* d'Orbigny (?).
" *heteroptycha* Pavlow.
" *Karakaschi* Uhlig (=cf. *Desori* Karak.).

1 In Professor Uhlig's original manuscript, *Hoplites Leopoldinus* was made the type of a subgenus *Solgeria*. In order to avoid burdening the nomenclature with synonyms, I have substituted the name *Leopoldia* previously established by Baumberger in 1905 for the same genotype. If the validity of the substitution be objected to on the grounds that the species included by Baumberger in his genus *Leopoldia* do not in every instance coincide with those included by Professor Uhlig in his subgenus *Solgeria*, the latter denomination may be reverted to. [E. V.]

2 The forms described by Baumberger from the western Jura are:—*Leopoldia Leopoldi* d'Orb., *Leop. Lorioli* Baumb., *Leop. Buxtorfi* Baumb., *Leop. Kiliani* von Koenen, *Leop. Renevieri* Baumb., *Leop. mucronata* Baumb., *Leop. incerta* Baumb., *Leop. castellanensis* d'Orb. (referred by Professor Uhlig to the group of *Neocomites neocomiensis* d'Orb.), *Leop. neocomiensis* Baumb. (*non Hopl. neocomiensis* d'Orb. *nec* Pictet), *Leop. hoplitoides* Baumb., *Leop. Bodei* v. Koenen, *Leop. consobrinoides* Sinzow. The following species, *Hopl. Leenhardti* Kilian, *Hopl. biassalensis* Kar. (including *Hopl. Brandesi* von Koen.), *Hopl. Karakaschi* Uhl., mentioned in Professor Uhlig's list, although studied by Baumberger, have not been included by him within his genus *Leopoldia*. [E. V.]

The general type of ornamentation and the shape of the shell are similar to the corresponding characters of *Neocomites*. Indeed, individual species possess a sculpture which is hardly distinguishable from that of *Neocomites neocomiensis*; such is for instance the case with *Leopoldia paraplesia*. Other species, such as *Leopoldia* aff. *Arnoldi* v. Koenen, *L. Zitteli* Uhlig, *L. Karakaschi* Uhlig, *L. heteroptycha* Pavlow, exhibit a slight tendency towards the formation of tubercles; in others again the ribs gradually disappear from the flanks and become reduced to obsolete traces in the vicinity of the external and umbilical margins. This retrograde evolution of the ornamentation during the adult stage is most strongly pronounced in the well-known instance of *Leopoldia Leopoldina*. The presence of close-set sigmoidal ribs on the upper part of the flanks characterises *Hoplites cryptoceras*, which, according to v. Koenen, has probably its proper place in the *Leopoldina* group.[1]

It is the suture-line which constitutes the peculiarity of this group. According to the prevailing opinion which is probably correct, the scanty and coarse ramification of the lobes and their low and broad trunks are to be considered as a case of reversion. In consequence of the stronger development and higher position of the outer lateral branch, the first lateral lobe acquires a strikingly asymmetrical form. D'Orbigny has already correctly represented this form of lobe in *Hoplites Leopoldinus*; latterly the same peculiarities have been commented upon by Sarasin, A. v. Koenen, and Baumberger. The unsymmetrical configuration of the *Leopoldia* lobes cannot be connected with that of the lobes of the *amblygonius* group. It is true that in the *amblygonius* group the outer lateral branch of the first lateral lobe is longer and more copiously ramified than the inner one; but it is very narrow, and the whole of the suture-line is copiously ramified. In *Leopoldia*, on the other hand, the lateral as well as the terminal branches are broad, stout and short, and the ramification is of a reduced type.

This difference in the conformation of the lobes is so considerable that the possibility of uniting *Leopoldia* with *Neocomites* is out of question, at least if we concede the necessity of subdividing the too comprehensive genus *Hoplites* into smaller groups. Solger[2] has already pointed out that the inclusion of the *Leopoldina* group in the Upper Cretaceous genus *Hoplitides* A. v. Koenen is not a satisfactory mode of procedure. *Hoplitides* possesses a wide umbilicus; the external region of its earlier volutions is depressed and accompanied by two smooth edges and the ribs are more strongly developed on the upper part of the flanks and not, as in *Hoplites Leopoldi*, on the external margin and the

[1] *H. cryptoceras* has been selected by A. Hyatt as the type of his genus *Lyticoceras*, to which that author refers also *H. amblygonius* (=*H. noricus*). We cannot utilise this name for the *Leopoldina* group no more than for the subgenus *Neocomites* for which it has already been found unsuitable, for Hyatt places *H. amblygonius* in the genus *Lyticoceras* and, therefore, assigns to the latter different limits to those which we have assigned to it. Moreover, it is by no means certain whether the still insufficiently known species *H. cryptoceras* really should be included in this group.

[2] *Ammonitenfauna der Mungokalke und das geologische Alter der letzteren*, p. 128.

umbilical wall. These facts prove that the genus *Hoplitides* is not closely related to *Hoplites Leopoldi*. Solger is not correct in his statement that *Hoplites Leopoldi* is nearly devoid of auxiliary lobes, since Ch. Sarasin has shown that it possesses two distinct auxiliary lobes which are separated from each other by broad saddles, but. in any case, the artificial union of the *Leopoldi* group with *Hoplitides* would not be in accordance with the actual natural conditions.

According to the present state of our knowledge the evolution of the subgenus *Leopoldia* took place during Middle Neocomian times, individual species such as *Leopoldia paraplesia* Uhlig, *L. Zitteli* Uhlig, *L. Kurmyschensis* Stschir., and *L. menensis* Stschir. making their appearance already in the Lower Neocomian. No transition exists between *Neocomites* or any of the other subgenera of *Hoplites* and *Leopoldia*. *Leopoldia*, therefore, occupies an isolated position side by side with *Neocomites*, and it is a remarkable fact that in individual cases we may trace parallel forms in *Leopoldia* and *Neocomites*, forms which resemble each other as regards shape and ornamentation, but which differ from each other with respect to the configuration of the suture-line. A good example is furnished by *Leopoldia paraplesia* with an unsymmetrical first lateral lobe and *Neocomites neocomiensis* with its first lateral lobe subsymmetrically constituted.[1] Other instances are quoted by A. v. Koenen.[2]

According to a somewhat plausible suggestion which was first advanced and ably advocated by Solger the reduction of the lobes might bear some connection with a change in the habits of the animal and might indicate a transition from a swimming to a crawling mode of life.

According to this view, the subgenus *Leopoldia* would consist of species of *Hoplites* which have exchanged a swimming for a crawling mode of life. Nevertheless, the majority of the forms, especially *L. gibbosa*, *L. gibbosula*, *L. Leenhardti*, *L. Brandesi*, *L. Leopoldi*, *L. heteroptycha*, produce the impression of a well-defined, perfectly natural group. Although our knowledge of the fauna of the Neocomian is as yet defective and does not allow us to arrive at quite definite conclusions, the available evidence is decidedly in favour of *Leopoldia* constituting a natural assemblage of closely allied forms.

A further fact seems rather to militate against Solger's explanation of the existence of parallel forms. We have already made the acquaintance of parallel forms within the form-circle of *Oppelia*. Here *Oppelia acucincta* and *Oppelia* (*Streblites*) *Griesbachi* exhibit fundamentally different lobes, although shape and ornamentation of the shell are very similar and of the same general type. Since, however, the lobes of both parallel forms are strongly laciniated, and since neither species shows any obvious reduction of the lobes, it is clear that the phenomenon of the parallelism of species may be perfectly unconnected with their mode of life, whether swimming or crawling.

[1] *Cephalopodenfauna der Teschener Schichten*, etc., pp. 60, 35.

[2] *Ammonitiden des norddeutschen Neocoms*, p. 169.

Considering the deficient state of material at our disposal, it is impossible to arrive at any final conclusion with regard to the points in question, and the definition of *Leopoldia* must be taken as somewhat provisional. Nevertheless, from the systematic point of view, the advantage gained by uniting these forms into one group is sufficiently obvious to justify the creation of a new generic term.

By placing *Leopoldia Leopoldi* together with *Leopoldia gibbosa* and *Leopoldia Leenhardti* (*H. neocomiensis* Pictet et Camp.) we differ from Pictet who connects *Hoplites Leopoldi* with *Hoplites radiatus* and even considers that the two forms may be specifically identical.[1] According to Pictet and Campiche the earlier stages of the two species are scarcely distinct from each other. This statement, however, does not agree with other experiences. *Acanthodiscus radiatus* from Northern Germany and *Acanthodiscus subradiatus* from the Spiti Shales as well as the species most closely allied to them do not show the least relation to *Leopoldia Leopoldi*. The suture-lines are totally different and, as has been observed in *Acanthodiscus subradiatus* as well as in *Acanthodiscus radiatus*, their innermost whorls exhibit even at the earliest stage the typical *Acanthodiscus* sculpture. We find it therefore impossible to connect these forms with *Leopoldia Leopoldi*. It is not impossible that the observations of Pictet and Campiche refer really to a form not identical with, but related to, *Leopoldia Leopoldi*, a form which shows a tendency towards the formation of tubercles and bears a certain external resemblance to *Hoplites radiatus*.

Another means of conciliating these contradictory views can be found in A. v. Koenen's conjecture that Pictet's *Ammonites Leopoldi* is really not the same species as d'Orbigny's, but a species with normal lobes, named *Hoplites Kiliani* by A. v. Koenen.[2] A solution of this difficulty by a study of Pictet's original specimens is very desirable.

III.—The species of Hoplites from the Aptian and the Gault.

The poverty of the Upper Neocomian in forms of *Hoplites* renders it extremely difficult to arrive at any satisfactory conclusion with regard to the connection between the species of *Hoplites* from the Aptian and the Gault and those from the Neocomian. The isolated form from the Barremian, such as *Hoplites Feraudi* d'Orb., *H. Soulieri* Math., *H. cruasensis* Torcapel, are probably connected with the Neocomian *Hoplites*. A number of other species, originally referred to *Hoplites* or else to *Acanthoceras*, have been united by D. Anthula[3] with certain tuberculiferous forms and raised to the dignity of a genus *Parahoplites*. This group also is probably a branch of the *Hoplites* stock and this is probably the

[1] *Ste-Croix*, p. 243.

[2] *Ammonitiden des norddeutschen Neokoms*, p. 168. Baumberger (*Abh. der Schweiz. pal. Ges.*, Vol. XXXII, 1905) has observed *Hoplites Kiliani* at Ste-Croix, and classified this species as a member of the genus *Leopoldia*. [E. V.]

[3] Kreidefossilien des Kaukasus. *Beitrage zur Palāontologie Oesterreich-Ungarns*, XII, s. 109.

case also with respect to the small, but geologically important, group of *Hoplites Deshayesi* and *Hoplites Weissi*, which also deserve separate generic designation.

In addition to *Parahoplites* and the *Deshayesi* group there occur forms, such as *Hoplites furcatus* Sow. (= *Amm. Dufrenoyi* d'Orbigny) and *Hoplites lurensis* Kilian of the Gault which by reason of their ornamentation can be considered as offshoots from the stock of the Neocomian *Hoplites*, as has already been pointed out by Ch. Sarasin. Closely related to these species, especially to *Hoplites lurensis*, are a number of still more extreme forms, such as *Hoplites regularis* Brug., *H. tardefurcatus* Leym., and perhaps also *H. Michelini* d'Orb. *Hoplites splendens* Sowerby also belongs perhaps to this group.[1]

These forms constitute only a small minority as compared with the richly ornamented types which we may suppose, as is probable, to have been specially aimed at by Neumayr when he founded the genus *Hoplites*, and to which, as was done by Hyatt, we have to refer the genus *Hoplites* if we intend to give it a narrower sense than understood by Neumayr.

Among these species of *Hoplites* proper some are distinguished by a very deep ventral furrow (*H. falcatus* Mant., *H. curvatus* Mant., *H. lautus* Parkinson, *H. tuberculatus* Sowerby, *H. auritus* Sowerby), whilst in the majority of forms the ventral face is normally developed (*H. denarius* Sov., *H. Archiaci* d'Orb., *H. interruptus* Brug., *H. Raulini* d'Orb., *H. Deluci* Brongn., *H. dentatus* Sov., *H. Benettiae* Sov., *H. Brongniarti* Pictet et Camp., *H. vraconnensis* Pictet et Camp., *H. Renauxi* d'Orb., *H. Chabreyanus* Pictet, *H. Senebierianus* Pictet, *H. Engersi* Rouill., *H. Canavarii* Par. et Bon., *H. talitzianus* Rouill.).

Leaving aside minor differences of the suture-line, the diagnostic characters which essentially distinguish the genus *Hoplites sensu stricto* from the stock of the Neocomian *Hoplites* consist in the absence of lateral tubercles and the absence of the rib-branching on the upper part of the flanks. In the species of *Hoplites* from the Gault only ventral and umbilical tubercles occur. The umbilical tubercles give rise to bundles consisting of two to three unbranched ribs, whereby arises a type of sculpture which is essentially identical with that of *Aulacostephanus*. And just as among the Upper Jurassic species of *Aulacostephanus* finely and coarsely costate types occur, so also are the *Hoplites* of the Gault differentiated into forms with fine, and others with coarse ribs. This fact suggests the possibility of considering the Gault *Hoplites* as an offshoot of the *Aulacostephanus* stock.

On the other hand we must not ignore the fact that the great gap existing between *Aulacostephanus* from the Kimeridgian and Tithonian and the genuine *Hoplites* of the Gault does not at all favour this view. Although this gap is occupied by the groups of *Hoplites Cautleyi* and of *Hoplites himalayanus* and *H. hystrix*, which, as we have seen, constitute possibly a continuation of the

[1] For *Hoplites splendens* Hyatt founded the new genus *Anahoplites* (Zittel-Eastman's Text-book of Palæontology, p. 584). No one can tell why Hyatt established this genus, nor how he intended defining it.

Aulacostephanus stock, those groups, which are in part trituberculous, are not clearly related to the *Hoplites* from the Gault and they can therefore not be considered as bridging over that gap. Moreover, the fact must not be overlooked that certain forms, such as *Hoplites furcatus, H. splendens, H. regularis, H. tardefurcatus* occupy a somewhat intermediate position between the species of *Hoplites* from the Neocomian and those from the Gault. By their ornamentation they are more closely connected with the former, whilst they are not without relations to the latter.[1]

Taking these facts into consideration, A. v. Koenen[2] and Ch. Sarasin[3] and other leading authorities on this subject have expressed the opinion that there exists a close connection between the group of the Gault *Hoplites* (Sarasin's group of *Hoplites interruptus*) and the Neocomian group of *Hoplites*, whilst Hyatt connects the genus *Hoplites sensu stricto* (the trituberculate species of *Hoplites* from the Gault) with *Reineckia*. We may hope that future exact studies based on a copious material may bring the question nearer to a satisfactory solution. Until then we may adhere to the more probable hypothesis that the *Hoplites* of the Gault are connected with the *Hoplites* of the Neocomian.

The few species of *Hoplites* from the Upper Cretaceous are generally too little known and have hitherto received too little attention to enable us to express any opinion regarding their relationship to other groups.

A.—PERISPHINCTOID FORMS.

HOPLITES (BERRIASELLA) CF. PRIVASENSIS, Pictet.

(Plate XC, fig. 6 *a*, *b*.)

Ammonites privasensis Pictet, Mélanges paléontologiques, pl. 18, figs. 1, 2, p. 84, p. 245.
Hoplites privasensis Kilian, Mission d'Andalousie, 1889, p, 660, pl. XXX, fig. 3.
Hoplites privasensis Toucas, Faune des couches tithoniques de l'Ardèche, *Bull. Soc. Géol. France*, 1890, 3ème ser., Vol. XVIII, p. 599, pl. XVII, fig. 1.

A fragment of a body-chamber, unfortunately incompletely preserved and showing indistinct traces of the last septum, represents a species which is very closely related to *Hoplites privasensis* and perhaps even identical with it. The ribs are exceedingly sharp and prominent, and nearly straight; they bifurcate somewhat above the middle of the volution height and are interrupted by a smooth and deep furrow on the ventral face. Below the point of bifurcation the ribs exhibit a slight swelling. Some of the ribs remain unbranched. The ribs are thickened on either side of the ventral furrow without forming real tubercles.

[1] For the true estimation of this relationship it is worth mentioning that, in the case of *H. regularis*, according to Pictet's researches, the umbilical tubercles of the outer volutions represent the lateral tubercles of the earlier whorls (Pictet, *Grès verts*, pl. 7, fig. 3, p. 331).

[2] *Ammonitiden des norddeutschen Neokoms*, p. 171.

[3] Quelques considérations sur les genres *Hoplites*, etc., *Bull. Soc. géol. France*, 3 serie, Vol. 25, p. 776.

The flanks are slightly arched and slope rather steeply towards the umbilicus. The cross-section has a flat elliptic form, the external margin being flattened. The proportion of height to thickness at the front end cannot be clearly ascertained in consequence of a slight distortion, due to pressure, of this part of the shell.

At the commencement of the body-chamber the height of the volution is 22·5 mm., the thickness, measured across the ribs, is 17 mm. As far as its general features are concerned, the suture-line appears to correspond with that of the following species, *Hoplites* aff. *privasensis*. The ornamentation of the described form agrees with *Hoplites privasensis* so closely that it is impossible to discover any difference worth recording. The ventral furrow of our form appears to be somewhat deeper than it is in the form from Southern France, but this may be due to the weathered condition of the ribbed decoration of the latter. The Asiatic form exhibits perhaps a somewhat greater thickness, more convex flanks and a somewhat narrower umbilicus. I am inclined to believe that these distinctive characters would not be worth considering if the European *Hoplites privasensis* were better known. This form, whose relationship to *Hoplites Callisto* D'Orb. and *Perisphinctes transitorius* Opp. has been very lucidly discussed by Pictet (l.c. p. 245), is often quoted by authors, but cannot be counted among those which are well known. A fragment from Stramberg figured by Zittel as *Ammonites Callisto* (plate XX, fig. 5) is considered by W. Kilian to be a developmental stage of *Hoplites privasensis*. Since this fragment possesses rather broad and flat ribs, whilst *Hoplites privasensis* has, on the other hand, high and sharp costæ, this supposition does not seem very acceptable.

Unfortunately the Asiatic material of this species is likewise very scanty, and this has prompted me to leave the exact identification of the Asiatic with the European species undecided for the present.

Hoplites privasensis is one of the typical zone fossils of the Berrias Stage. Pictet mentions this species from the Marl with *Belemnites latus*, Kilian and Toucas from the Upper Tithonian of Andalusia, Algeria, and the Department of Drome et Isère. Its occurrence at Stramberg should be verified.

Occurrence.—One species from Lochambelkichak, third Stage.

HOPLITES (BERRIASELLA) n. sp. ind. aff. PRIVASENSIS, Pictet sp.

(Plate XC, fig. 2 *a—d*.)

This species is also represented by a single small fragment with several septa and with the commencement of the body-chamber. The incompleteness of the material forbids the establishment of a new species. This is all the more regrettable as we have here to deal with an interesting species which stands near the boundary line between *Perisphinctes* and *Hoplites*.

The costation shows the greatest resemblance to that of *Hoplites privasensis* Pictet with the difference that the ribs bifurcate somewhat higher up, are somewhat more crowded, and perhaps less prominent. In consequence of the latter feature the ventral furrow seems shallower. A striking difference consists in the presence of a distinct constriction bounded posteriorly by a simple rib which seems stouter and somewhat more deflected anteriorly than the rest of the costæ, and which, on the lower part of the flank, unites with the preceding dichotomous rib.

As is the case in *Hoplites privasensis*, the flanks are rather flat; the rounded umbilical wall is rather steep, and the ventral face is broad and flattened. The shape of the cross-section is similar to that of *Hoplites privasensis*, but the shell is somewhat thicker. With a height of volution equal to 28 mm. the thickness amounts to 23·8 mm.

The suture-line is characterised by a combination of broad sellar phylla and broad lobal stems scantily ramified. In the first lateral saddle the suture-line ascends to a slightly higher level than is reached by the external saddle, after which it rapidly descends. The indistinctly preserved external lobe is comparatively short and extends scarcely as low down as the lateral branches of the first lateral lobe. The external saddle is broad and is subdivided by a short secondary lobe into two nearly equal broad leaflets. The trunk of the first lateral lobe is rather broad and bears a number of short scantily ramified lateral branchlets and a slender and longer terminal branch. The two main lateral branches originate at about the same height. The first lateral saddle is decidedly smaller than the external saddle and is subdivided by a narrow, somewhat obliquely placed secondary lobe into a lower exterior leaflet and a higher and broader interior leaflet. The short second lateral lobe is succeeded by a second lateral saddle which is cut into by a small secondary lobe, and finally by a small umbilical lobe. The latter is succeeded by a narrow and short inner lateral lobe and the slender subsymmetrical antisiphonal lobe.

The present species is closely allied to *Hoplites privasensis*. It is distinguished from the latter by the somewhat more numerous ribs, the somewhat higher situation of their point of bifurcation, perhaps also by the somewhat greater thickness of the volutions, and finally by the existence of a constriction. Whilst the last-mentioned character and also the high situation of the point of bifurcation and the straight course of the ribs recall the genuine *Perisphinctes*, the lobes as well as the nature of the external margin speak in favour of a reference to the genus *Hoplites*. It should be specially noticed that although the lobes exhibit a rather primitive structure, the suture-line shows all the peculiar characteristics of that of *Hoplites*, a fact which is entirely in accordance with the position of our species near the lower boundary line of the genus *Hoplites* taken in a wider sense.

The complete elucidation of the present species has to be postponed until fresh finds have been made.

Occurrence.—One specimen from Lochambelkichak, third Stage.

Hoplites (Blanfordia) Wallichi, Gray sp.

(Plate XXXI. fig. 1 *a*—*c*, fig. 2; Plate XXIX. fig. 1 *a*, *b*, fig. 2 *a*, *b*, fig. 3 *a*, *b*; Plate XXX. fig. 1 *a*–*c*.)

Ammonites Wallichi T. E. Gray, *Illustrations of Indian Zoology*, Calcutta, 1830-32, vol. I, pl. C, fig. 3.
Ammonites Wallichi H. F. Blanford, On Dr. Gerard's collection of fossils from the Spiti valley. *Journ. Asiat. Soc. of Bengal*, 1863, vol. XXXII, p. 127, pl. III, figs. 2, 3 (*non* pl. I, fig. 4).
Ammonites Wallichi in H. F. Blanford and Salter, Palæontology of Niti, 1865, p. 84, pl. XV, fig. 1 *a*, *b*, and the suture line 2 *d* (wrongly named *Amm. tenuistrialus*), pl. XIX, fig. 1 *a*—*c* (*non* 2 *a*—*c*).
Ammonites Parkinsoni Stoliczka, *Mem Geol. Survey of India*, Calcutta, V, 1865, p. 98.
Ammonites Wallichi G. C. Crick, The Cephalopoda in the Strachey Collection from the Himalaya. *Geol. Mag.*, Dec. V, vol. I, Febr. and March 1904, p. 13.
Hoplites Wallichi G. Boehm, Beitrage zur Geologie von Niederländisch Indien. *Palaeontographica*, Suppl. IV, Stuttgart, 1904, pl. III, fig. 4; pl. IV; pl. V, fig. 1 *a*, *b*. Text, figs. 7—9, p. 31.
Non Hoplites Wallichi Steuer, Argentinische Juraablagerungen. *Palaeontologische Abhandlungen von Dames und Kayser*, Neue Folge, Vol. III, Jena 1897, p. 58.

Dimensions:—

	Plate XXIX, fig. 1.	Plate XXIX, fig. 2.	Plate XXX, fig. 1.	Plate XXXI, fig. 1.
Diameter	132 mm.	76 mm.	109 mm.	
Width of umbilicus	49 „	25 „	42·5 „	
Height of the last volution above the volution-line	46 „	28·4 „	38 „	48 mm.
Thickness of the last volution, measured at the ribs	44 „	24 „	33·5 „	46·5 „

The real type of this species is the specimen figured by Gray in the year 1832. We owe to the labours of G. E. Crick the proof that this is the same specimen which Blanford has again figured in the "Palæontology of Niti" in 1865. Although I have at my disposal a rather rich material of *Blanfordia Wallichi*, not a single specimen agrees exactly with Gray's forms. It is true that the discrepancies are unimportant, but they are nevertheless noticeable. At the same time the general resemblance of the specimen is so marked that the impression received is one of the most intimate relationship. It might be possible to indicate particular points of difference, if only the living-chamber of a greater number of specimens had been preserved. Since this is not the case, the correct proceeding appears to be to give to our species a rather wide definition and to mention the different varieties in the text only without giving them special names. G. Boehm, with a much richer material from the Dutch Indies, appears to have had a similar experience with respect to the variability of this species; for he unites forms with each other which differ considerably with regard to cross-section and width of umbilicus.

Certain characters are observable in all specimens of *Blanfordia Wallichi*; all of them have a disc-shaped shell with a rather wide umbilicus, slightly convex flanks, the ventral face flattened, and the umbilical wall rather flat. All specimens are ornamented with strong, more or less rounded, slightly sigmoidal ribs, which, during the middle stages of growth bifurcate at about the middle of the

flanks into two secondary ribs and which are interrupted on the external margin by a rather broad, depressed, smooth band. On either side of this band the terminations of the ribs show slight swellings. All the ribs originate independently on the umbilical wall, certain isolated ones remaining undivided. On the umbilical wall, at their origin, the ribs are slightly deflected backwards; they do not show any inclination to becoming thickened at their point of origin. The number of ribs on a complete volution is 34 on an average; of these 3—5 remain, as a rule, undivided.

On the body-chamber, and perhaps already a little earlier, the smooth ventral band becomes gradually indistinct, and the ribs pass across the ventral face without pronounced interruption, although more or less reduced. In full-grown specimens, a third set of short ribs is intercalated close to the external margin while the branch-ribs become somewhat disconnected from the main-ribs.

The inner volutions have an elliptical cross-section, which increases in breadth with increasing size and thus acquires a more depressed form. The difference is, however, not remarkably striking. The volutions overlap one another by about one-third to one-fourth of their height.

The external lobe is only slightly shorter than the first lateral lobe. The external saddle is unsymmetrically divided by a secondary lobe in such a way that the broader half is situated on the outer side. The first lateral lobe has rather a broad stem with a slender branch and two lateral branches of which the inner one is more feebly developed than the outer one. The first lateral saddle is narrower and somewhat higher than the ventral saddle; a secondary lobe, somewhat obliquely placed, divides it into a lower and weaker outer and a higher and stronger inner portion. The second lateral lobe is much shorter than the first one, slightly oblique and unsymmetrical. It is succeeded up to the umbilical suture by three small obliquely directed auxiliary lobes. The successive septa follow closely one upon the other.

The body-chamber is not completely preserved in any of the specimens.

The original form of Gray and Blanford (variety *a*) exhibits proportionately low, very slightly overlapping volutions of a broadly elliptic cross-section, the greatest breadth of which is situated only a little below the middle of the volution. The steepness of the umbilical wall, especially in the last volution, is less prominent than in any of the remaining forms. With a diameter of 94 mm. the anterior portion of the shell already exhibits a distinct tendency towards an irregular development of the ornamentation with the intercalation of secondary ribs. In one place two main-ribs follow each other closely, in another place there is intercalated a secondary rib which extends nearly to the umbilical wall. The type form of *Blanfordia Wallichi* approaches *Blanfordia rotundidoma*: that is, if we imagine the special characters of the type to become more exaggerated we would arrive at *Blanfordia rotundidoma*.

Of the two specimens described by Blanford in 1865 as *Ammonites Wallichi* one (loc. cit. pl. XIX, fig. 1) appears to approach the typical form fairly close. The

specimen referred to only measures 43 mm., and therefore the specific characters are not yet sufficiently pronounced to form any definite opinion as to its true affinity. The specimen from the Dutch Indies figured by G. Boehm in pl. V, fig. 1, of his memoir agrees with the type better than any of the available specimens from the Spiti Shales.

A fairly common form (variety *b*) is represented in plate XXIX, figs. 1 and 2, and in plate XXXI, fig. 2. The umbilicus is somewhat narrower, the volutions overlap one another to a somewhat greater extent, are somewhat taller, especially on the inner portions of the shell, and have an umbilical wall which is flatter than in the typical variety. At the commencement of the body-chamber the ribs recede from each other in a marked manner; the cross-section assumes a trapezoidal form; the sloping portion of the umbilical wall becomes very broad. The greatest breadth of the cross-section is next to the umbilical wall.

A third variety (*c*), represented in fig. 1 of plate XXX, is principally distinguished by its very strong stout ribs. At the commencement of the body-chamber the cross-section has its greatest width in the vicinity of the umbilical wall, just as in the case of variety *b*; but it does not taper so much towards the external margin so that the ventral part of variety *c* appears broader and stouter.

Strong involution is the distinguishing character of variety *d*, which, unfortunately, is represented only by young individuals. The volutions overlap one another about half way and the umbilicus is consequently narrower than in the other varieties. Finally an additional variety (*e*) is indicated by a specimen of 85 mm. diameter from Kuti. The anterior part of the last volution already belongs to the body-chamber; the cross-section is trapezoidal, as in the case of variety *b*, but tapers more decidedly towards the external margin.

The forms which G. Boehm has described from the Dutch Indies exhibit likewise variable characters. A form figured in plate V, fig. 1, and in the text (fig. 7) agrees with Blanford's type (variety *a*). The form, plate IV, fig. 5, answers near enough to our variety *d* with strongly overlapping volutions. The cross-section, plate IV, fig. 16, approaches that of our variety *b*; the cross-section, plate IV, figs. 2—3, reminds us of our variety *c*.

The differences between *Blanfordia Wallichi* and the remaining forms of this genus are noted in the following descriptions. The form from the Tithonian of Argentina described by Steuer as *Hoplites Wallichi* is not identical with the Indian type, as has already been noticed by G. Boehm. In the species described by Steuer the ribs are not so curvilinear and are frequently branched in the vicinity of the volution-line. These features cannot be reconciled with the characters of *Blanfordia Wallichi*. We propose the name *Hoplites Steueri* for the Argentinian species.

Blanford united *Ammonites Mörickeanus* Opp. with *Am. Wallichi*. We are unable to accede to this opinion as will be explained when describing *Am. Mörickeanus*. Stoliczka's reason for referring *Am. Wallichi* and *Am. Mörickeanus* to *Am. Parkinsoni* is to be sought for in the idea of species then in vogue at the time when he wrote, and need not arrest any attention any further.

Blanfordia Wallichi has been obtained at the following localities:—

Lochambelkichak, third Stage: seven specimens, among them four specimens of variety *c*, one specimen of variety *d*, and two specimens of variety *b* (Coll. Diener).

Chojan, Middle Spiti Shales: one specimen.

Kuti, Upper and Middle Spiti Shales, among them one specimen each of varieties *c*, *d*, *e* (Coll. Krafft).

Kibber in Spiti, one specimen (Coll. Gerard).

Ladakh in Kashmir, probably from the Spiti valley (preserved in Berlin; Coll. Prochnow).

According to the statement of G. C. Crick the original specimen of Gray together with eight other specimens of this species are preserved in the British Museum; five of the specimens belong to the Strachey Collection and are labelled from the Niti Pass, another is marked Chirchun.

HOPLITES (BLANFORDIA) ROTUNDIDOMA, nov. sp.

(Plate LXXXIII, fig. 1 *a*, *b*; fig. 2 *a*, *b*.)

Only after much hesitation have we finally decided to separate from *Bl. Wallichi* the present form which closely approximates Gray and Blanford's type. Certain peculiarities of the type of *Bl. Wallichi* become, however, still more exaggerated, as if *Bl. rotundidoma* represented a further step in the mutational direction foreshadowed by that original type.

The volutions assume a still more rounded cross-section; the rather tall umbilical wall slopes more steeply, and the umbilicus is rather wider than in the type. The volutions overlap scarcely by one-quarter of their height, so that the bifurcation of the ribs is distinctly recognisable even inside the umbilicus. The number of ribs amounts to 33 on each volution; the ribs bifurcate at half the height of the volution, individual ones remaining undivided, while further incomplete ribs are occasionally intercalated in the neighbourhood of the external margin. In one place where the shell bears a slight impression on the ventral face, the succeeding rib is shorter than the remainder. The ventral furrow is appreciably sunken, and the rib terminations on either side of the furrow are thickened into something like tubercles. The suture-line is not distinctly preserved.

Of this species only two specimens are available. The larger one has a diameter of 90 mm., and a width of umbilicus equal to 38·4 mm.; the last volution is 30·4 mm. high and about 26 mm. broad. The anterior part of the outer volution of this specimen (plate 83, fig. 1) belongs probably to the body-chamber. The smaller specimen is distinguished by a somewhat narrower umbilicus and a smaller number of ribs which at the same time are apparently somewhat sharper. The inner volutions show distinct tubercular thickenings at the points of bifurcation of the ribs. The ribs are here preserved almost up to the innermost parts of the shell, and one can observe that they originate singly along the umbilical suture even at a diameter of only 3 mm. More copious material and larger specimens

might necessitate a specific separation of the second form. Both specimens are from the Lingti River and were collected by Krafft.

Blanfordia rotundidoma bears an unmistakable resemblance to *Hoplites australis* and *Hoplites molinensis* Burckh., but it cannot be united with either of these South American species; in both Argentine species the ribs are fewer and less distinctly curved and the secondary ribs originate much more frequently by intercalation. The umbilical wall slopes more steeply. The lobal bodies appear to be stouter and less branched than in the Indian form. In any case, however, the relationship is worth noticing.

Hoplites (Blanfordia) sp. ind. aff. Wallichi, Gray sp.

(Plate XXVIII, fig. 2 *a—d.*)

A chambered fragment 38 mm. high by 37·5 mm. broad is ornamented with slightly curved ribs which bifurcate about midway up the height of the volution. The ribs traverse the ventral face uninterruptedly, but are weakened along the median band. On either side of the median band they are slightly thickened. The flanks and external margin are gently rounded, the umbilical wall is low and rounded and has a rather steep slope. The greatest thickness is near the umbilical wall. The suture-line is only slightly ramified; the first lateral lobe has a broad stem; the external saddle is divided into two nearly equal parts by a secondary lobe. The first lateral saddle is subdivided by an oblique secondary lobe into two unequal portions of which the outer one is smaller and lower, while the inner one is larger and taller.

The described fragment is closely related to *H. Wallichi*, as shown by the suture and ornamentation. Nevertheless the peculiar cross-section, the rounding off of the flanks and of the external margin, and the low but rather steep umbilical wall, forbids its reference to that species. The shape of the cross-section and of the umbilical wall indicates a relationship to *H. acuticosta* n. sp. It is distinguished from *Blanfordia subquadrata* by the more pronounced convexity of its flanks and external margin, from *Bl. applanata* n. sp. by its lower whorls, more convex flanks, lower umbilical wall, the lower situation of the point of bifurcation of the ribs, and the structure of the suture-line.

This is evidently a particular form of the *Wallichi* Series in the narrower sense, the more detailed characterisation of which must be deferred until the discovery of more complete material.

One fragment from Spiti. Collection Gerard.

Hoplites (Blanfordia) aff. rotundidoma, n. sp.

(Plate LXXXIII, fig. 3 *a*, *b.*)

Like *Bl. rotundidoma*, so does the present species belong to the wide umbilicated *Blanfordiæ*. The outer volution has an approximately elliptical cross-

section, with truncated ventral face, flat convex flanks and roundish, rather steeply descending umbilical wall. The ribs are strongly curved, wider spaced than in *H. rotundidoma* and terminate in distinct small nodes on either side of the ventral furrow.

The small number and consequent wide-spacing of the ribs have mainly induced me to separate this form from *Bl. rotundidoma.* Unfortunately the available material is too poorly preserved and too incomplete to permit a satisfactory characterisation of this species. The biggest specimen has a diameter of 68 mm. and a width of umbilicus equal to 28 mm.; the outer volution is only partially preserved, the inner ones are missing. It comes from "Ladakh in Kashmir" (Coll. Prochnow in the Berliner Museum für Naturkunde). On a second specimen collected by von Krafft in Kuti, which has a diameter of 52 mm. and a width of umbilicus equal to 21 mm., the ribs on the inner portion of the shell are rather crowded, but suddenly become widely spaced on the anterior portion of the shell where they assume the condition observable on the larger specimens from Ladakh. Finally, a small fragment from Kuti, gathered by F. H. Smith, may have its place here.

Hoplites (Blanfordia), n. sp. ind.

(Plate LXXXIV, fig. 3 *a, b.*)

In consequence of its unsatisfactory state of preservation, this small fragment, which measures 27 mm. in height by 19 mm. in thickness, is unsuitable for a more accurate characterisation, but nevertheless deserves our attention, because of all the Indian forms it stands nearest to the European *Hoplites Callisto* d'Orb. The ribs are distinctly more crowded than in *Bl. Wallichi,* the cross-section is somewhat taller and the ventral furrow much narrower. Bifurcation of the ribs takes place well above the middle of the flanks. On one side of the fragment the ribs are preserved as cores and have a rather thin cord-like appearance. On the other side the shell is preserved and one notices then that they are very prominent and sharp-edged and are developed in the shape of ridges.

The position and the course of the ribs reminds us vividly of *Hoplites Callisto,* but the oblique umbilical wall and elliptic cross-section precludes its identification with the European species while indicating a close approach to *Blanfordia Wallichi.*

The specimen is from Hundes (Coll. Walker).

Hoplites (Blanfordia) Cricki, n. sp.

(Plate XXVIII, fig. 1 *a—d.*)

This species is represented unfortunately only by a single specimen, which has a diameter of 168 mm. and a width of umbilicus of 73·7 mm. The thick-

ness of the volution is 57 mm. as measured over the ribs at the anterior end at the commencement of the body-chamber. About one volution before this the thickness is 32·5 mm., the height 35 mm. In the last volution the thickness increases therefore relatively more rapidly than the height.

The volutions overlap by about one-quarter of their height. On the inner portion of the shell the flanks are compressed-convex; they slope obliquely towards the umbilicus. The cross-section has a broad elliptic outline, the greatest width being next to the umbilical wall; it gradually tapers towards the external margin, which results in a trapezoidal shape, similar to that of variety *b* of *Blanfordia Wallichi*, only more pronounced.

The sculpture of the inner volutions does not seem to differ essentially from that of *Bl. Wallichi*. The number of ribs on a volution is 33. The point of bifurcation of the ribs is situated rather high up during the middle stages of growth, but becomes shifted low down before the commencement of the final body-chamber. The ribs exhibit a ridge-like thickening at the point of bifurcation. Near the external margin a third adventitious rib is intercalated, usually shorter than the branch-ribs. The ventral furrow decreases in depth on the last volution, the ribs of the anterior portion of the shell either passing normally across the external face or constituting a shallow arch; although they are not interrupted, yet they are decidedly reduced along the median line.

The suture-line shows in general the same structure as in the other species of *Blanfordia;* nevertheless, it is distinguished by certain specific peculiarities. It is copiously ramified; the ramifications follow closely upon each other and are fairly long. The first lateral lobe has a strikingly broad and low, nearly funnel-shaped stem. The external saddle is relatively narrow and almost symmetrically divided by a deep adventitious lobe. The second lateral and auxiliary lobes could not be observed.

The present species bears undoubtedly a close relationship to *H. Wallichi*. The decided trapezoidal cross-section at the commencement of the body-chamber and the ridge-like prominence and the deep separation of the ribs in the anterior part of the shell would not suffice to separate this form from *Blanfordia Wallichi*, were it not for the suture-line which strongly deviates from that of *Bl. Wallichi*, owing to the shortness of the external lobe, the much narrower and nearly symmetrically divided external saddle, and the copious ramification, and remarkable funnel shape of the first lateral lobe.

The disposition of the ribs at the commencement of the body-chamber closely resembles that of the specimen of *Hopl. Wallichi* from the Dutch East Indies, which G. Boehm has figured in plate IV, fig. 1 *a*, *b*, of his monograph. In this form, too, the cross-section shows an inclination towards a trapezoidal shape; it is, however, much higher and tapers much more abruptly towards the ventral face than is the case in our species.

One specimen from Lochambelkichak, third Stage.

Hoplites (Blanfordia) applanatus, n. sp.

(Plate XXX, fig. 2; Plate XXXI, fig. 3 *a—c*.)

Dimensions :—

Diameter	133	mm.
Width of umbilicus	51	„
Thickness of last volution measured over the ribs	42	„
Height of the last volution above the volution line	48·5	„

In its fully grown condition the present species differs from *Bl. Wallichi* by its higher and flatter volutions and its generally more depressed shape. The volutions overlap one another by about one-fourth of their height. The flanks are rather flat on the inner volutions as well as at the commencement of the body-chamber; the rounded umbilical wall of the inner volutions slopes obliquely, that of the outer volution slopes down quite steeply into the umbilicus. The external margin is rounded, but somewhat flattened along the median line.

The ribs of the last volution are rather widely spaced. Their number is 31. They commence on the umbilical wall a little above the umbilical suture, and are already sharply defined on the umbilical wall. They are moderately curved on the flanks and bifurcate relatively high up, close to the external margin. The ventral furrow is already obliterated before the commencement of the body-chamber.

The lobes are characterised by very broad and low trunks; the saddles are, on the other hand, remarkably narrow. The lateral branches of the first lateral lobe spring at about the same height at the terminal branch and are directed downwards, not sideways, in consequence of which they run parallel with the terminal branch. The external saddle is divided into two parts by an adventitious lobe and is greatly hemmed in owing to the great breadth of this adventitious lobe. In the same manner the first lateral saddle is much encroached upon. Its division into a higher inner and lower outer leaflet is not due to one, but to two somewhat oblique, parallel, and closely approximate adventitious lobes.

These peculiarities of the suture-line are so characteristic that it is impossible to unite the form here described with *Bl. Wallichi*, the more so as in addition to them there are differences in the shape of the shell and in the sculpture. The relatively tall whorls and discoidal shell and the high position of the points of bifurcation of the ribs would make it possible to identify this species even if the suture-line were not present.

One specimen from Lochambelkichak, third Stage, with a portion of the body-chamber preserved.

Closely connected with *Bl. applanata* are two incompletely preserved specimens, the shells of which are rather flat with ribs bifurcating above the middle of the flanks. The ribs, however, appear to be somewhat closer set than in the type. The fragmentary condition of these remains, which I mention as *Bl.* aff.

applanata, does not allow of a more detailed characterisation. One of the specimens is from Kuti (Coll. F. H. Smith), the other from Laptal in Ngari Khorsum (Coll. Schlagintweit, Munich).

HOPLITES (BLANFORDIA) SUBQUADRATUS, n. sp.

(Plate LXXXIII, fig. 4 *a*, *b*, *c*; Plate LXXXIV, fig. 1 *a*, *b*.)

During the middle stages of growth the shell is characterised by a nearly square cross-section. At this stage the volutions overlap by about one-quarter of their height, their flanks are rather flat; the external margin is flattened, the umbilical wall rounded, but sloping rather steeply into the umbilicus. The diameter is 128 mm., the width of umbilicus is 52 mm., the height of the volution at the anterior end is 40 mm. The height of the preceding volution is 25 mm., and its breadth only 22 mm., so that in this species also there is a relative increase in thickness as the shell grows larger. The inner volutions exhibit therefore a somewhat taller and more rounded elliptical cross-section with a gentler slope of the umbilical wall.

The ribs are generally similar in character to those of *Bl. Wallichi*; but they bifurcate higher up and are somewhat less curved. The ventral furrow is still quite distinct when the diameter of the shell has reached 96 mm.; beyond this stage it becomes shallower, and is traversed by the ribs which then extend continuously, although somewhat reduced across the external margin.

The suture and body-chamber are unfortunately unknown.

This species is unfortunately represented only by a single, entirely chambered specimen; it is from Kuti, Upper and Middle Spiti Shales (Coll. Krafft).

In its earlier stages *Blanfordia subquadrata* is certainly very near *Bl. Wallichi*; in the adult stage, however, it undergoes a development which removes it considerably from *Bl. Wallichi*. The cross-section assumes a square shape; the ribs bifurcate on the upper part of the volution, so that the discrimination of these species, at least during the middle stages of growth, should not be a matter of great difficulty. The distinction would be still greater if the fragment depicted on plate LXXXIV, fig. 1 *a*, *b*, under the name of *Blanfordia* cf. *subquadrata* really belongs to this species, a view which is not improbable, but which cannot be absolutely confirmed owing to the deficient state of preservation of the specimen. The indistinct remainder of a middle volution exhibits a square cross-section and strong forked ribs, like *Bl. subquadrata*. The last portion of the chambers and a portion of the body-whorl indicate a considerable change in the sculpture and cross-section. The thickness amounts to 59 mm., the height is only 50 mm., the flanks are flattened as in *Bl. subquadrata*, the convex umbilical wall is low and steep, the external margin is more convex than in the chambered portion of the shell, and is greatly depressed. The course of the main-ribs along the flanks is almost radial; the subsidiary ribs, however, are decidedly deflected

forward, forming a shallow arch upon the ventral face. Side by side with the bifurcate-ribs there occur additional branch-ribs, so that for every 5 main-ribs there are 13 subsidiary ribs. Of the suture-line only the antisiphonal lobe and the second lateral lobe is preserved.

Amongst the forms most closely related to *Bl. Wallichi*, the species *Bl. subquadrata*, and more particularly the specimen described as *Bl.* cf. *subquadrata*, exhibit more than any other form a marked tendency towards a mutational variation in the direction of a dorso-ventral flattening of the whorls.

Bl. cf. *subquadrata* occurs in the Spiti Shales of Gieumal.

HOPLITES (BLANFORDIA) BOEHMI, n. sp.

(Plate XXXIV, fig. 1 *a—d.*)

Dimensions :—

Diameter	129 mm.
Width of umbilicus	53 „
Thickness of the last volution measured at the ribs	55 „
Height of the last volution above the umbilical suture	45 „

The solitary specimen upon which this species has been established exhibits a thick discoidal shape with whorls overlapping one another by about one-third of their height. The maximum breadth of the cross-section measured in the interspaces between the ribs occurs at the lower third of the height, but when the cross-section is taken actually through the ribs, its greatest width occurs about half-way up. The rounded umbilical wall slopes steeply towards the umbilicus; the flanks are rounded along their lateral surfaces, becoming slightly flattened towards the external margin; the external margin is depressed. The solitary available specimen does not allow the exact determination of the proportion of thickness to height in the case of the inner whorls; it is, however, possible to ascertain that the height of the innermost whorls is somewhat greater in proportion to their thickness than it is in the case of the outermost volution. Hence, in the course of development the thickness increases at a more rapid rate than the height, but the difference does not amount to much. Moreover, the flanks of the inner volutions are somewhat flatter than those of the outer whorls.

The ornamentation consists of very strong radially disposed ribs, which arise singly at the umbilicus, swell up into stout ridges and form an elongated rather prominent tubercle on the middle of the flanks. On the outer part of the shell each main-rib has three corresponding secondary ribs of which one owes its origin usually to intercalation, whilst two are branch-ribs. In the case of the majority of the rib-bundles the junction of the posterior branch-rib with the main-rib is more clearly marked than the corresponding junction of the anterior branch-rib. In this manner individual rib-bundles show a tendency towards assuming the falciform course which is characteristic of the costal sculpture of *H. Wallichi*. The secondary ribs of some of the rib-bundles have a nearly fan-shaped disposition. The ventral furrow appears to become obliterated already

at an early stage; on the last whorl the furrow is replaced by a broad band which is traversed by the ribs uninterruptedly, although they are distinctly reduced. On either side of the ventral band the ribs are sightly and just visibly thickened. On the last volution the number of main-ribs is twenty-five, on the last but one whorl it amounts to thirty.

The suture-line does not entirely conform to the type of *Bl. Wallichi*. The external saddle is subdivided by a deep secondary lobe into two parts which instead of being conspicuously unequal are of nearly equal size and subsymmetrically constructed. The first lateral saddle is divided, not as in *Bl. Wallichi* into a lower outer and a higher inner portion, but into two parts which stand nearly at the same level and are cut into by short and slender secondary lobes. The secondary lobes of the inner part of the saddle are longer than those of the outer one. The first lateral lobe has a strong and broad stem and is subsymmetrically built.

The specimen being chambered nearly up to its end, the characters of the body-whorl remain unknown.

Blanfordia Boehmi is so closely related to *Hoplites Asseni* Boehm[1] as regards sculpture and external form that at first sight one feels inclined to assume complete specific identity. It is true that on closer examination one notices that the volutions of *Hoplites Asseni* are somewhat broader and more depressed than in the present species, but this difference would be too insignificant to justify a specific separation of the two forms, were it not for the striking differences in the suture-line. The external saddle of *H. Asseni* is cut into by two distinct adventitious lobes, whilst that of *Bl. Boehmi* is intersected by only one. On the other hand, the lateral saddle of *H. Asseni* is narrower and indented by a smaller number of secondary lobes than is the case with *Bl. Boehmi*. Finally, the first lateral lobe of the latter species has a regular subsymmetrical conformation with a long terminal branch, whilst the corresponding lobe of *H. Asseni* is somewhat curved and possesses, besides the real terminal branch, a second subsidiary branch which is nearly as long as the terminal one. The importance ascribed by palæontologists to the details of the suture-line in the discrimination of species precludes the identification of the present species with *Hoplites Asseni*.

Hoplites Boehmi is represented by a single specimen from Lochambelkichak, third Stage.

HOPLITES (BLANFORDIA) LATIDOMUS, n. sp.

(Plate XXXV, fig. 1 *a*—*c*.)

Of this species there is unfortunately only one available specimen; its diameter is 93 mm. and its width of umbilicus equals 36 mm.; the last volution has a thickness of 40 mm. at the ribs and 35·2 mm. between the ribs and is 34·2 mm.

[1] *Palaeontographica*, Supplement IV, p. 37, pl. V, fig. 2, and pl. VII, fig. 6.

high. The height of the volution is therefore at the stage of growth reached by the specimen exceeded by the thickness only by a very small fraction and the cross-section has on the whole a squarish outline. The flanks are rounded; the ventral face is flattened; the convex umbilical wall slopes rather steeply into the umbilicus. The shape and cross-section of the inner volutions are not known.

The ornamentation of the last volution consists of 24 strong ridge-like ribs which at half the height of the whorls or a little above it swell into low elongated tubercles, bifurcating at the same time into two secondary ribs. Only at one place is a third secondary rib intercalated. The ribs are feebly falciform and are interrupted along the median zone of the external margin by a broad and smooth band at the sides of which the rib-terminations project in the shape of feeble elongated tubercles. It is only at the anterior end of the last volution that the ventral band ceases to be so distinct.

It is unfortunately impossible to make out the whole of the suture-line. But we are able to ascertain that it is generally related to that of *Bl. Wallichi*. The external saddle is divided into two subsymmetrical portions. The first lateral saddle consists of a small outer and a larger inner half which latter is situated somewhat higher than the outer one. The first lateral lobe is comparatively narrow and constructed subsymmetrically.

The unequal spacing of the septa is remarkable. At the commencement of the last volution they are so closely packed that the ends of the lateral branches of the first lateral lobe nearly touch the extremities of the saddles of the preceding septum; anteriorly to this point they recede farther and farther apart while the most anterior of the preserved septa once more approach one another as closely as they did on the older part of the last volution.

The inner volutions and the full-grown stage are unknown.

Blanfordia latidoma is distinguished from *Bl. Boehmi* by a somewhat narrower and a more quadrilateral form of the cross-section, by the greater spacing of the ribs at the same stage of growth and the more distinct ventral furrow.

In *Bl. latidoma* there are only two secondary ribs, instead of three as in *Bl. Boehmi*. The suture is distinguished chiefly by the somewhat different configuration of the first lateral saddle. Among the species from the Dutch East Indies *H. Rooseboomi* Boehm is its nearest ally.

The sculpture of both species closely agrees except that the branch-ribs of *H. Rooseboomi* are more decidedly inclined forward; but the cross-section of *H. Rooseboomi* is much broader and much more depressed and the suture-line has much broader sellar phylla than that of *Bl. latidoma*.

Bl. latidoma is represented by a single specimen from Lochambelkiehak (Coll. Diener).

Hoplites (Blanfordia) Middlemissi, n. sp.

(Plate XXXVII, fig. 1 *a*—*c*.)

The shell is thick, much inflated, with a wide umbilicus, and depressed.

laterally expanded volutions. At the anterior end the height of volution is 34·4 mm. above the umbilical suture, while above the ventral face of the preceding volution it is 28·5 mm.; the greatest thickness amounts to 57 mm. The thickness reaches its maximum at about half the height of volution. The inner volutions appear to be proportionately narrower, but this fact cannot be established with absolute certainty owing to the deficient state of preservation of the specimen. The external margin is slightly rounded, with a flat or slightly depressed median band. The flanks are decidedly convex and pass gradually into the umbilical wall, which slopes steeply into the umbilicus.

The sculpture consists of wide-spaced, exceedingly bulky radial ribs swelling out into blunt stout knobs at about half the height of the volutions. For every main-rib there are three, rarely four, subsidiary ribs originating either by ramification or by intercalation, and slightly inclined forward. They form a shallow arch across the external margin, showing a slight reduction along the median line of the last volution, while along the inner volutions they are interrupted by a smooth ventral band. On both sides of the ventral band a slight strengthening of the ribs is noticeable. On the inner volutions the ribs are dichotomous, the intercalary ribs being somewhat more inclined forward, in consequence of which the ribs assume a more distinctly curvilinear course. The suture-line is not distinctly preserved; to judge from the extant traces it may have been similar to that of *Bl. Boehmi*. The body-whorl is not known.

In *Bl. Middlemissi* the volutions are still more depressed than in *Bl. Celebrant*. The number of branch-ribs in each fascicle is five or even six in *H. Celebrant*, while in *Bl. Middlemissi* it is usually three and only rarely four. Moreover, the volutions of *H. Celebrant* are evenly rounded along the external margin, while in our species the median band and the adjoining lateral surfaces are distinctly flattened. From *H. Rooseboomi* Boehm the present species is distinguished by its more strongly depressed volutions, its more prominent, stronger, and wider-spaced ribs, its much stronger tubercles and greater number of branch-ribs; from *Hoplites* sp. Boehm[1] it differs by its thicker ribs, the earlier appearance and stronger development of tubercles, the more numerous branch-ribs and the form of the cross-section.

Most striking is the resemblance to an Argentine species described by Steuer as *Reineckia latior*.[2] This species, however, has no ventral band, and shorter main-ribs, so that we have not to deal with a case of true relationship, but only with one of resemblance due to convergence. Even on the unlikely event of the Argentine species eventually proving to be a member of the same genus, the greater breadth and feebler costation of *R. latior* would preclude specific identity.

Bl. Middlemissi is represented by a single entirely chambered specimen, from Lochambelkichak, third Stage.

[1] *Palaeontographica*, Supplement IV, pl. VII, fig. 1, p. 36.

[2] Steuer, Argentinische Jura-Ablagerungen. Ein. Beitrage zur Kenntniss der Geologie und Pal. der Argentinischen Anden. *Pal. Abh.*, vii, p. 151.

Hoplites (Blanfordia) Celebrant, n. sp.[1]

(Plate XXXVI, fig. 1 *a*—*e*.)

Dimensions :—

Diameter	220	mm.
Width of umbilicus	105	„
Thickness of last volution between the ribs	90	„
Thickness of last volution across the ribs	111	„
Height of the last volution above umbilical suture	64	„
Greatest thickness for a diameter of about 22·5 mm.	14	„
Height of volution	10·5	„

The shell is disc-shaped and consists of very thick depressed volutions, the ventral face of which forms a flat arch. The cross-section exhibits a flattened approximately elliptical shape. The greatest thickness in the intervals between the ribs lies at about half the height of the flanks in the last volution and somewhat higher in the inner volutions. The umbilicus is wide and funnel-shaped; the umbilical wall of the inner volutions slopes obliquely into the umbilicus and is not distinctly marked off from the flanks. On the outer volutions the umbilical wall is more rounded and somewhat steeper. Comparing the quoted dimensional numbers it follows that the shell is proportionately thinner in its younger stages, and that with age its thickness increases more rapidly than its height. The difference, however, is small.

Up to a diameter of 15 mm. the ornamentation consists of rather fine, apparently dichotomous, slightly sigmoidal ribs. At this early stage the branch-ribs are interrupted on the ventral face by a distinct median furrow and form on either side of the latter small tubercles (see fig. 1 *d*). As growth proceeds, the ribs assume the form of sharp ridges and expand at the branching points into strong blunt knobs. The ribs are gently inclined forward and slightly sigmoidal. The number of branch-ribs constituting a bundle at this stage cannot be ascertained. There is a gradual decrease in the relative number of main-ribs with increasing age: the last shows 14, the last but one 17, and the preceding one about 20. On the last volutions the tubercles project from the flanks in the shape of bulky blunt spines, whilst the inner portion of the main-ribs is relatively less strongly developed. At the commencement of the last volution each set of five subsidiary ribs constitutes a sheaf originating from a tubercle. In some places a sixth subsidiary rib is intercalated. On the most anterior portion of the shell the grouping of the subsidiary ribs into distinct rib-bundles is less pronounced. The subsidiary ribs have a gently undulating form, and at the median band of the ventral face they are weakened as if they had been planed down. The subsidiary ribs are strongly inclined forward; some of them do not originate at the tubercles, but somewhat higher up from the adjoining subsidiary rib.

1 *Celebrant*=*Leviathan*, the mythical giant-fish of the middle ages.

The external saddle of the suture is divided by a secondary lobe into two nearly equal branches in the same manner as in *Hoplites curvatus*. The next saddle is also subdivided nearly symmetrically. The outer lateral branch of the first lateral lobe is more strongly developed and originates higher than the inner one. The second lateral lobe is placed parallel to the first one and has a short trunk with a long terminal branch. Although all the details of the suture-line are not distinctly preserved, yet one cannot fail to notice its typical resemblance to the suture peculiarities of all the other species of *Blanfordia*.

The body-chamber is unknown. The single available specimen, notwithstanding its large size, is entirely chambered.

Blanfordia Celebrani might at first sight be mistaken for a *Holcostephanus* or a *Spiticeras* or even a *Simbirskites*. It also approaches certain forms of *Himalayites*. The existence of a ventral furrow on the inner whorls, the relationship to such forms as *Bl. latidoma* indicating a connection with the typical forms of *Hoplites* clearly proves that this remarkable species is allied to *Hoplites*, and that its resemblance to various forms of *Holcostephanus* or *Himalayites* is merely a case of accidental mimicry, one of those instances of apparent convergence, such as have already been alluded to in the introductory discussion of the genus *Hoplites*.

The species most closely allied to *Blanfordia Celebrani* is *Blanfordia Middlemissi* n. sp.; the differences are noted in the description of the latter species. Another very closely related form is *Hoplites* sp. ind. G. Boehm (*loc. cit.* p. 36, plate VI, fig. 1; plate V, fig. 1; plate III, fig. 5; and fig. 12 of the text). This species preserves its original sculpture up to a diameter of 105 mm., at which stage it is still possible to observe individual bifurcate, slightly sigmoidal ribs. In *Bl. Celebrani*, on the other hand, this primitive type of sculpture is abandoned at a much earlier stage, probably when the diameter is only 50 mm. Moreover, in *Hoplites* sp. Boehm the formation of tubercles is deferred until a later stage of development, and they do not become as bulky as those of *Bl. Celebrani*. The number of subsidiary ribs constituting a sheaf is smaller in the case of Boehm's species than in the Indian form. The suture-lines of both species bear a great resemblance to each other; in both of them the terminal branches of the first and second lateral lobes are remarkably long and slender, and the outer lateral branch of the first lateral lobe originates much higher up than the inner lateral branch.

Blanfordia Celebrani is represented by a single specimen from Lochambel-kichak, third Stage.

HOPLITES (BLANFORDIA) CURVATUS, n. sp.

(Plate XXXV, fig. 2 *a—d*.)

Of this species only a single, entirely chambered fragment is available; for a height of volution of 46 mm., the thickness, measured across the ribs, is

61 mm. and between them 51 mm. The ribs originate at wide intervals on the umbilical wall in the form of slight swellings, they soon develop into stout ridges and, about half-way up the flanks, are thickened into knots which ramify into a bundle of three branch-ribs. In one case only, one of the subsidiary ribs is observed to originate by intercalation instead of branching. Along the median line of the ventral face the ribs are somewhat reduced, but at the stage of growth reached by the type specimen they do not exhibit any distinct swelling on either side of the median band. The ribs are decidedly sigmoidal. The cross-section of the existing volution fragment has a depressed rounded shape. The cross-section through the interval between the ribs reaches its maximum breadth near the rounded obliquely sloping umbilical wall. Across the ribs, the maximum breadth occurs at about the middle of the flanks owing to the knot-like swelling at the branching-points.

The suture is extensively ramified. The lobes possess broad trunks. The external saddle is divided into two nearly symmetrical halves by a long subsidiary lobe; the first lateral saddle is divided by an obliquely disposed secondary lobe into a smaller and lower outer and a higher and larger inner portion. The first lateral lobe is distinguished by its broad trunk and the subsymmetrical disposition of its branches. The second lateral lobe is much shorter than the first one, but it is not placed obliquely and is more regularly developed than in most of the other species. The body-chamber and inner whorls are unknown.

Taking into account the fragmentary state of the available specimen it was only with great reluctance that I decided on the establishment of a new species. I was, however, induced to take this step by the conviction that this very interesting form ought not to be left unnoticed, being distinguished by so sharply pronounced characters that we may expect the species to be recognised again at some future date, when the elaboration of a more complete diagnosis may become possible.

Blanfordia curvata shares with *Bl. Cricki* the massiveness of the prominent ribs and their sigmoidal course; but the ribs of *Bl. curvata* are still more massive than those of *Bl. Cricki*, and are moreover distinguished by the more manifest combination of the secondary ribs into clearly defined rib-bundles, quite apart from the fact that the cross-section of *Bl. curvata* is more rounded and more strongly depressed than that of *Bl. Cricki*.

From *Bl. latidoma* n. sp. the present form differs by its greater thickness, stouter ribs and the ramification of the main-ribs into three secondary ribs.

Blanfordia curvata was found at Chanambaniali.

HOPLITES (BLANFORDIA) ACUTICOSTA, n. sp.
(Plate XXXVII, fig. 2 *a*–*c*.)

Ammonites Wallichi, Blanford: *Journal Asiat. Society*, Calcutta, 1865, Vol. XXXII, p. 127, pl. I, fig. 4 (*non* pl. III, fig. 2, 3).

Blanford already recognised correctly that the two small specimens which he described as *Ammonites Wallichi* Gray do not completely agree with each

other. The differences are indeed so marked that according to present views they can no longer be united. The specimen depicted by Blanford in plate III, figs. 2, 3, has been left by us, though hesitatingly, with *Bl. Wallichi*; but the other specimen certainly represents a different species. Unfortunately there is no other specimen available besides the small fragment figured by Blanford, which is too incomplete for the establishment of a satisfactory diagnosis. If notwithstanding this fact we propose a new name for this specimen, it is because it represents a mutational tendency which is not exhibited by any of the other well defined species.

At a diameter of 44 mm. the shell has an umbilical width of 17·5 mm.; the height of volution is 16 mm. at the anterior end, and the maximum thickness, measured over the ribs, is 15·8 mm. The umbilicus is somewhat wider than in the majority of the *Wallichi*-forms. The volutions, close up to the body-chamber, have very flat flanks, a low and rather steep umbilical wall and a flattened ventral face, which is fairly distinctly marked off from the flanks. At a short distance behind the commencement of the body-chamber, to which the most anterior portion of the existing shell belongs, the cross-section assumes a distinct trapezoidal shape; the maximum thickness occurs close to the umbilical wall; from there the cross-section tapers considerably up to the external margin, and the upper part of the flanks becomes decidedly flattened.

The system of ribs is generally similar to that of *Bl. Wallichi*, but certain noticeable differences do exist. On the more central portion of the shell the ribs are slightly curved and they are continued on to the ventral face as in *Bl. Wallichi*, but the branching is less pronounced, and in two places single ribs approach the point of origin of the preceding main-rib so closely as to give the impression that two ribs originate together at the same place. At the commencement of the body-chamber and for a short distance behind it, the ribs assume a nearly radial course and appear on the flanks in the shape of high and sharp ridges which are slightly thickened at the point of bifurcation. The ventral furrow is very deep and narrow; the rib-terminations on either side of the furrow are distinctly thickened.

The suture is only moderately ramified owing to the small size of the specimens. The external saddle is very broad and is divided by an accessory lobe into two nearly equal parts. The accessory lobe of the first lateral saddle is disposed obliquely and divides it into a smaller and lower outer and a higher and larger inner portion. The lateral saddle is also comparatively broad.

Although, as has just been pointed out, and as had been already indicated by Blanford, the anterior portion of the shell belongs to the body-chamber, it is not very likely that this species was really one of small size. The changes in the sculpture and in the cross-section are not sufficiently great to indicate that the existing fragmental body-chamber could correspond with the final body-chamber. Since all the allied species are much larger and some of them

very large, we may assume that the present species also grew to a larger size.

The steep umbilical wall, the exceedingly sharp ribs, which on the anterior part of the shell are not distinctly curved, but radially disposed, and the deep ventral groove, constitute characters which preclude referring this fragment to *Bl. Wallichi*, and indicate a distinctive mutational tendency which we recognise also in the following, only incompletely known species. The trapezoidal cross-section reminds us particularly of variety *e* of *Bl. Wallichi*.

We must await future discoveries for a more complete knowledge of the present species as well as of the suspected mutational series.

One specimen from the Spiti Valley (Coll. Gerard).

HOPLITES (BLANFORDIA) n. sp. aff. ACUTICOSTA, n. sp. Pl. XXV

The collections from the Spiti Shales include two small fragments which probably belong to two specifically distinct forms allied to *Bl. acuticosta*, but are too insufficiently and incompletely preserved for the establishment of new species. Nevertheless they deserve notice, because, owing to their relation to *B. acuticosta*, they represent a peculiar mutational tendency of which there is only slight evidence amongst other species of *Blanfordia*, which are so plentiful in the Spiti Shales.

One of these forms (plate XXVIII, fig. 3 *a—c*) is ornamented with exceedingly sharp forked ribs, which are slightly thickened at the point of bifurcation and interrupted on the ventral face by a deep furrow. On both sides of this furrow the ribs terminate in distinct acute tubercles. The umbilical wall is rounded and slopes rather steeply into the umbilicus. The small fragment probably belongs to the body-chamber. The inner volutions and the suture-line are unknown. We cannot unite this form with *B. acuticosta*, because the cross-section is more oval, the maximum breadth lies somewhat higher up and the ribs are somewhat more deflected forward than in *B. acuticosta*. With better preserved material additional differences would probably be noticeable.

From the Spiti Shales (Coll. Gerard).

The second form (plate XXVII, fig. 4 *a—c*) also exhibits sharp forked ribs projecting in the form of ridges on the lower part of the volution and raised into incipient nodes in the vicinity of the point of bifurcation at half the height of the volutions. The ribs are slightly thickened on either side of the well-developed ventral furrow. The height of volution of the fragment, which apparently belongs to the body-chamber, is 32·5 mm., the breadth, measured across the ribs, 32·8 mm. Between the ribs the cross-section is trapezoidal.

The present fragment differs from the previously described form owing to the somewhat greater relative breadth and trapezoidal shape of the cross-section.

Spiti Valley (Coll. Gerard).

B.—TRITUBERCULATE FORMS.

ACANTHODISCUS, nov. subgen.

HOPLITES (ACANTHODISCUS) OCTAGONUS, Strachey sp.

(Plate XXII, fig. 1 *a—e*; Plate XIX, fig. 1 *a*, *b*; Plate XX, figs. 1 *a*, *b*, 2; Plate XXVII, fig. 3 *a—c*.)

1863. *Ammonites octagonus*, H. Blanford: On Dr. Gerard's collection of Spiti fossils, *Journ. Asiatic Society of Bengal*, XXXII, p. 128, pl. I, fig. 5 *a—c*.
1865. *Ammonites octagonus*, Blanford: Palaeontology of Niti, p. 83, pl. XII, fig. 2 *a*, *b*.
1866. *Ammonites octagonus*, Stoliczka: *Mem. Geol. Survey of India*, Calcutta, V, p. 96 and ff.
1904. *Ammonites octagonus*, G. C. Crick: Strachey's Cephalopoda from Himalaya, *Geol. Magazine*, Dec. V, vol. I, p. 12.

Dimensions :—

	a (Plate XX, fig. 1.)	*b* (Plate XIX, fig. 1.)	*c* Strachey-Blanford's original specimen (plate XXVII, fig. 3).
Diameter	125 mm.	121 mm.	
Umbilical width	48 „	49 „	
Height of last volution the above volution-line	45 „	41·6 „	
Thickness of last volution, measured between the ribs	37·5 „	38 „	
Height of body-chamber			20·8 mm.
Thickness of volution before commencement of body-chamber			19·8 „

In this richly decorated form, the transition from a normal rib sculpture to a tubercle ornamentation takes place at an earlier stage of growth than in any of the other spine-bearing species of *Hoplites* from the Spiti Fauna. Even at a diameter of only 6 mm. the fine ribs have already a distinct lateral tubercle and a slight umbilical swelling. Weaker intercalary ribs, or ribs without any lateral tubercle, or with only an obsolete one, are already absent in these small specimens, so that even at this early stage, *H. octagonus* already exhibits the ornamentation that characterises the full-grown form. It is only the outer series of tubercles which is subject to a gradual change. During youth, two external tubercles correspond to each lateral tubercle with which they are connected by faint ribs. In full-grown specimens, the external tubercles become reduced in number, so that each whorl carries an equal number of umbilical, lateral, and external knobs, each set of three tubercles being disposed along a slightly anteriorly inclined ridge.

The first appearance of the full-grown type of sculpture takes place sooner or later in different specimens, though it usually commences on the body-whorl. For instance the specimen illustrated in plate XXII, fig. 1, still shows isolated supernumerary external tubercles, while these are not observed upon Blanford's original type-specimen refigured in plate XXVII, fig. 3, which is provided with the body-chamber, although it is of smaller size than the former. In one specimen obsolete intercalary ribs of variable length are here and there faintly indicated

between the tuberculiferous ribs (see plate XX, fig. 1). At one point this same specimen shows an irregularity of the ornamentation, probably caused by some injury. The number of ribs on the last volution fluctuates between 18 and 20; on the next inner volution it amounts to 16. The tubercles of the three series increase respectively in size from the inner to the outer margin. The outer spines of the body-chamber in the large individuals must have reached a length of at least 15 mm. The spines were hollow and in the body-chamber their inner cavity was not separated by a lamella from the interior of the shell. In the chambered portion of the shell, on the other hand, such lamellæ appear to have existed for the purpose of separating their cavity from the inner portion of the shell.

As suggested by the specific name, the cross-section of the volutions is approximately octagonal. The flanks are slightly flattened between the lower and middle series of tubercles, sloping down into the umbilicus from the lower series, and up to the external margin from the middle series. The external margin is slightly flattened. Between the ribs the cross-section is more rounded. The maximum width is situated at the lower series of tubercles, but the thickness at the level of the upper row of tubercles is only very slightly less. In the majority of specimens the height of a volution is only slightly greater than the width; in the specimen depicted in plate XXII, fig. 1, the thickness, however, nearly equals the height. The volutions overlap by about one-fourth to one-third of their height; the umbilical suture runs just outside the median series of tubercles. Towards the anterior extremity of the body-whorl the shell becomes slightly less involute, the umbilical suture slightly receding from the median row of spines.

None of the specimens have the aperture preserved.

The suture-line is dimly recognisable in only two specimens. In one of these (plate XXVII, fig. 3 *c*) the first lateral lobe is irregularly distorted by a strong lateral tubercle situated just at the origin of the lateral branches. Moreover, the only two distinct sutures are the two last ones and succeed each other so closely that the development of the extremities of the lobes is interfered with. In the second specimen the suture is more regularly developed, but the external lobe is not visible. The external lobe of the first specimen appears to be somewhat longer than the first lateral. The external saddle is rather broad and subdivided by a secondary lobe into a larger outer and a smaller inner portion. The first lateral lobe is rather slender and has a strong terminal branch and two long lateral branches. The second lateral lobe is shorter than the first one and runs parallel to it and is also subsymmetrically constructed, with a terminal branch and two lateral ones originating at nearly the same height. The first lateral saddle is subdivided symmetrically by a long accessory lobe. The latter descends approximately to the level of the side-branches of the lateral lobes whose extremities it approaches. Three small auxiliary lobes are disposed obliquely along the umbilical wall.

Hoplites octagonus is closely allied to *Hoplites octagonoides* and *H. polyacanthus*. The distinguishing characters are given in the description of these species.

Of Extra-Indian species which are similar to *H. octagonus* we may mention *Hoplites hystrix* (Bean) Neum. et Uhlig, *H. Rerollei* Pasquier, *H. Sayni* Simionescu, and finally an immature form which Neumayr and Uhlig have figured as *Hoplites* cf. *curvinodus*.[1] *Hoplites hystrix* has non-tuberculate intercalary ribs and a narrower cross-section than *H. octagonus*. The inner whorls carry recurring groups of ribs which are never observed in *H. octagonus*. *Hoplites* cf. *curvinodus* has a still narrower cross-section, a still steeper umbilicus, while the ribs on the inner whorls lack the inner and lateral series of tubercles.

Hoplites Sayni Simionescu[2] from the Berriasian of Southern France is probably still more closely related to *H. octagonus* than the above-mentioned North German forms, but is still distinguished by the persistence of non-tuberculate intercalary ribs. These non-tuberculate intercalary ribs are only rarely developed in *H. Rerollei* Pasquier, also from the Berriasian of Southern France, and this form must be regarded as the nearest ally to the Indian species. Nevertheless it has also to be separated specifically, for it lacks the regular bifurcation of the ribs on the inner volutions as well as their occasional bifurcation on their body-whorl, which constitute so noticeable feature in *H. octagonus*.

At one time *H. octagonus* was thought to be related to certain Jurassic Ammonites which later on received the generic names of *Peltoceras* and *Cosmoceras*. This conception is quite conceivable with the degree of information then existing. With the rich material of *H. octagonus* now available it is now possible, as has already been mentioned, to establish with certainty the relationship of this form. It is evidently a *Hoplites* which at an early stage develops a tubercular ornamentation. For the sake of completeness we may briefly summarise the reasons which preclude its reference to *Peltoceras* and *Cosmoceras*. In *Cosmoceras* there are never any umbilical tubercles; the branch-ribs are inclined backward; whilst in *Hoplites* they are inclined forward. In *Cosmoceras* the ribs are filiform and are not differentiated into main-ribs and subsidiary ribs, while in *Hoplites octagonus* they are swollen and differentiated. The lobes of *Hoplites octagonus* bear no resemblance to those of a *Cosmoceras*. In *Peltoceras* the inner volutions are radically different, the lateral and ventral tubercles, when they exist, are much closer together, and the suture differs entirely in the number and shape of the lobes.

Hoplites octagonus is represented by seven specimens. Nearly all of them possess a recognisable part of the body-whorl so that we may assume that they all represent full-grown individuals. Three specimens belong to the older collections, and have been already mentioned by Stoliczka; they were found near

[1] *Hils-Ammoniten*. pl. 42, fig. 2.

[2] Note sur quelques Ammonites du Néocomien français, *Annales de l'Université de Grenoble*, XI, No. 3, 1899, p. 6, pl. I, figs. 7, 8.

Kibber in Spiti. Three more were obtained from the Upper and Middle Spiti Shales of Kuti (Coll. Krafft 2; Coll. Smith 1 specimen). The original specimen referred to in the *Journ. As. Soc.*, XXXII, is labelled "Spiti Valley." Of the original specimen described in the "Palæontology of Niti" I have been able to study a plaster cast which agrees perfectly with the other specimens.

HOPLITES (ACANTHODISCUS) OCTAGONOIDES, n. sp.

(Plate XXVII, figs. 1 *a*, *b*; 2 *a*, *b*.)

Dimensions :—

Diameter	72—76 mm.
Width of umbilicus	25·1—26 „
Height of the last volution	28—29·5 „
Breadth of the last volution between the ribs	24—27 „

At first sight we might feel inclined to assign to this species the rank of a subordinate variety. But a more careful study discloses differences which speak in favour of a more independent position being allowed to this form.

The anterior portion of the last volution carries, as in *A. octagonus*, stout ribs, each of which bears an umbilical, lateral, and an external tubercle. In addition to these, however, feeble companion ribs make their appearance, which show a slight swelling on the ventral face and which, in their downward course, come close to the umbonal tubercle of the preceding rib. These branch-ribs do not occur on the older portion of the last volution, where the main-ribs bifurcate at the median tubercle and the two branch-ribs terminate on the ventral face in two stout tubercles. Moreover, a slight rib-like swelling proceeds from the anterior side of the umbilical tubercle suggesting a feeble remnant of an anterior branch-rib or intercalary costa. The ribs are more decidedly inclined forward than in *A. octagonus*. Greater still are the differences exhibited by the ornamentation of the inner volutions. These carry densely packed, fine forked ribs which terminate at the ventral furrow in fine minute tubercles, while along the flanks and umbilical margin they only occasionally develop slight thickenings. Whilst *H. octagonus* assumes its tubercular sculpture when only 6 mm. in diameter, *H. octagonoides* maintains its primitive costation even after the diameter has attained 20 mm.

The umbilicus of *A. octagonoides* is somewhat narrower, the umbilical wall is somewhat steeper, and the volutions are somewhat higher than in *H. octagonus*.

The suture-line and body-whorl are unknown.

The present species is represented by four specimens. Two of these are from Lochambelkichak, third Stage (Coll. Diener), the other two from the Upper and Middle Spiti Shales of Kuti (Coll. Krafft).

Hoplites (Acanthodiscus) polyacanthus, n. sp.

(Plate XIX. fig. 2 *a*—*c*.)

Dimensions :—

	82 mm.
Diameter	30 „
Width of umbilicus	31 „
Height of the last volution	31 „
Thickness of the last volution measured between the ribs	

The cross-section in the intercostal spaces is almost circular; the strongly rounded flanks pass gradually into the external margin as well as into the obliquely sloping umbilical wall. The shell is ornamented on either side with an umbilical, a lateral, and an external series of tubercles. The umbilical and lateral series of tubercles approach one another much closer than they do in *H. octagonus*, so that the portion of the shell constituting the flanks is noticeably contracted. There are usually two external tubercles to every lateral one. They are joined together by means of indistinct ribs. The ribs between the lateral and umbilical tubercles are also feebly developed as compared with the pronounced tubercles; the shell, nevertheless, is deeply excavated between the shallow ribs. As a consequence of this disposition, the tubercles are exceedingly prominent and protrude as long, acute, hollow spines which, in the available specimen, are mostly broken off. The penultimate and antepenultimate whorls exhibit the same sculpture as the outermost volution; the spines of the median series are enveloped by the umbilical wall of the succeeding volution. At a diameter of 6 to 8 mm. one observes traces of fine ribs; as in the case of *H. octagonus* the tubercular sculpture makes its appearances at an early age. The suture-lines are unknown.

A. polyacanthus differs from *A. octagonus* in the greater thickness and circular cross-section of its volutions, the closer approximation of the umbilical and lateral tubercles, the double number of the external tubercles in the middle stages of growth and the deep furrows between the ribs.

One specimen from Lochambelkichak, third Stage (Coll. Diener).

Hoplites (Acanthodiscus) subradiatus, n. sp.

(Plate XXIII, fig. 1 *a*, *b*; Plate XXVI, fig. 1.)

Dimensions :—

	121 mm.
Diameter	46 „
Width of umbilicus	44 „
Height of the last volution above the umbilical suture	50 „
Thickness of last volution	

This interesting species is so closely related to the well-known *Hoplites radiatus* Brug. from the Neocomian of Europe, that it is only after considerable hesitation that I decided to separate the Indian form as a new species.

As regards dimensions, *A. radiatus* and *A. subradiatus* fairly agree with one another, the umbilical width being however greater in the Indian species. There are very noticeable fluctuations in the relation of thickness to height amongst the various European forms described as *Hoplites radiatus;* the proportion also varies according to the age of the individual, fully grown specimen possessing relatively higher volutions than smaller immature forms. It is therefore difficult to ascertain exactly the relation between the Indian and European species in this respect. Compared with the illustration published by Neumayr and Uhlig[1] the inner volutions of the Indian species appear somewhat narrower. On the whole, however, the differences in the dimensions are very slight.

The differences in the sculpture are somewhat more noticeable. In *A. subradiatus* there are seventeen main-ribs per volution, while in *A. radiatus* there are only eleven to thirteen. In *A. subradiatus* we have 43 subsidiary ribs corresponding to 15 main-ribs, so that for every main-rib, excepting two, there is a fascicle of three subsidiary ribs, namely, two branch-ribs and one intercalary rib. In *A. radiatus*, on the other hand, the number of branch-ribs and intercalary ribs is much greater, a fact which is especially striking in Quenstedt's illustration of this species. In both species the main-ribs are radially disposed, the subsidiary ones strongly inclined forward; but in *A. subradiatus* the subsidiary ribs are much more prominent and more distinctly joined to the median tubercle than in *A. radiatus*. The external margin of A. *subradiatus* does not quite agree with that of *A. radiatus*. On the last volution of the former species the external tubercles grow proportionately feeble, while, at the same time, the ribs become stouter and experience only a slight reduction along the median zone. Umbilical and lateral tubercles are about equally strongly developed in both species; in both species the inner hollow of the spines is probably shut off from the interior of the volutions by a secondary plate. The spines are, however, not preserved in the Indian species, their place being occupied merely by stout tubercles. The innermost volutions are not clearly visible; but it is possible to observe that the tubercular sculpture makes its appearance at an early stage, as is also the case with *H. radiatus*.

In a small immature specimen from Kuti, probably belonging to *A. subradiatus*, the diameter of which has only reached 18 mm., one observes that up to a diameter of 6 mm. the ornamentation consists of slightly sigmoidal forked ribs interrupted on the ventral face and carrying occasional small tubercles. Of the regular series of tubercles, the earliest to develop are the lateral ones, the umbilical ones appearing next; at a succeeding stage the ribs recede from one another and a third subsidiary rib is intercalated. With a diameter of no more than 16 mm. all the essential characters of the adult ornamentation are already developed.

[1] Hilsammonitiden, *Palaeontographica*, 1881, XXVI, p. 37, pl. XXXV, figs. 2, 3. A very complete synonymy of *H. radiatus* is given in Pictet's "Ste-Croix."

The suture-line is unfortunately not completely preserved, but the observable traces show that the trunk of the first lateral lobe is very narrow at its base and that it gives off narrow lateral branches and a copiously ramified terminal branch. Very careful attention is needed to detect the differences in sculpture between *A. subradiatus* and *A. radiatus*, but the differences in the suture are far more evident: the narrow and tall first lateral lobe of the Indian fossil as compared with the broad and low first lateral lobe of the European one very distinctly suggests a specific separation of the two forms. In spite of the unfortunately incomplete condition of the suture, the portion preserved is sufficient to confirm our views as to the specific distinctness of the Indian fossil. The differences between *A. subradiatus* and *A. acanthinus* are enumerated under the latter species. We refer the reader to the description of *Acanthodiscus Sömmeringi* as regards the intermediate characters of this species. Compared with *Hoplites curelensis*, *Acanthodiscus subradiatus* differs in its coarser sculpture, its fewer subsidiary ribs which are more decidedly deflected forward, and probably also its greater thickness.

Hoplites subradiatus is represented by a large specimen from Lochambelkichak, third Stage, and a small immature specimen from Kuti (Upper and Middle Spiti Shales. Coll. Krafft).

HOPLITES (ACANTHODISCUS) ACANTHINUS n. sp.

(Plate XXI, fig. 1 *a*—*c*.)

The present species is closely allied to *Acanthodiscus radiatus* and *A. subradiatus*. Like them, *A. acanthinus* has a thickly disc-shaped, inflated shell, the volutions of which overlap one another by about one-third. The umbilical suture runs along the outer edge of the lateral series of tubercles of the preceding whorl. The flanks are rounded between the ribs and pass gradually inwards into the somewhat rounded, rather steeply sloping umbilical wall and outwards into the flattened external margin. On the inner volutions the umbilical wall is steeper and the flanks are flatter than on the body-whorl. At the commencement of the body-whorl the thickness amounts to 50 mm. for a height of 41 mm. The width of the body-chamber therefore somewhat exceeds its height.

On the penultimate volution there are 13 main-ribs, each with a weaker inner and a stronger outer tubercle. This was probably their number also on the last volution when complete. At the commencement of the penultimate volution two or at most three subsidiary ribs originate from each lateral tubercle. In an outward direction the number of subsidiary ribs increases considerably, there being as many as 26 subsidiary ribs to 6 main-ribs. The subsidiary ribs are strongly inclined forward; on the inner volution they bear stout round tubercles on either side of the ventral zone. As the shell increases in size,

the ventral tubercles become relatively less pronounced, until, on the body-whorl, they are merely indicated by a slight thickening of the corresponding part of the ribs. The subsidiary ribs are comparatively strongly developed and cross the ventral face without interruption, though somewhat reduced. On the middle and the anterior part of the body-chamber individual subsidiary ribs continue uninterruptedly inward up to the region of the umbilical tubercles, sometimes even down to the umbilical suture. On the umbilical wall they slope backward; only on reaching the lateral surface of the whorls do they assume a forward inclination. The interior of the spines was shut off from the general cavity by a lamella on which traces of suture-lines may be discovered. Whether the spines were hollow or solid cannot be clearly ascertained, as they are broken on the available specimen.

The suture is not distinctly preserved; the existing traces indicate that it is rather copiously ramified. The last suture occurs on the fragmental posterior portion of the last volution, which consequently belongs almost entirely to the body-chamber.

Acanthodiscus acanthinus differs from *A. radiatus* by its strong secondary ribs, the close approximation of the inner and lateral tubercles, the greater thickness of the volutions, and the disappearance of the outer tubercles on the body-chamber. From *A. subradiatus* it is distinguished by its fewer main-ribs and the larger number of subsidiary ribs, the closer approximation of the inner and lateral tubercles, the higher umbilical wall and the development of the longer individual subsidiary ribs.

Acanthodiscus acanthinus is represented by a single specimen from Lochambelkichak, third Stage (Coll. Diener).

Hoplites (Acanthodiscus) hundesianus, n. sp.

(Plate XXII, fig. 2 *a—e*.)

Within the form-circle of the *Acanthodiscus radiatus* group the present species is distinguished by such extraordinary characters that it is impossible to pass it by unnoticed, although the species is founded on an incomplete and poorly preserved specimen.

The diameter of the thick, widely umbilicated disc measures 87 mm., the umbilical width is 43 mm., the volution-height above the umbilical suture is 25·8 mm., the thickness between the ribs about 30 mm. At a spot situated somewhat further back, where the shell is well preserved, the height measures 19 mm., the thickness 26 mm. The volution has an approximately octagonal cross-section at the ribs, whilst between them the cross-section is more circular. The narrow flanks pass gradually inwards into the rounded, rather steeply sloping umbilical wall, and outwards into the external margin. The umbilical suture is not situated above the series of medial tubercles as in the other forms of the

radiatus-group, but a little further outward, so that the origin of the subsidiary ribs of the inner volutions is visible even inside the umbilicus.

On the last volution the sculpture consists of eighteen bulging radially disposed main-ribs, each carrying rounded broad inner and lateral tubercles. Each lateral tubercle gives forth two stout subsidiary ribs strongly deflected forward. On the external margin they become slightly thickened longitudinally and are interrupted along the mesal line by a narrow furrow. In several places a third intercalary rib intervenes, so that certain lateral tubercles give origin to fascicles of three secondary ribs of which the anterior one is most strongly deflected forward. The main-ribs do not exactly correspond on opposite side of the shell so that the subsidiary ribs which meet one another from either side along the external margin are often differently situated in their respective fascicles.

On the anterior portion of the last volution which seems partly to belong to the body-chamber the sculpture undergoes a very abrupt change. The ventral furrow becomes suddenly broader, and bordered on either side by very strong spines, while the subsidiary ribs grow indistinct. Unfortunately the connection between these prominent external tubercles and the lateral ones is not clearly preserved. Whilst in other species of *Hoplites* the external tubercles and the external furrow dwindle in an anterior direction, frequently almost entirely disappearing on the body-chamber, precisely the opposite occurs in the present instance. In all probability, however, this is a deceptive appearance. What probably happens is this: the external tubercles probably do exist on the innermost volutions, and, according to the usual plan of growth of *Hoplites*, they gradually disappear. The external tubercles of the body-chamber are probably an entirely independent adult character in no way homologous with the usual external tubercles.

The suture-line is unfortunately not distinctly preserved.

Of all the species of the *radiatus*-group in its wider sense, *Hoplites octagonus* is probably the one most closely allied to the present species. In *H. octagonus* the stout external tubercles do not originate from the secondary ribs, but are the true successors of the external tubercles of the earlier volutions. *Acanthodiscus octagonus* does not pass through any stage characterised by ridge-like external ribs such as distinguish *A. hundesianus*, whilst the present species lacks the characteristic phase of *A. octagonus* in which the massive main-ribs carry three tubercles.

There is a certain resemblance between *Acanthodiscus hundesianus* and *Hoplites Micheicus* Bogoslowsky from the Russian Rjazan horizon. The sculpture of the Russian species is much more delicate and the ribs are somewhat further apart, but the general type of ornamentation, the shape of the shell and the appearance of the external margin suggest a rather close relationship.

The species is represented by a single specimen obtained north of the Ting Jung La (pass) in Hundes (Coll. Griesbach.)

Hoplites (Acanthodiscus) Sömmeringi, Oppel sp.

(Plate LXXXVI, fig. 4 *a*, *b*.)

Ammonites Sömmeringi, Oppel: Palaeontol. Mitteil., p. 280, pl. 80, fig. 1.

Together with the two small fragments described by Oppel as *Ammonites Sömmeringi* I propose to unite a third specimen discovered by F. H. Smith at Kuti, although it does not in every respect agree with Oppel's original types. Oppel's figured type as compared with the Kuti specimen has the umbilical wall somewhat more obliquely sloping, the internal tubercles somewhat less prominent, the lateral ones more so. Consequently the angle between the upper part of the flanks and the flattened external margin is somewhat greater in the former than it is in the latter specimen: the former appears therefore somewhat thicker than the latter, although the ratio of height to breadth of volution is nearly the same in both. Oppel's figured specimen has a height of volution of 21 mm. to a thickness of 20 mm., the Kuti specimen has a volution-height of 26 mm. to a thickness of 25 mm. The differences mentioned are too slight to justify a specific separation of the two specimens.

Acanthodiscus Sömmeringi occupies a peculiar intermediate position between *A. subradiatus*, *A. Hookeri*, and *A. octagonus*. *A. Sömmeringi* and *A. subradiatus* agree in the great breadth of the ventral face and the bifurcation of the main-ribs from the medial tubercle, but they are distinguished by the presence of intermediate ribs in *A. Sömmeringi* and the higher cross-section of the latter species. It is precisely in the two latter characteristics that *A. Sömmeringi* approaches *A. Hookeri*. The intermediate ribs of *A. Sömmeringi* are, however, less regularly developed than those of *A. Hookeri*, and they seem to disappear entirely towards the anterior end. The shape of the cross-section and the somewhat pronounced forward deflection of the ribs recall *A. octagonus*. Our species, however, deviates strongly both from *A. Hookeri* and from *A. octagonus* by the nature of the broad ventral face.

There is no doubt that the closest ally is *A. subradiatus*; this is proved not only by the ornamentation and the nature of the ventral face, but also by the suture-line. It is not possible, however, to unite the two species into one, for *A. Sömmeringi* unquestionably occupies an independent position owing to the presence of slight intermediate ribs which persist until the volution has acquired a height of at least 29 mm., not to mention the somewhat lesser thickness and the somewhat slower rate of increase in size. The lobes of *A. Sömmeringi* are long, copiously branched, and of slender build; the second lateral lobe is placed obliquely and the line of auxiliary lobes slopes obliquely backwards fairly distinctly. The second lateral lobe of *A. subradiatus* is unfortunately imperfectly known; it seems, however, to be less oblique than in *Acanthodiscus Sömmeringi*.

Amongst European species, *Hoplites hospes* Bogoslowski from the Central Russian Rjazan horizon exhibits a prominent likeness to our species. Its intermediate ribs are somewhat less distinct, the external margin is somewhat narrower, the volutions are perhaps somewhat higher,[1] the tubercles are weaker than in *A. Sömmeringi*.

These differences preclude uniting the two forms, though the relationship must be very close.

The two specimens of *Acanthodiscus Sömmeringi* described by Oppel from the Schlagintweit collection were obtained in Spiti; their exact locality is not known. The third specimen is from Kuti (Coll. F. H. Smith).

Hoplites (Acanthodiscus) n. sp. ind. aff. subradiatus, n. sp.

(Plate XXVI, fig. 3 *a*—*c*.)

A specimen 36 mm. in diameter, with an umbilical width of 12 mm., represents a new species closely allied to *A. subradiatus*, though not identical. The ribs are much more crowded than those of *A. subradiatus*. The inner volutions bear fine ribs which already at a very early stage develop slight umbilical swellings and lateral tubercles. The present form, which unfortunately is very incompletely known and therefore cannot receive a specific name, proves that the group of *A. subradiatus* must be represented in the Spiti Shales by a considerable number of species.

The specimen is from the Spiti Valley.

Hoplites (Acanthodiscus) Medea (Strachey), Blanford sp.

Ammonites Medea, F. Blanford: Palæontology of Niti, 1865, p. 84, pl. XIX, fig. 5 *a*, *b*.

Ammonites Medea, G. C. Crick: Strachey's Cephalopoda from the Himalaya, *Geol. Mag.*, Dec. V, Vol. I, 1904, p. 13.

Strachey gave the name of *Ammonites Medea* to a small fragment with a broad, smooth external margin beset with tubercles on either side. These tubercles are connected with lateral ribs inclined forward. The middle and lower part of the flanks is not preserved. The cross-section seems to have been very broad.

Blanford already laid stress on the difficulty of ascertaining the relationship of a species so incompletely preserved; he suggested relationship to *Am. Jason* or *Am. Wallichi*. The new collections from the Spiti Shales do not include any further specimen of *A. Medea*; nevertheless judging from a plaster cast of the type specimen and from G. C. Crick's remarks on the subject, I suspect that *A. Medea* belongs to the group of *A. subradiatus*. Should this supposition prove correct, *A. Medea* would differ from the other forms of the *subradiatus*

[1] The representation of the oral aperture in the illustration of *H. hospes* in the monograph of Bogoslowski is misleading; the aperture is drawn much too high.

group owing to its weaker and more crowded ribs. These faint and uniform ribs remind us also of *Hopl. spitiensis;* we have therefore also to keep in mind the possibility of *Am. Medea* representing a somewhat thicker form of the *spitiensis* group. Judging, however, from the great breadth of the external margin, its connection with the *subradiatus* group seems more probable.

According to Strachey *A. Medea* was found in the Niti Pass. It is to be hoped that better specimens may be found in the original locality, which would allow a correct consideration of this species.

Hoplites (Acanthodiscus) Hookeri, Blanf. sp.

(Plate XXV, fig. 2 *a—d.*)

Ammonites Hookeri, Strachey msc.—Blanford: Palæontology of Niti, 1865, p. 83, pl. 17, fig. 1 *a—d.*
Ammonites Hookeri, Crick: Strachey's Cephalopoda from the Himalaya, *Geol. Mag.*, Dec. V, Vol. 1. p. 12.

Dimensions :—

Diameter	67 mm.
Width of umbilicus	24 „
Height of the last volution above the umbilical suture	25·5 „
Thickness of the last volution	25 „

Shell discoidal, wide-umbilicated, consisting of roundish volutions, the flanks of which are slightly flattened and pass gradually both into the external margin and the moderately steep umbilical wall.

On the anterior portion of the last volution belonging to the body-chamber the sculpture consists of two kinds of ribs: strong main-ribs and fainter intermediate ribs. Each main-rib bears an umbilical and a very stout lateral tubercle; at the lateral tubercle they bifurcate into two branch-ribs which are inclined forward and are tuberculiferous on the ventral face. On the external margin, the intercalary ribs bear tubercles as strong as those of the main-ribs, but they bear only slight swellings at the level of the median tubercles. The number of intercalary ribs fluctuates between one and three. The intercalary ribs immediately succeeding a main-rib unites with it at the umbilical tubercle. In one case only a main-rib is observed to unite with the preceding intercalary rib instead of the succeeding one. On the inner volutions there is more than one intercalary rib developed; it does not, however, originate from the umbilical tubercle of a main-rib, but arises independently at the umbilical margin. The tubercular structure already makes its appearance at a very early stage; the stronger lateral tubercles appear somewhat earlier than the weaker inner ones. A small immature specimen exhibits distinct lateral tubercles at a diameter of only 10 mm. The tubercles grow out into spines, which although broken off in the available specimen, have left impressions in the umbilical wall of the succeeding volution. The spines were shut off from the interior of the whorl by a lamella. The umbilical suture runs above the series of lateral tubercles. On the external

margin there exists a distinct median furrow between the two series of external tubercles.

The suture-line has a fairly simple configuration. The external lobe is somewhat shorter than the first lateral lobe which is characterised by a rather broad trunk and short lateral branches. The second lateral lobe is much shorter and disposed somewhat obliquely. The first lateral lobe is at a level with the series of lateral tubercles, the second lateral lobe nearly in a line with the inner side of the umbilical tubercles; it is consequently often more or less distorted. The external saddle is divided by a small secondary lobe into two almost equal parts; the first lateral saddle is subdivided into a smaller and somewhat lower outer and a large and higher inner portion.

Acanthodiscus Hookeri appears to have been a small specimen when full grown; in the specimen which I have studied, which has a diameter of 67 mm., somewhat more than half of the outer volution belongs to the body-chamber. Similarly, according to Crick, Blanford's smaller type specimen, although of small size, also shows the commencement of the body-chamber. Blanford, however, also referred to *A. Hookeri* a somewhat larger fragment, which is entirely chambered.

I have only been able to examine a single specimen of *A. Hookeri*, which, however, agrees very well with the smaller of Blanford's type specimens. The number of intermediate ribs is somewhat greater in the latter specimen. The significance of this difference cannot be very precisely estimated owing to the incompleteness of Blanford's specimen, but it is evidently too slight to call for a specific discrimination between the two.

Blanford incorrectly identified *Am. Sömmeringi* Oppel with *Am. Hookeri*. It is quite true that the two species are closely allied, but they are not identical. As has been shown when describing *Acanthodiscus Sömmeringi*, this species is nearer *Acanthodiscus subradiatus* than *A. Hookeri*. The band between the two rows of ventral tubercles is much broader in *A. Sömmeringi* than in *A. Hookeri*, and, instead of being smooth, it is traversed squarely by the ribs which are only moderately reduced along the median line. The suture-line of *Acanthodiscus Sömmeringi* is much more copiously and more finely ramified; the first lateral lobe of *A. Sömmeringi* has a much narrower trunk and longer branches; the second lateral lobe is situated on the outer side of the umbilical tubercle, whilst in *A. Hookeri* it occupies the inner side of this tubercle.

From the European Berriasian several allied forms have been described under the names of *Hoplites Rütimeyeri* (Oost.) Sarasin and Schondelm., *Hoplites Sayni* Simion., *Hoplites Rerollei* Pasq. None of these are identical with *A. Hookeri*. In all these species the ventral tubercles are developed into powerful spines, similar to those of the *octagonus*-group, a mode of development which differs from that of the present species. The number of intercalary ribs in the species above mentioned is not so great, and they do not exhibit the bifurcation of the main-ribs at the lateral tubercles.

Acanthodiscus Hookeri was obtained at Lochambelkichak, third Stage. Two specimens.

Hoplites (Acanthodiscus) La Touchei, n. sp.

(Plate XXV, fig. 1 *a*, *b*.)

Dimensions :—

Diameter	77 mm.
Width of umbilicus	29 „
Height of last volution	29 „
Thickness of last volution at the ribs	24 „

The discoid shell is ornamented with strong main-ribs and weaker intermediate ribs, the total of which amounts to twenty-nine on the last volution. Between each two main-ribs, which are beset with umbilical, lateral and external tubercles, there is intercalated an intermediate rib which originates independently at the umbilicus and terminates on the smooth external face in a tubercle. Individual intermediate ribs show a slight swelling in the vicinity of the lateral tubercles. On the most posterior portion, four main-ribs occur in succession without any intercalary ones. As a rule, two branch-ribs arise from each of the lateral tubercles of the main-ribs ; only three main-ribs of the last volution do not ramify. The sculpture of the inner volutions is unknown.

The flanks are slightly rounded and pass gradually into the rounded sloping umbilical wall. Between the ribs the cross-section has an elliptical form ; the height is considerably greater than the breadth.

The suture-line is not distinctly preserved ; but its agreement with the sutural type of the whole group is unmistakable. The body-chamber is unknown.

Acanthodiscus La Touchei n. sp. is chiefly characterised by the flat shape of the shell, the massive coarse costation and the independent origin of the intermediate ribs at the umbilicus. As regards the form of the shell and the massiveness of the ribs the present species reminds us of *Hoplites Sayni* Simionescu, but an identification with the latter is precluded by the regular appearance of the secondary ribs in *H. Sayni*, where they lie close to the main-ribs and neither reach the umbilical suture nor the external margin. Moreover, the main-ribs never seem to bifurcate in *H. Sayni*. Finally, the external spines of the latter are much longer than those of *A. La Touchei*. *Acanthodiscus Euthymi* Pictet has fewer ribs, and its intermediate ribs do not reach the umbilical wall. The present species differs from *A. Hookeri* Strachey owing to the greater flatness of the shell, a flatter umbilical wall and a greater height of volution. Moreover, in *A. Hookeri* several umbilical tubercles give rise to two ribs, namely, a main-rib and a secondary rib ; this is never observed in *A. La Touchei*. With *A. acanthoptychus* the present species has the flat shape of the shell in common, but it differs owing to the ribs being stronger and more uniform and the umbilical wall more gradually declivous, and at the same time broader.

Acanthodiscus La Touchei n. sp. is represented by a single specimen, which is entirely chambered up to its end and comes from Lochambelkichak, third Stage.

HOPLITES (ACANTHODISCUS) ACANTHOPTYCHUS, n. sp.

(Plate XXV, fig. 4 *a*, *b*.)

The shell is rather flat-discoidal with a diameter of 57 mm. and umbilical width of 22 mm.; the flanks are flattish-rounded, the umbilical wall low, rounded and moderately steep. The height of the last volution is 21·8 mm., the thickness between the ribs amounts to 17·2 mm. The cross-section has an elongated oval form between the ribs. The smooth ventral face, which is bordered on either side by a row of tubercles, is proportionately broad.

In this species, just as amongst those related to it, the ornamentation is differentiated into stronger main-ribs and weaker intermediate ones; but the difference in thickness between the two sets is not great. The main-ribs carry an umbilical and lateral tubercle; from the lateral tubercles arise two branch-ribs which are curved forward. As a rule one of the branch-ribs, usually the posterior one, is somewhat stouter than the other. In one place three branch-ribs proceed from one lateral tubercle, but this is counterbalanced by the preceding main-rib remaining entire. In addition to the main-ribs, there are intercalary ribs usually originating independently at the umbilical suture, or, less frequently, from an umbilical tubercle. On the anterior portion of the last volution, which already belongs to the body-chamber, the sculpture becomes somewhat irregular, the external tubercles are not all of equal strength and are irregularly distributed: the tubercles of the intercalary ribs are mostly somewhat weaker than those of the branch-ribs and they are situated quite close to those of the preceding branch-ribs. The inner volutions are not well preserved, but we are able to ascertain that the tubercular sculpture makes its appearance at an early stage.

The suture is only indistinctly preserved in the figured specimen, but somewhat better so in a second one. The trunk of the first lateral lobe is rather broad and has moderately ramified lateral branches and a rather short terminal branch. The second lateral lobe is not so complex, it is much shorter, and is somewhat obliquely disposed.

Acanthodiscus acanthoptychus belongs to the cycle of *A. Hookeri*, *A.* aff. *hystricoides* Uhlig, *A. Smithi* n. sp., and *A. La Touchei*. *A. Hookeri* is distinguished from *A. acanthoptychus* by its coarser ornamentation and much greater thickness. *A.* aff. *hystricoides* is also thicker and has much more numerous intermediate ribs. *A. Smithi* has strong and wider-spaced main-ribs, external tubercles of uniform massiveness, a regular sculpture and a thicker shell, so that *A. acanthoptychus* cannot be united with this species. The nearest ally appears to be *Acanthodiscus La Touchei* which I had originally intended uniting

with *A. acanthoptychus*, but which I eventually kept separate owing to the more slender and less regular ribs, and the steeper and narrower umbilical wall of the latter. Amongst European species, *Hoplites perornatus* Retowski, *Hoplites sub-Chaperi* Sarasin and Schondelm (*non* Retowski), and *Hoplites Rütimeyeri* (Oost.) Sarasin and Sch. should be specially mentioned as allied to *A. acanthoptychus*. *H. perornatus* has a somewhat more delicate sculpture and does not exhibit the regular branching of the main-ribs at the lateral tubercles which is so characteristic of the present species. This regular mode of branching appears also to be wanting in *Hoplites sub-Chaperi* Sarasin and Schondelm. The illustration of the poorly preserved specimen of Sarasin and Schondelm unfortunately does not enable us to form a definite opinion with regard to this species which perhaps is very close to *A. acanthoptychus*. In any case Sarasin and Schondelm's *Hoplites sub-Chaperi* differs from both the species described under that name respectively by Simionescu and G. Retowski. Should the Swiss species prove identical with *Acanthodiscus acanthoptychus* it would have to assume the latter name. *Hoplites Rütimeyeri* Sarasin and Schondelm (*non* Ooster) is distinguished from the present species by the broadening of the main-ribs above the lateral tubercles, the want of regularity in the bifurcation of the main-ribs and by the narrower umbilicus.

Hoplites acanthoptychus is represented by one specimen from Lochambelkichak, third Stage, and a second one from Hundes.

Hoplites (Acanthodiscus) Smithi, n. sp.

(Plate XXIV, fig. 3 *a*—*c*.)

There are unfortunately only two available fragmentary specimens of this richly ornamented species, so that the diagnosis is unavoidably incomplete.

The figure represents the larger specimen in which the last volution belongs to the body-chamber; it has an approximately elliptical cross-section with the maximum thickness in the vicinity of the umbilical tubercles just above the level where the flattened flanks pass into the steep umbilical wall. Above the lateral tubercles the cross-section gradually tapers into the narrow flattened external margin. At the anterior end the volution height is 25·2 mm., the breadth between the ribs, 21·5 mm.; the preceding volution is proportionately thicker, both the height and width measuring 12 mm.

On the outer volution the sculpture consists of strong, anteriorly sloping main-ribs which carry an umbilical and a more massive lateral tubercle. Two anteriorly inclined branch-ribs proceed from the lateral tubercle. A slightly sigmoidal subsidiary rib which is also inclined forward, issues from the umbilical tubercle. All the ribs terminate at the narrow, smooth ventral band in a distinct ventral tubercle. On the inner volution, too, the main-ribs as well as the tubercles are very prominent, and some of the subsidiary ribs originate

independently on the umbilical wall. The strong development of ribs and tubercles on the inner volution indicates that the tubercular sculpture of the present species is first developed at an early stage of growth.

The suture-line is unknown.

Acanthodiscus Smithi differs from *A. Hookeri* owing to its fewer intermediate ribs, taller elliptical cross-section, steeper umbilical wall, and narrower external margin. The same characters distinguish it from *A.* aff. *hystricoides*, but the latter is further distinguished by a much more crowded and proportionately finer sculpture and probably also a much later appearance of the tubercles. *A. Smithi* is also allied to *A. Euthymi* Pictet sp., but cannot be brought into closer relation with it, because the subsidiary ribs of *A. Euthymi* never reach the umbilical tubercles as they do in the Indian species, and its external margin is much broader.

The figured specimen is from Lochambelkichak, third Stage; a second small specimen is from Hundes.

HOPLITES (ACANTHODISCUS) aff. HYSTRICOIDES, Uhlig.

(Plate XXV, fig. 3 *a*—*c*.)

Hoplites hystricoides, Uhlig: Cephalopodenfauna der Teschener und Grodischter Schichten. *Denkschr. k. Akademie der Wissenschaften, Wien*, 1901, Vol. 72, p. 39, Pl. I, fig. 8 *a*—*c*.

The present species is unfortunately represented only by a single incomplete fragment of a body-chamber exhibiting distinctly flattened flanks, a slightly rounded external margin, and a very steeply sloping umbilical wall. At the anterior end, the cross-section of the intercostal spaces is 30·2 mm. in height by 29 mm. in breadth.

The sculpture consists of stronger main-ribs and weaker intermediate ribs. Each main-rib carries an umbilical and a lateral tubercle and a slight thickening of the external margin. The number of intermediate ribs fluctuates from one to four. The intermediate rib immediately following a main-rib originates in the umbilical tubercle, while the following ones arise independently on the umbilical wall. In one place two intermediate ribs unite on the umbilical wall, and one of them is again divided into two branch-ribs higher up. The stronger main-ribs assume a straight, radial course between the umbilical and lateral tubercles; at the lateral tubercles they split up into two subsidiary ribs inclined forward. The intermediate ribs are slightly sigmoidal and somewhat deflected forward on the external margin. The external tubercles are considerably reduced on the body-chamber; on the inner volutions they project in the shape of acute small tubercles, as indicated by the remains of the external portion of the preceding volution preserved along the dorsal groove of the body-chamber (see fig. 3 *c*). This remnant also indicates that the ventral furrow of the inner volutions was

narrow and deep. With increased growth, the furrow became broader and shallower. It is still fairly distinct on the body-chamber, but the ribs are faintly connected across it, while at the same time the external tubercles become reduced to slight swellings. The external tubercles of the inner volutions succeed one another very closely; the inner volutions must therefore have been ornamented with crowded ribs which probably did not yet carry any lateral tubercle.

The present species is certainly very closely related to *Hoplites* (*Acanthodiscus*) *hystricoides* Uhlig from the Valanginian of Silesia. The sculpture of the Indian shell-fragment compared with that of the corresponding stage of development of *A. hystricoides* scarcely shows any perceptible difference, except, perhaps, a somewhat weaker development of the ribs. The dimensions as well as the shape of the shell also agree tolerably well; the Indian form is perhaps somewhat thicker. The proportionate narrowness of the inner volutions in *Hoplites* (*Acanthodiscus*) *hystricoides* also appears to be a characteristic feature of the Indian form, as may be inferred from the external groove on the preserved fragment of an inner volution.

In the absence of the inner volutions and of the suture of the Indian form it is impossible to accept a direct identification with the Silesian species. It is possible that further discoveries of more perfect specimens would necessitate a specific separation of the two forms. In the meanwhile it is impossible to arrive at a final decision.

The present species is distinguished from *A. Hookeri* by its finer, more distinctly curved and more densely crowded ornamentation, the much more crowded ribs of the inner volutions, which probably develop lateral and umbilical tubercles only at a very late stage of growth, and finally by its larger size.

Acanthodiscus aff. *hystricoides* is represented by a single specimen from Lochambelkichak, third Stage.

HOPLITES (ACANTHODISCUS) SPITIENSIS, n. sp.

(Plate XXVI, fig. 2 *a*, *b*, *c*.)

The shell is flat, discoidal, ornamented on the inner volution with slightly sigmoidal ribs which persist up to a diameter of at least 70 mm. when they give place to a tubercular ornamentation. On the innermost of the preserved volutions the ribs originate, mostly in pairs, from slight swellings along the umbilical wall; single ribs arise independently between the pairs of ribs. On the upper portion of the flanks certain ribs bifurcate, while others remain undivided. The same type of sculpture predominates also on the succeeding volution, with the difference that the ribs recede further from one another. The ribs carry slight tubercles on either side of the smooth external band, a feature which certainly existed also on the innermost volution. The body-chamber exhibits the tubercular sculpture in its full development: the ribs are grouped into main-ribs and

secondary ribs—the former are stout, provided with strong umbilical and lateral tubercles and disposed radially, the latter are thinner and more inclined towards the front. Some of the secondary ribs arise in pairs from the lateral tubercles, others from umbilical tubercles, and the remainder originate independently on the umbilical wall or on the flanks. The divergence of the branch-ribs is not nearly so pronounced as in the thick-shelled forms. Occasionally the posterior secondary rib does not originate at the lateral tubercle, but somewhat lower down from the main-rib; the lateral tubercle appears then as if outwardly displaced. The rather broad external band is smooth; the ribs end against it in slight swellings without forming real tubercles. The portion of the shell on which the transition to the tubercular sculpture takes place has unfortunately been broken off.

The diameter probably measures about 133 mm., the umbilical width 52 mm. The height of volution at the anterior end is 48 mm., its thickness between the main-ribs 40 mm. The flanks of the inner volutions are flat and taper outward in a wedge-like manner, or else with a slightly rounded surface towards the external margin. The umbilical margin is steep. With increasing size the umbilical margin becomes more oblique and the flanks appear, as it were, blunted, owing to the prominence of the lateral tubercles, in consequence of which the cross-section assumes a somewhat octagonal outline.

The suture-line is indistinctly preserved. The first lateral lobe has a comparatively narrow trunk and copiously ramified branches. The first lateral saddle, which is subdivided by an oblique secondary lobe, is placed at a higher level than the external saddle; the second lateral lobe, is much shorter than the first lateral lobe and somewhat unsymmetrically constructed. The point of the inner lateral branch of the first lateral lobe reaches close to the point of the second lateral, and the oblique secondary lobe of the first lateral saddle also protrudes close up to the second lateral lobe, in consequence of which the first lateral saddle is strongly incised and constricted at its base. *Hoplites spitiensis* is distinguished from *Hoplites tibetanus* by its much coarser sculpture, the much later appearance of the tubercular ornamentation and the configuration of the suture-line. The lobes of *Hoplites tibetanus* are lower, the trunk of the first lateral is narrower, the external and the lateral saddles stand at about the same level, the external saddle is less deeply incised and constricted than in *Hoplites spitiensis*. *Hoplites asiaticus* has much more crowded ribs, and its main-ribs and tubercles are much weaker than in the present species.

Amongst European species the closest ally to *A. spitiensis* is *Hoplites Michaelis* Uhlig from the Valanginian of Silesia. The sculpture of the inner volutions of both species appears to be very similar; but the tubercular phase of the Indian species is characterised by much greater regularity and extends over a larger portion of the whorls than in *H. Michaelis*, in which it rapidly passes into strong, ridge-like, straight ribs. Whether a phase similar to the final sculpture of the body-chamber of *Hoplites Michaelis* ever develops is uncertain, the front portion of the body-chamber of the Indian specimen being broken off. The

suture-line of *H. Michaelis* differs considerably from that of *A. spitiensis* owing to the greater breadth of the first lateral lobe and of the first lateral saddle as well as the uniform level at which the external and the first lateral saddles are situated.

The present species also exhibits points of contact with *Hoplites (Acanthodiscus) hystricoides* Uhlig. It is especially the sculpture of the inner volutions which shows great similarity. But the outer volution of *Acanthodiscus spitiensis* is much higher and the ribs are less curved on the ventral margin, so that the two species are easily distinguished from one another. From *Hoplites (Acanthodiscus) Malbosi* Sarasin and Schondelm,[1] *A. spitiensis* is distinguished by its stronger main-ribs and tubercles, by the smaller number of intermediate ribs and by the discontinuity of the ribs on the external margin; from *Hoplites (Acanthodiscus) asinensis* Canav. it differs owing to its greater thickness and the extension of the intercalary ribs as far as the umbilical margin.

Acanthodiscus spitiensis is represented by a single specimen from Lochambel-kichak, third Stage.

HOPLITES (ACANTHODISCUS) aff. MICHAELIS, Uhlig.

(Plate XXI, fig. 2 *a*, *b*.)

Hoplites Michaelis, Uhlig: Cephalopodenfauna der Teschener und Grodischter Schichten. *Denkschriften kais. Akademie, Wien*, Vol. 72, pl. VII, figs. 1—4, p. 35.

Amongst the material collected from the Spiti Shales is a fragment whose appearance invites comparison with *A. Michaelis* Uhlig from the Valanginian of the Silesian Carpathians. It consists of a portion of a volution 33 mm. high by 28 mm. broad with flat flanks converging towards the flat and broad external margin, and an oblique rounded umbilical wall. *Hoplites Michaelis* comes especially close to the Indian fossil at that particular stage of growth when its main-ribs are only yet of moderate strength, and the tubercles only slightly developed. In the Indian form, two to four intermediate ribs arising from the umbilical wall, and exhibiting slight thickenings at the level of the lateral tubercles, are intercalated between the main-ribs. All the ribs are strongly developed, wide-spaced, radially disposed on the lower part of the flanks, curved forward on the upper part, and thickened on the external margin.

The resemblance of the present species to *A. Michaelis* is so great that one feels tempted to unite the Indian and Silesian fossils. Nevertheless it is best to be content with expressing the close relationship of the two forms, as may be judged from the following reasons: although the external margin is broad in both forms, the greatest thickness in the case of *Acanthodiscus Michaelis* lies in the region of the umbilical tubercles, whilst in the Indian species it is situated somewhat higher up. The ornamentation that characterises the fragment of

[1] Etude monogr. des Ammonites du Crét. inf. de Chatel-St. Denis. *Mém. Soc. paléont. suisse*. XXVIII, 1901, pl. X, figs. 1, 2, p. 79.

the body-chamber in the case of the Indian fossil is similar to that observed on the chambered phase of *A. Michaelis*. It is doubtful, therefore, whether the body-whorl of the Indian form could ever have carried such prominent costal ridges as those which constitute such a prominent feature in the Silesian form. Further discoveries must be awaited in order to arrive at a definite conclusion.

Locality.—Lochambelkichak, third Stage.

HOPLITES (ACANTHODISCUS) TIBETANUS, n. sp.

(Plate XIV. fig. 2 *a*, *b*.)

Dimensions :—

Diameter approximately	89 mm.
Width of umbilicus	30·3 „
Height of last volution approximately	33·5 „
Breadth of last volution approximately	28 „
Height of volution in the region of the penultimate suture	25 „
Breadth of volution in the region of the ponultimate suture	20·2 „

The innermost volutions of the only available specimen are unfortunately not preserved. At a diameter of only 30 mm., one already observes strong main-ribs, beset with umbilical and lateral tubercles, produced by the partial fusion of two adjacent ribs. True intercalary ribs seem to be of rare occurrence at this stage of growth. At a somewhat later stage, one or two fainter intermediate ribs with a slight anterior inclination become intercalated between each pair of tuberculiferous main-ribs; they originate either from an umbilical tubercle or near the latter on the umbilical wall. From the prominent, round lateral tubercle there arise two slightly divergent branch-ribs. All the secondary ribs form distinct small tubercles on either side of the smooth narrow ventral margin. On the anterior part of the last volution, which belongs to the body-chamber, the sculpture undergoes no essential change. Here also individual main-ribs consist of two only partly fused ribs, and in one place three branch-ribs detach themselves from the lateral tubercle.

The flanks are flat between the lateral and umbilical tubercles, somewhat bluntly curved between the lateral tubercles and the external edge. The external margin is narrow and not furrowed; the umbilical wall is rounded and rather steep. The volutions overlap one another by about one quarter to one-fifth their height.

The suture-lines succeed each other closely and are considerably ramified. The trunk of the first lateral lobe is rather narrow and short, while its terminal and lateral branches are long. The external and lateral saddles are on about the same level; they have broad stems and are subdivided by a deep adventitious lobe. The details of the lobe-line are unfortunately badly preserved.

Acanthodiscus tibetanus is related to several species of the Spiti Fauna. *A. spitiensis* has a coarser ornamentation and assumes the tuberculate sculpture a

a much later stage of growth. *Hoplites himalayanus* has fewer intermediate ribs, a broader external face and the tubercular phase of its sculpture also appears later. *Acanthodiscus Smithi* has fewer intermediate ribs and a more cuneate cross-section; *A. asiaticus* is more densely ribbed, its tubercles are less developed and the lateral tubercles become reduced on the anterior portion of the shell

Locality.—Lochambelkichak, third Stage One specimen.

HOPLITES (ACANTHODISCUS) ASIATICUS, n sp.

(Plate XXIV, fig. 1 *a*, *b*)

Dimensions :—

Diameter	105 mm.
Width of umbilicus	38 „
Height of volution	40·3 „
Thickness of last volution between the umbilical tubercles	31 „

Acanthodiscus asiaticus is very closely related to *Acanthodiscus tibetanus*. The external shape, the general character of the ornamentation and the dimensions all agree sufficiently close as to raise the question whether both forms might not be united. On closer examination, however, certain differences become apparent necessitating their separation.

In the case of *A. asiaticus*, the volutions are somewhat higher and flatter than in *A. tibetanus*, the umbilical wall slopes somewhat more steeply and the maximum thickness more nearly coincides with the umbilical series of tubercles. The flat ventral face is somewhat broader, and the small ventral tubercles are somewhat fainter. In both species the umbilical and lateral tubercles make their first appearance at an early stage of development; whilst, however, in *A. asiaticus* one to two entire intermediate ribs, rising on the umbilical wall, exist, at that early stage, between the tuberculiferous ribs, such intermediate ribs are almost entirely wanting in *A. tibetanus;* and while in the course of further development the lateral tubercles of *A. tibetanus* become more and more prominent, in *A asiaticus* they disappear entirely for about half a volution, and although they reappear for some distance, they again disappear on the foremost portion of the shell. The tubercle-bearing main-ribs are not much more prominent than the intercalary ones in *A. tibetanus*, while in *A. asiaticus* the distinction almost entirely ceases to be appreciable. In the latter species the number of intermediate ribs between each pair of main-ribs (the main-ribs being those arising from the umbilical tubercles) amounts to two to four, while in *A. tibetanus* there are only one or two. Of these intercalary ribs, at least one, sometimes two, originate from the umbilical tubercles. As in *A. tibetanus*, two branch-ribs spring from the lateral tubercles of the main-ribs, but in *A. asiaticus* certain intercalary ribs also bifurcate, a circumstance never observed in *A. tibetanus*. The number of ribs in *A. asiaticus* is decidedly greater than in *A. tibetanus*, the last

volution carrying 58 ribs, while there are only 42 in *A. tibetanus*. Finally the ribs of *A. asiaticus* are somewhat more strongly curved and they are somewhat more decidedly deflected forward, especially in the vicinity of the external margin.

The suture-line of *Acanthodiscus asiaticus* has unfortunately not been preserved. At a short distance behind the broken anterior extremity, a trace of the external lobe is discernible. The most anterior part of the last volution corresponds probably to the commencement of the body-chamber. The umbilical wall appears already to curve inwards, the involution spiral grows wider; the coiling becomes looser, similarly to what is known in certain forms of the Neocomian of Europe (*H. amblygonius, paucinodus*, etc.).

Amongst European species *Hoplites Paquieri* Simionescu, *H. pseudo-Malbosi* Sarasin and Schond., *H. sub-Chaperi* Retowski remind us of *Hoplites asiaticus*. The first species has a much coarser ornamentation and fewer ribs; the second species is distinguished by the ribs being interrupted on the ventral face; the third has much finer and more crowded non-tuberculate ribs, but suddenly acquires a prominent tubercle-sculpture at its anterior end, exactly where in *A. asiaticus* that structure becomes less pronounced. If it were not that Sarasin and Schondelmayer laid special stress on the close relationship of their *Hoplites pseudo-Malbosi* to *Hoplites angulicostatus*, and also for the fact that on its ventral face it exhibits neither any reduction or "inflexion" of the ribs, one might be tempted to refer Indian fossil to *H. pseudo-Malbosi*. This step is precluded by the definiteness of the statement made by the Swiss authors.

Locality.—Lochambelkichak, third Stage. One specimen.

Incidentally we may here mention another specimen from the same locality (Lochambelkichak, third Stage); its ornamentation is similar to that of *Hoplites asiaticus*, but the volutions are much thicker and lower and the ventral band is very narrow. The state of preservation of the specimen is not very good, and it is possible that the greater thickness is connected with its state of preservation. It is, however, more probable that we have here to deal with a distinct species which it is impossible to characterise more precisely. The suture-line resembles that of *A. Michaelis* Uhlig. We enumerate this form under the name of *Hoplites* (*Acanthodiscus*) aff. *asiaticus* nov. sp.

Hoplites (Acanthodiscus) n. sp. ind. aff. spitiensis, n. sp.

A fragment of a body-chamber, which was found as a loose fragment by T. L. Walker at Lochambelkichak, represents a new species closely allied to *Acanthodiscus spitiensis*, but distinguished by its taller volutions and its more crowded as well as finer costation. Whilst the umbilical and lateral tubercles are more feebly developed than in *Acanthodiscus spitiensis*, the ventral tubercles are more strongly developed. The intercalary ribs are sometimes branched.

The fragment in question has a volution-height of about 62 mm., and hence belongs to a species reaching somewhat large dimensions. Although the sculpture

of this fine fragment is very characteristic, we do not consider it advisable to definitely name it having regard to the incompleteness of the available specimen.

HOPLITES (ACANTHODISCUS) RUPRECHTI, Oppel sp.

Ammonites Ruprechti, Oppel: *Palãontolog. Mitteil.*, p. 287, pl. 84, fig. 1.

The specimen upon which Oppel founded the above-mentioned species, and which I have also been able to examine, is an external cast. Up to the present no other specimen has been discovered, and I am unable to add anything to Oppel's description except some comments as to its relation to other forms. Oppel compared his *Ammonites Ruprechti* with *Peltoceras athleta*; in the light of a more accurate knowledge of the Spiti Fauna we are able to assert that the place of the present species is evidently in the genus *Hoplites* (*Acanthodicsus*). The inner volutions bear rather fine, *Perisphinctes*-like ribs most of which originate singly on the low umbilical wall. It is only at a diameter of 55 to 58 mm. that the lateral umbilical tubercles first appear. At that stage, the strong, tuberculiferous ribs succeed one another rather closely, while, at the same time, to judge at least from the incompletely preserved fragment, only very few intercalary ribs appear to be developed. In this respect *Acanthodiscus Ruprechti* rather differs from *A. spitiensis*, *A. tibetanus*, *A. asiaticus*, and *A. Michaelis*, which otherwise resemble *A. Ruprechti* owing to the construction of their inner volutions. Nevertheless the difference in the tubercular sculpture is not sufficient to exclude *A. Ruprechti* from the immediate precincts of the form-circle of *A. spitiensis*.

Oppel's type-specimen was found in the vicinity of the village of Tengdi in the province of Spiti (Coll. Schlagintweit).

HOPLITES (ACANTHODISCUS) HIMALAYANUS, n. sp.

(Plate XXIII, fig. 2 *a*, *b*, *c*.)

Dimensions :—

Diameter	75 mm.
Width of umbilicus	27 „
Height of last volution	29 „
Thickness of last volution between the ribs	25·5 „

The shell is disc-shaped, with a rather narrow umbilicus, flat flanks, a broad, flattened external margin, and a steep, rounded umbilical wall. The cross-section is approximately rectangular, with a wedge-shaped bevel between the lateral and external tubercles.

On the earlier part of the last volution, the sculpture consists of falciform ribs, some of which originate in small umbilical tubercles, whilst the remainder are intercalated in the interstitial spaces. Numerous intercalary ribs originate

on the flanks of the volutions: consequently they are much more numerous on the outer than on the inner margins, so much so that to every seven umbilical tubercles there are as many as seventeen ribs on the external margin.

With increasing growth the falciform costation gives place to a very characteristic tubercle-sculpture: the umbilical tubercles become more distinct, certain ribs become more prominent than others and swell into distinct thickenings along the upper part of the flanks at the same level as some very faint thickenings only just perceptible at the earlier stage of growth. At first long intercalary ribs persist between the tubercle-bearing ones, but they are soon replaced by broad and rather flat main-ribs giving off branch-ribs from the strong lateral tubercles. In one part of the shell one intermediate rib makes its appearance on the lower region of the flank, but it fades away higher up. The differentiation of the main-ribs first becomes evident at a diameter of about 55 mm., while at 72 mm. the first bifurcation of the ribs in a lateral tubercle takes place, but the two branch-ribs unite again into a ventral tubercle on the ventral face. It is only the branch-ribs belonging to the next succeeding main-rib which remain divergent, each terminating in a separate tubercle on the external margin. In the region of the falciform ribs the external tubercles are all of the same size, but after the establishment of the tubercle-sculpture individual external tubercles become specially noticeable by their massive appearance. The external band is broad, but not quite smooth, being squarely traversed by faint ribs which connect the two rows of tubercles situated along the external edges.

The suture-line is unfortunately not visible, and it is therefore impossible to tell whether the anterior part of the last volution belongs to the body-chamber, or whether the species grew to a still larger size perhaps with further changes in the ornamentation.

Hoplites himalayanus occupies an isolated position amongst the Asiatic forms, as has already been pointed out in the introduction to the genus. It is the only Indian species in which one observes a transition from the fascicles of sigmoidal ribs to the tuberculate type of costation. A similar feature is observed in the case of *Hoplites hystrix* (Bean) Neum. et Uhl. and *Hoplites spiniger* v. Koenen and it is probable that these forms are closely allied to the Indian one. *Hopl. hystrix* is distinguished by a somewhat wider umbilicus, more distinct intermediate ribs and an earlier appearance of tritubercular sculpture; *Hopl. spiniger* differs in the great number of its intermediate ribs. *Hopl. sub-Chaperi* Retowski recalls the present species by the sudden appearance of its tubercle-sculpture at the anterior end of the shell, but the exceedingly fine, filiform, densely crowded ribs of *Hoplites sub-Chaperi* preclude any possibility of a closer connection with *Hoplites himalayanus*.

The possible relationship of *Hopl. himalayanus* to *Hopl. progenitor* Oppel and to *Aulacostephanus* has already been discussed in the introduction to the genus.

Locality.—Lochambelkichak, third Stage; one specimen.

C.—COSTATE FORMS.

HOPLITES (KILIANELLA) PEXIPTYCHUS, Uhlig.

(Plate LXXXII, fig. 2 *a—c.*)

Hoplites pexiptychus, Uhlig: Zur Kenntniss der Cephalopodon der Rossfeldschichten, *Jarhb. geol. Reichsanst., Wien*, 1882, Vol. 32, p. 389, pl. IV, figs. 4, 5.

Hoplites pexiptychus, Uhlig: Ueber neue Foss. vom Gardenazza, mit Anhang über Neocom von Ladi. *Jarhb. geol. Reichsanst.*, 1887, Vol., p. 106.

Hoplites Roubaudi (d'Orb.). W. Kilian: Descr. géolog. de la mont. de Lure, p. 423 (partim), 1889.

Hoplites Roubaudi, W. Kilian: Sur quelq. Foss. du Crét. inf. de la Provence, *Bull. Soc. géol. France*, 3 sér., Vol. XVI, p. 679, pl. XVII, figs. 2, 3.

Hoplites pexiptychus, P. Lory: Sur les *Hoplites* du groupe de *H. neocomiensis*, *Trav. Labor. de Géologie de la Fac. des Sciences de Grenoble*, 1892, p. 22.

Hoplites Roubaudi, Sarasin: Quelques consid. sur les genres *Hoplites*, *Sonneratia*, *Desmoceras* et *Puzosia*, *Bull. Soc. géol. France*, 3me série, Vol. XXV, p. 766.

Hoplites pexiptychus, Simionescu: Ueber einige Ammoniten mit erhaltenem Mundsaume. *Beitrage zur Palaeontologie Oesterreich-Ungarns*, IX, 1898, p. 209.

Hoplites pexiptychus, Uhlig: Cephalopodenfauna der Teschener und Grodischter Schichten. *Denkschr. k. Akademie d. Wissenschaften, Wien*, Vol. 72, 1901, pl. IV, figs. 4-7, p. 41.

Hoplites pexiptychus, Sarasin et Schondelmayer: Etude monogr. des Amm. du Crét. inf. de Chatel-St Denis. *Mém. Soc. pal. suisse*, XXVIII, 1901, p. 67.

SYN. *Ammonites subserratus* Mallada Synopsis esp. foss. en España, III. *Boletin de la Com. d. Mapa geol. de España*, XIV. Madrid, 1887, p. 15, pl. 10, figs. 10, 11.

SYN. *Hoplites* n. f. (cf. *Borrowae* Uhlig): Parona, Descr. di alc. amm. del Neocom. Veneto, *Palaeontographica Italica*, III, 1899, pl. XVIII, fig. 3, p. 140.

In view of the numerous detailed accounts already published with regard to this species, we may dispense with an exhaustive account of the Indian specimens. Dimensions, shape and ornamental details all agree so well with the corresponding features of the specimens from the South of France, the Eastern Alps and the Carpathian Mountains, that it is impossible to detect any difference worth mentioning. The Indian form agrees fairly well with the type-race of *Hoplites pexiptychus*. The thickening of the ribs on the external margin is quite noticeable without being exaggerated. A slight increase in thickness takes place also at the point of bifurcation of the ribs of the figured specimen, and faint umbilical tubercles occur at places where two ribs originate conjointly. Some of the ribs remain simple, others bifurcate. The Indian specimens do not exhibit very distinct constrictions along the flanks, but a considerable amount of variation in this respect has also been noticed amongst European specimens. Moreover, the deeper excavation of certain individual furrows along the external margin indicates that the constrictions are really present in the Indian specimens also.

The suture-line is unfortunately not distinctly preserved; nevertheless one can recognise the forward directed convexity of the septa from the external margin to the first lateral saddle, a feature which, according to the illustrations published by Sarasin, also characterises the sutures of the European specimens of *Hoplites pexiptychus*.

There are three specimens of this species in the collections from India. The figured specimen has septa up to a diameter of 47 mm. The traces left by the umbilical suture on the last volution suggests that the specimens must have reached a diameter of at least 70 mm. The second specimen seems to be the fragment of a body-chamber; it has a volution-height of 12·5 mm. and a breadth of 9 mm. The third specimen is likewise a fragment of a body-chamber of 22 mm. height of volution. In this specimen the ribs are somewhat more strongly bent on one side and somewhat distorted on the other, an irregularity which is probably only the consequence of an injury.

Kilianella pexiptycha is one of the commonest zone-fossils in the Valanginian of Europe. It is known to occur at this horizon in Southern France, in Switzerland, in the Eastern Alps, in Silesia (Upper Teschener Schiefer) and in Spain.

Locality.—Lochambelkichak, third Stage, Hundes.

Hoplites (Kilianella) constrictus, n. sp.

(Plate LXXXII, fig. 5 *a*, *b*, *c*.)

Whilst the previously described Indian specimens of *Kilianella pexiptycha* exhibit only slight intercostal constrictions, this character is exceedingly strongly marked in another closely allied species, namely, in *Kilianella constricta* n. sp. The species is established on a mere fragment of a body-chamber, which corresponds to about one-fourth of a volution, and which exhibits three deep and broad sigmoidal constrictions bounded by strongly thickened ribs. The more prominent ribs are those bounding the constrictions posteriorly; on the external margin they project in a cord-like fashion and, on the umbilical wall, form an acute tubercle from which originates a weaker subsidiary rib. The ribs forming the anterior boundary of the constrictions are also of broad build, but it is only on the external margin that they project beyond the level of the ordinary ribs, and, even there, they are not so prominent as the ribs on the posterior margin of the constrictions. As far as can be judged from the available specimens, they remain undivided. Between each two constrictions there are two to three decidedly sigmoidal ribs originating singly on the umbilical wall and bifurcating half way up the flanks or somewhat lower down. The branch-ribs are strongly curved forward; at the junction of the lateral and external margins they carry minute tubercles, so small as to be only just perceptible, and, on the external margin, they are interrupted by a shallow median furrow. It is only at the foremost portion of the shell that a few individual ribs traverse, more or less obscurely, the median furrow forming a faint anteriorly convex arch.

The shell has a rounded-rectangular cross-section with strongly flattened flanks and a flattened external margin. The umbilical wall slopes rather steeply. The volution-height is 22·3 mm. at the anterior end, the breadth 19·5 mm.

The inner volutions and the sutures are unknown.

Kilianella constricta differs from *K. pexiptycha* in its greater thickness, much deeper constrictions and much more massive constriction-ribs; further, in the absence of swellings at the points of ramification of the ribs and in the presence of fine small tubercles on the external edge. Whether the absence of unbranched ribs in *K. constricta* furnishes an invariable character cannot be determined with certainty owing to the small size of the available fragment.

In any case the differences between the present species and *K. pexiptycha* are very considerable and its characters are striking. We may hope therefore that it will be possible to recognise the present species when found again, although our present knowledge of it is very deficient. Under the circumstances, we think it permissible to bestow on it a specific designation.

The specimen described above is from Lochambelkichak, third Stage.

HOPLITES (KILIANELLA) aff. EPIMELOIDES (Meneghini), Parona.

(Plate LXXXVI, fig. 5 *a*—*c*.)

Hoplites epimeloides, Meneghini (*in sched.*), Parona : Descrizione di alcuni Ammoniti del Neocomiano Veneto. *Palaeontographica Italica*, III, 1897, p. 138, pl. II, fig. 2.

The group of *Hoplites pexiptychus* is further represented by an additional interesting species of which we unfortunately possess nothing but a small fragment of a body-chamber. At the anterior end the height of volution is 20 mm., the thickness 19 mm. The cross-section has an approximately elliptical or rounded-squarish form. The flanks are slightly rounded; the umbilical wall is oblique. The disposition of the ribs generally coincides with that observed in *Hopl. pexiptychus*, but their backward inclination on the middle part of the flanks, and forward inclination on the upper part, are both more pronounced, while on the external edge they show isolated ridge-like swellings. The majority of the ribs start singly from the umbilical suture, only one exception being observed where two ribs issue simultaneously from a faint umbilical tubercle. One rib undergoes a subdivision into three branch-ribs, the anterior subsidiary rib becoming fused on the external margin with the next-following rib. The ribs situated behind the trichotomous rib are exceedingly strongly inclined backwards and assume a forward curvature only on the external margin. Slight thickenings affect individual ribs on the umbilical wall and on the flanks. The marginal furrow is somewhat narrower than in *Hoplites pexiptychus*.

In consequence of the narrow marginal furrow and the pronounced anterior arching of the ribs on the external margin, the present species reminds us forcibly of *Hoplites epimeloides* (Mgh.) Parona from the Venetian Neocomian. The Indian form has a somewhat thicker section than the Venetian species, and the two can scarcely be regarded as identical. The single available fragment of the Indian species is, however, too small to allow us to arrive at a satisfactory conclusion. Moreover, the irregularities in the sculpture as well as the slight asymmetry of the shell suggests a pathological deformation. We must therefore be

content with a description of this remarkable form and postpone the definite characterisation of the species until additional material has been discovered.

The specimen described above is from Hundes.

Hoplites (Kilianella), n. sp. ind.

(Plate LXXXII, fig. 4 *a*, *b*, *c*.)

Amongst the material at our disposition is another specimen too incomplete for specific diagnosis, yet sufficiently interesting to deserve notice.

The specimen in question is a fragment of a body-chamber with approximately elliptical cross-section, rounded flanks, oblique umbilical wall and slightly flattened external margin. The height of volution is 33 mm., the maximum thickness 29 mm. The greatest thickness coincides approximately with the middle of the flanks. The shell is ornamented with rounded prominent ribs, most of which originate singly at the umbilical suture; their direction is at first radial or slightly retrograde, but they abruptly assume a sickle-shaped disposition at about half-way up the flanks. Towards the external margin, the ribs become considerably thickened, without, however, forming proper tubercles. The median zone of the external margin remains smooth. Two of the ribs bifurcate about half-way up the flanks; the point of bifurcation is, in one case, distinctly thickened. There are no distinct umbilical tubercles, though one observes a distinct thickening at one spot where two ribs originate conjointly.

The suture-line and inner volutions are unknown.

The abrupt falciform curvature of the ribs, after they have run a straight course on the flanks, their increase in thickness on the ventral face and their predominantly independent origin are features recalling the characters of the group of *Kilianella pexiptycha*. The fossil cannot be connected with any other groups of Ammonites, though it cannot be referred to any hitherto described species of the group of *K. pexiptycha*. Evidently the fragment represents a new species. But in the absence of the inner volutions it is impossible to arrive at definite conclusions with regard to its relationships, nor to frame a sufficiently detailed diagnosis, and we have therefore refrained from assigning to it a new specific name.

The fragment described above is from Lochambelkichak, third Stage.

Hoplites (Kilianella) leptosoma, n. sp.

(Plate LXXXII, fig. 3 *a*, *b*.)

Dimensions :—

Diameter (approximately)	62·5 mm.
Width of umbilicus	25·5 „
Height of last volution	20·6 „
Thickness (approximately)	14 „

The shell has the shape of a flattened disc, the inner volutions of which are ornamented with fine filiform ribs. On the last volution the ribs increase rapidly

in thickness, and on the outer part of the flanks they are frequently considerably broadened and somewhat thickened, after the manner of *Hopl. pexiptychus*. The arrangement and general course of the ribs also remind us of *Hopl. pexiptychus*. Most of the ribs originate singly on the umbilical wall; occasionally between them are found pairs of ribs originating from slight swellings at the suture. The individual ribs split up on the upper part of the flanks into two branch-ribs which are sigmoidally curved forward; of the paired ribs one remains simple, the other branches off into two. On the external margin the ribs are thickened and interrupted by a narrow furrow. On the anterior portion of the last volution the ribs show a tendency to cross the ventral face in the shape of an arch. The last volution is ornamented with 33 main-ribs.

The cross-section has a tall elliptical shape; the flanks are slightly arched, the umbilical wall is low and rather steep, the external margin is slightly flattened. The sutures are unfortunately not visible; the anterior portion of the last volution may belong to the body-chamber.

At first sight the present species has a rather bewildering appearance. But on closer examination it becomes evident that the fossil belongs to the group of *Kilianella pexiptycha*. This is conclusively proved by its mode of involution, and the characteristic features of its sculpture—the independent origin of most of the ribs, the bifurcation of the latter and the dilatation of the extremities of the ribs on the upper part of the flanks. Moreover, slight constrictions appear to exist, though their existence cannot be absolutely established owing to the somewhat deficient state of preservation of the specimen. Compared with *Kilianella pexiptycha*, the present species *Kilianella leptosoma* is distinguished by its taller and much more slender volutions, straighter main-ribs and less decidedly retrograde branch-ribs, and finally by the absence of lateral tubercles.

Locality.—Lochambelkichak, third Stage. One specimen.

Hoplites (Thurmannia) Boissieri, Pictet sp.

(Plate LXXX, fig. 1 *a*, *b*.)

Ammonites Boissieri, Pictet: Mélanges paléontologiques, II. Genève, 1867, p. 79, pl. 15.

To this species we refer two specimens, one of which has been figured. This latter specimen attains a diameter of 224 mm.; its umbilical width amounts to 89 mm., the height of the last volution at the anterior end is 82 mm., the thickness is approximately 66 mm. At some distance from the anterior end the volution height is 74 mm., the thickness 55·5 mm. The chambered portion of the shell is only represented by an indistinct and incomplete impression; all that can be recognised is that the sculpture of the inner whorls agrees with *Hoplites Boissieri*. The body-chamber is very well preserved and exhibits characters which harmonize exceedingly well with those of the European specimens of *Hopl. Boissieri*. The flanks are flat; the umbilical wall is steep, nearly vertical; the external margin which is somewhat flattened along the median zone passes into

the flanks with a gentle curvature. The cross-section has a rounded-oblong form. The great umbilical width as well as the shape of the cross-section and the ratio of thickness to height (3 : 4 in round numbers) deviate in no respect from the Alpine specimens of *Hoplites Boissieri*. The same agreement is observed with respect to the sculpture. The latter consists of roundish, not very strong ribs with a feeble sigmoidal curvature on the flanks, becoming strongly inclined forward only on reaching the vicinity of the external margin, while they are also drawn forward on the umbilical wall. The ribs originate on the umbilical wall partly singly, partly in pairs; the latter form tubercle-like swellings on the umbilical margin. Between each two pairs of ribs are intercalated usually only one, rarely two or three unpaired ribs. By far the greater number of ribs bifurcate on the upper part of the flanks, only a few of them remaining unbranched. The bifurcation takes place at various levels, but invariably above the middle of the flanks. The ribs traverse the ventral face in a slightly convex arch; they become fainter along the median zone; this reduction is somewhat more pronounced at the commencement of the body-chamber and may probably correspond to an interruption of the ribs on the inner volutions.

The second specimen is somewhat smaller; the last volution likewise belongs to the body-chamber, the inner volutions are partly preserved. The specimen is unfortunately somewhat distorted by compression, and is by no means perfect in other respects; yet one can recognise that the ornamentation and shape agree satisfactorily with *Hopl. Boissieri*. The shell being of smaller size, the ribs are more distinctly interrupted on the external margin than is the case in the larger specimen. Exactly as in the Alpine specimens of *Hopl. Boissieri*, there is no true ventral furrow, but a smooth median band at either side of which the ribs become obliterated. The terminal parts of the ribs are thickened, but they never show any tendency towards the formation of tubercles.

The suture-line is unfortunately not known.

The agreement of the Asiatic form with the Alpine *Hopl. Boissieri* is so complete that notwithstanding our ignorance with regard to the suture of the Indian fossils, we cannot but identify them with the European prototypes. It is impossible to trace any truly distinctive characters: the ribs of the Indian fossils are somewhat weaker than those of Pictet's type of *Amm. Boissieri*, but this difference is too insignificant to take into account, especially as this peculiarity perhaps results merely from the state of preservation of the specimens.

Thurmannia Boissieri is one of the characteristic zone fossils of the Berriasian Stage of the Alpine Neocomian.

The Indian specimens are both from Lochambelkichak, third Stage.

HOPLITES (THURMANNIA) n. sp. ind. aff. BOISSIERI, Pictet sp.

(Plate LXXXI, fig. 1 *a*, *b*.)

A third specimen though closely related to *Thurmannia Boissieri* probably represents a distinct species, though its state of preservation is unfortunately very

unsatisfactory. The diameter is 109 mm., the volution-height 42 mm. to 22·7 mm. thickness, and the umbilical width 32 mm. At first sight it seems identical with the European species; but on closer inspection one notices that it possesses a proportionately much narrower umbilicus. In *Thurmannia Boissieri* the ratio of the width of umbilicus to the total diameter is 0·4, while in *Thurmannia* aff. *Boissieri* it is only 0·3. Moreover, the relative height of the volutions is not the same being greater in *Thurm.* aff. *Boissieri* though the difference is very slight. The umbilical wall is somewhat steeper, the external margin somewhat more angular and more flattened. Finally the proportion of undivided ribs is less than in *Thurmannia Boissieri.*

The aggregate of these differences appears to justify a specific separation of this form from *Thurmannia Boissieri.* Considering, however, the poor state of preservation and the fragmental character of the specimen, we have refrained from giving it a new specific name. The present species is distinguished from *Hopl. scioptychus* Uhlig by its more massive costation and its flattened external margin.

The external margin of the above-described fragment is better preserved than that of the specimens which we have identified with *Thurmannia Boissieri.* The ridge-like ribs abruptly obliterated reproduce exactly the disposition exhibited by *Ammonities Boissieri* in Pictet's illustrations of this species (see particularly fig. 2 *a*, plate XV in Mélanges paléont.).

The described specimen is from Lochambelkichak, third Stage.

Hoplites (Thurmannia) Kingi, n. sp.

(Plate LXXXVI, fig. 3, *a*, *b*.)

This species is represented by a single specimen, the outer volution of which is somewhat distorted by compression. The diameter can therefore be only approximately ascertained; it measures about 110 mm.; the width of the umbilicus is 43 mm. At a diameter of about 53 mm. the height of volution is 21 mm., the thickness 15·5 mm. The shell constitutes a rather flat and very widely umbilicated disc the volutions of which overlap one another by scarcely one-quarter of their height. The flanks are slightly convex; the rounded umbilical wall descends rather steeply; the external margin is flattened. The cross-section has a rounded-oblong, nearly elliptical outline.

The ornamentation consists of crowded nearly straight ribs sharp and prominent; some of them start on the umbilical wall in pairs; they are somewhat inclined forward on the flanks and they bifurcate on the upper third of the shell. Only a few isolated ribs remain unbranched. The paired ribs form small conical tubercles at their point of origin on the umbilical wall, while there is also a

suspicion of the formation of tubercles at the point of bifurcation. Usually one of the paired ribs remains undivided, either the anterior or the posterior one as the case may be. Near the anterior end the paired ribs become slightly thickened, suggesting the first indications of a differentiation between main-ribs and secondary ribs. On the anterior portion of the last volution two or three single ribs are intercalated between successive pairs. Further inwards one observes as many as twelve single ribs in continuous succession. At a diameter of 53 mm. the ventral face develops a rather deep furrow. The ribs here become slightly thickened on either side of the furrow without forming tubercles. Further forward the furrow becomes gradually obliterated, and the ribs, though somewhat reduced, continue right across the external margin either straight or in a slightly curved arch. The number of ribs on the flanks of the last volution is 48.

Thurmannia Kingi is closely allied to *Thurmannia Boissieri* Pictet sp., but it cannot be united with this species, on account of the much greater number of single ribs, the fewer paired ribs and the tendency towards a differentiation and thickening of individual ribs and points of bifurcation, none of which characters has so far been observed in *Th. Boissieri*. The number of ribs on a volution amounts to about 69—70 in *Thurm. Boissieri*, whilst it is only 48 in *Thurm. Kingi*. The slight differentiation of the ribs near the anterior margin of the shell in *Thurm. Kingi* reminds one of certain forms described by Retowski under the name of *Hoplites incompositus*; these forms, however, are very clearly distinguished by their rounded low ribs, the much more numerous paired ribs, and the low level at which the bifurcation occurs.

Still further removed is *Hopl. Paquieri* Simionescu distinguished by its coarser ribs, its more distinct tubercles recognisable even on the inner volutions and the much fewer undivided ribs.

Thurmannia Thurmanni Pictet approaches the present species with regard to the features of the external margin and, to a certain extent, the general ornamentation. Specific identity, however, cannot be claimed, for, according to Kilian's description, *Thurm. Thurmanni* frequently bears fasciculated ribs on the inner volutions, whilst in *Thurm. Kingi* the great majority of ribs originate singly. The strengthening of individual ribs and the formation of tubercles on the anterior portion of the shell in *Thurm. Kingi* constitutes another distinctive character. The latter feature recalls the forms of the *spitiensis* group. Whilst, however, in this group the tubercle-sculpture is fully developed, it is barely suggested in *Thurm. Kingi* and that only on the anterior portion of the shell. Not only in this respect, but also with regard to the development of the ventral furrow and the feebly sigmoidal curvature of the ribs *Thurmannia Kingi* represents a somewhat primitive facies of development as compared with the *spitiensis* group of *Acanthodiscus*.

The species is only represented by one solitary specimen.

Locality: Lochambelkichak, third Stage.

HOPLITES (THURMANNIA) aff. RAREFURCATUS, Pictet sp.

(Plate LXXXIV, fig. 4 *a*, *b*.)

Ammonites rarefurcatus, Pictet : Mélanges paléontologiques, pl. 16, fig. 2, p. 82.

We are unfortunately unable to give a precise specific diagnosis of this species which is represented by nothing but one small fragment apparently belonging to the body-chamber and quite insufficient for accurate characterization.

The crowded slightly sigmoidal ribs vividly recall those of *Hoplites rarefurcatus*. A few ribs bifurcate at the upper third of the flanks, the majority remaining simple. At one place only do two forked ribs immediately succeed each other; otherwise one to three unbranched ribs are intercalated between successive forked ribs. Generally the ribs appear to start singly on the umbilical wall; but as they are very crowded, it is quite possible that two ribs may occasionally become fused on the umbilical wall, as described by Pictet in the case of *Hopl. rarefurcatus*. On the external margin the terminations of the ribs form two ridges separated by a broad smooth furrow.

The flanks are slightly arched, the external margin is flattened, the cross-section has a high-elliptical outline. The shell is fairly widely umbilicated. With a height of 21·4 the thickness is 17·8 mm.

The suture-line is unknown.

On careful examination one notices certain differences between the present species and *Hoplites rarefurcatus*. In the French species the bifurcation of the ribs takes place at varying heights, while in the Asiatic fossil it always occurs at a uniform level. This feature places the present species in the neighbourhood of the group of *Hoplites pexiptychus*. Certain features also recall *Hoplites Callisto*. Within the limits of the comprehensive genus *Hoplites*, the present species represents a primitive developmental stage and consequently its relationships extend in different directions. It is only to be regretted that the fragment is so incomplete, and we have to postpone the definite establishment of the species until fresh discoveries have been made, especially as the French species itself is imperfectly known.

Hoplites rarefurcatus is a characteristic species of the Berriasian Stage of Southern France. Pomel has also mentioned it from Oran, but to judge from his illustration the reference of the Algerian fossil to this species is at least doubtful.

Hoplites cf. *rarefurcatus* is represented by a single fragment from Lochambel-kichak, third Stage.

Hoplites (Sarasinella) varians, n. sp.

(Plate LXXXI, fig. 3 *a—d.*)

Dimensions :—

Diameter	93 mm.
Width of umbilicus	31 „
Height of last volution	39·3 „
Thickness of last volution	32·5 „

The shell is discoidal and bears a very characteristic sculpture: on the inner volutions simple filiform ribs alternate with strong tuberculiferous ones; on the outer volutions the lateral tubercles gradually disappear and the ribs are uniformly constructed. The tubercles of the inner volution are very strongly developed; the lateral tubercles were prolonged into long spines, the position of which coincides with that of the umbilical suture, so that impressions of the spines can be observed on the umbilical wall of the outer volution. Each of the stronger ribs carries a lateral and an umbilical tubercle; whether the external tubercles were stronger on the main-ribs than on the intermediate ones cannot be clearly ascertained. On the inner volutions, two non-tuberculate thread-like ribs are intercalated between successive spine-bearing ribs.

At the commencement of the last volution, the main-ribs bifurcate at the lateral tubercle, and a subsidiary simple rib originates at the umbilical tubercle; in addition to these an additional rib or pair of ribs are intercalated. At this stage the intercalary ribs also show a slight trace of a swelling at the level of the lateral tubercles. The chief change in the sculpture coincides with the final disappearance of the lateral tubercles on the first quarter of the last volution: whilst on the inner volutions only the main-ribs bear umbilical tubercles, all the ribs now originate in pairs from the strong umbilical tubercles. Starting from these the ribs first follow a straight course, and it is only on the upper part of the shell that they slightly curve forward. By far the greater majority of the ribs remains unbranched, only a few of them bifurcate on the upper third of the flanks. In two places three ribs unite to form a fascicle. At the anterior end of the shell the sculpture once more appears to enter into a new developmental stage in so far as one notices the appearance of intercalary ribs extending from the external margin to about the middle of the flanks. The last stages in the evolution of the ornamentation are unknown. The external margin possesses a broad, distinctly excavated, smooth furrow on either side of which the ribs terminate in the shape of moderately prominent ridges, without forming distinct tubercles.

At the commencement of the last volution the thickness and height of the cross-section are equal; from the point where the tubercle-sculpture ceases, the height increases proportionately more than the thickness, and the flanks gradually occupy a broader surface. The remarkably high and nearly smooth umbilical

wall is declivous and distinctly separated from the flanks by the series of umbilical tubercles. The maximum thickness in the last volution coincides with the umbilical tubercles; from here the cross-section tapers outward, first gradually, further on somewhat more rapidly. The external margin is slightly flattened. The volutions overlap one another by nearly half their height.

The specimen is chambered nearly to its end. The first lateral lobe has a broad and at the same time rather long stem; the terminal branch is not exactly in a line with the bisectrix of the trunk, but is situated a little more inwards. The outer lateral main-branch of the first lateral lobe is somewhat more developed than the inner one. The broad external saddle is bisected by a long slender adventitious lobe into two subsymmetrical parts; the first lateral saddle is narrower and is divided by a slender adventitious lobe into a smaller and lower outer and a larger and higher inner portion. The second lateral lobe is much smaller than the first one and nearly symmetrical. The umbilical series of tubercles coincides with the second lateral saddles so that the feeble auxiliary lobes come to be situated entirely on the umbilical wall.

The body-chamber is unknown.

The present species is closely allied to *Hopl.* (*Sarasinella*) *ambiguus* Uhlig[1] from the Upper Teschener Schiefer of the Carpathian Mountains (Valanginian). Both species pass through the same cycle of changes, and the general type as well as the tubercular sculpture of the inner volutions, as also the costation of the outer volution, are very similar. *Hopl.* (*Sarasinella*) *ambiguus* also exhibits on the anterior portion of the outer volution feebly sigmoidal ribs originating from umbilical tubercles and mostly unbranched. Only whilst in *Hoplites ambiguus* the last volution has about 45 ribs, there are 54 to 55 in the Asiatic species. The ribs of the Silesian form are stronger, the umbilical tubercles are not so close set, and less distinctly developed, while the external tubercles are more pronounced. The first lateral lobe of *Hopl. ambiguus* is somewhat far removed from the external margin, occupying the same position in the flanks as in the case of *Hopl. varians*. Another species which should be compared with *Hopl. varians* is *Hopl. teschenensis* Uhlig which also exhibits a prevalence of unbranched ribs united into bundles on the umbilical wall. Only in *Hopl. teschenensis* the tubercle-sculpture of the inner volutions is not known; moreover, it has a much narrower umbilicus and stronger external tubercles.

Locality:—Lochambelkichak, third Stage. One specimen.

HOPLITES (SARASINELLA) SUBSPINOSUS, n. sp.

(Plate XC, fig. 4 *a*—*c*.)

Dimensions:—

Diameter (approximately)	55 mm.
Width of umbilicus	20 „
Height of last volution	21 „
Thickness	17·4 „

The shape is flat discoidal; the umbilicus is wide; the volutions are nearly

[1] Cephalopoden der Teschener und Grodischter Schichten, pl. VI, figs. 3—5, p. 45.

elliptical in cross-section, with slightly arched flanks and a rounded rather steeply descending umbilical wall.

The tubercle-sculpture of the inner volution is only very feebly developed, yet it is possible to ascertain that some of the ribs bear umbilical and lateral tubercles. Between these tuberculiferous ribs we find three or four intermediate ribs which originate either singly or in pairs. The difference between the tuberculiferous and the intermediate ribs is not as striking as in *Hopl. varians*; the tubercles are weaker and not regularly distributed. With increasing size (at a diameter of 40 mm. in the only available specimen) the number of lateral tubercles increases, while the number of intermediate ribs is reduced to one or two. From the lateral tubercles originate two branch-ribs of which the anterior one is more strongly inclined forward than the posterior one. In addition to the branching ribs each umbilical tubercle also gives rise to a rib which extends up to the external margin without bifurcation. When the diameter has reached 47 mm., the lateral tubercles disappear, their place being finally indicated at one spot only by a slight swelling situated at the same level of the previous lateral tubercles. Simultaneously with the obliteration of the lateral tubercles, the umbilical tubercles gain in strength and become the points of origin of fascicles of ribs each of which consists of three entire ribs. Between each two of these rib-bundles there occurs one unbranched rib originating independently on the umbilical wall. On the anterior part of the shell, a large portion of which is unfortunately broken off, the rib-bundles appear to consist of only two ribs each. So long as the lateral tubercles remain visible, the ribs assume a straight course, but after their disappearance the ribs become more and more sigmoidal. Along the external margin there runs a narrow but rather deep furrow bordered on either side by the ridge-like and thickened terminations of the ribs exhibiting a nearly transverse disposition. This disposition is especially marked on the older part of the shell, where one moreover notices that the terminations of the ribs which bear lateral tubercles are more prominent than the remainder. On the anterior portion of the shell the marginal furrow is less deeply excavated and the rib-terminations less perceptibly thickened.

The suture-line is not particularly well preserved. The displacement of the terminal branch of the first lateral lobe towards the inner side of the trunk is less marked than in *Hoplites varians*.

Sarasinella subspinosa differs from *Sarasinella varians*, owing to its narrower cross-section, the much weaker development of the tubercles and the more frequent occurrence of rib-bundles consisting of three ribs. A closely allied form is *Sarasinella ambigua* Uhlig from the Upper Teschener strata already mentioned with reference to the previously described *Sarasinella varians*. *Sarasinella ambigua*, however, has a narrower umbilicus, stronger ribs, weaker umbilical tubercles, and the formation of rib-fascicles is less pronounced, the tricostal bundles being almost entirely wanting.

Owing to the deficient state of preservation of the only available specimen

the characterisation of the present species leaves much to be desired. As in the case of many other species of *Hoplites* from the Spiti Shales we must await future finds for a more complete elucidation.

The solitary fragment is from Lochambelkichak, third Stage.

HOPLITES (SARASINELLA) n. sp. ind. aff. SUBSPINOSUS, n. sp.

(Plate LXXIX, fig. 2 *a—d.*)

Amongst the numerous fragments of *Hoplites* shells from the Upper Spiti Shales is a specimen exhibiting affinities both to *Hoplites subspinosus* and *Hoplites varians*. The fragment in question shows parts of two volutions. On the inner volution groups of two to three rather feeble ribs unite into a broad roundish umbilical tubercle. On the outer volution there are rather faint radial ribs which originate in comparatively feeble elongated umbilical tubercles and assume an anteriorly directed curvature only on reaching the outer third of the volution. On the flanks the ribs are so faint that their fusion into an umbilical tubercle cannot be clearly made out; they assume a decided relief only on the upper part of the volution terminating in distinct swellings on either side of the rather smooth flattened external margin.

The flanks are nearly flat; the umbilical wall is tall and bevelled. The cross-section is approximately elliptical; in the vicinity of the umbilical tubercles it is somewhat broader than at the flanks. The height of the outer volution is 45·4 mm. at its posterior end to a breadth of 31 mm.; the height of the preceding volution is 19 mm., its breadth 14·5 mm. The height increases, therefore, at a more rapid rate than the thickness. The specimen is entirely chambered.

The suture-line bears a great resemblance both to *Sarasinella varians* and *S. subspinosus;* its distinguishing character, namely, the asymmetrical disposition of the inward deflected terminal branch of the first lateral lobe, being clearly observable in the present species.

With respect to its suture, general character of ornamentation and cross-section, *Sarasinella* n. sp. ind. aff. *subspinosa* agrees so well both with *S. subspinosus* and *S. varians* that we do not hesitate to admit the existence of a close relationship between these three forms, although the tubercle-sculpture of the immature stage of *Sarasinella* aff. *subspinosa* is not known. At the same time it is probably undesirable to unite it with either of the above-mentioned species. *Sarasinella* aff. *subspinosa* has a much higher oral aperture and is much more slender than *S. varians*, its sculpture is much more delicate, several of the rib-fascicles of the inner volution consist only of three ribs, whilst in *S. varians* they generally include only two. On the inner volution of *Sarasinella* n. sp. ind. individual neighbouring umbonal tubercles approach one another so closely that they almost coalesce, a feature not observable on the only available fragment of *S. varians*. The existence of rib-fascicles made up of three ribs

approximates the present species to *S. subspinosa*. But in the latter species the volutions overlap one another to a larger extent, and the umbilical tubercles are more massive, so that the two forms can scarcely be regarded as specifically identical. Considering, however, the insufficiency of the available material the latter point cannot at present be decided with complete certainty. We have therefore avoided creating a new specific name.

Locality.—Hundes (Coll. T. L. Walker).

It is here worth mentioning another species also showing the closest affinity to *Sarasinella varians*; it is figured in plate LXXVI, fig. 2 *a—d*. The form is also represented only by the merest fragment, which imperfect as it may be, yet unquestionably represents a separate species. As in the case of the undetermined species above described, the cross-section is relatively tall, but the external margin is broader and more strongly flattened. Here, too, the ribs are very faintly developed on the flanks; they are more distinct on the upper part of the volution, but are less numerous than in the species previously described. Finally the suture exhibits considerable discrepancies. The terminal branch of the first lateral lobe is less distinctly deflected inwards and all the lobe-branches diverge at a much smaller angle from their stems, communicating a peculiar character to the general appearance.

The figured specimen is interesting as indicating the great abundance of the group of *Sarasinella ambigua* in the Spiti Fauna; still less than the undeterminable fossil previously described does it lend itself to the establishment of a new species.

The fragment was obtained from the Neocomian beds of the Lingti river.

HOPLITES (SARASINELLA) sp. ind. aff. AMBIGUUS, Uhlig.

Hoplites ambiguus, Uhlig: Cephalopodenfauna der Teschener und Grodischter Schichten. *Denkschr. kais d. Wissensch., Wien*, Vol. 72, 1901, p. 45, pl. VI, figs. 3—5.

A fragment, probably derived from the commencement of a body-chamber, suggests by its form and sculpture a relationship with *Hoplites ambiguus*, a species from the Valanginian of the Carpathian Mountains of Silesia. The fragment is unfortunately too badly preserved for description. We have therefore to content ourselves with a brief reference and await future finds in order to establish its specific diagnosis.

Locality.—Lochambelkichak, third Stage (Coll. Diener). Valanginian

HOPLITES (SARASINELLA ?) CAUTLEYI, Oppel sp.

(Plates LXXXVIII, fig. 4 *a, b, c*; LXXXIV, fig. 2 *a—d*.)

Ammonites Cautleyi, Oppel: Palāontologische Mitteilungen, pl. 78, fig. 2 *a, b*, p. 278, *non* fig. 1 *a, b* (*Spiticeras Cautleyi*).

Ammonites Theodorii, Stoliczka: *Mem. Geol. Survey of India*, V, 99, pl. IX, fig. 1 (*non Amm. Theodorii*, Oppel).

On plate 78 of his *Palāontologische Mitteilungen* Oppel has figured a specimen consisting of a body-chamber with oral aperture preserved (fig. 1) together

with a small fragment of an inner volution (fig. 2) under the name of *Ammonites Cautleyi*. This combination is rather unfortunate and has subsequently given rise to various, and partly erroneous interpretations.

Stoliczka was the first to express surprise at Oppel's conception and suggested referring the smaller specimen (plate 78, fig. 2) to *Amm. Theodorii* Oppel. This interpretation was correct in so far as this smaller specimen is indeed a true *Hoplites* and therefore allied to *Hoplites Theodorii*, as will be shown later on. We are, however, unable entirely to adopt Stoliczka's view, because our conception of a species is much narrower and we consequently can detect specific differences between the small specimen and *Hoplites Theodorii*.

Neumayr also correctly detected that Oppel's *Ammonites Cautleyi* included two distinct species, belonging moreover to two different genera. But he erroneously referred the smaller of Oppel's specimens to the genus *Cosmoceras*, and further confused the matter by referring Oppel's two figures of *Ammonites Theodorii* to two different genera. He distinguished a *Cosmoceras Theodorii* and a *Hoplites Theodorii*, failing to notice that, according to the explanation of Oppel's plate 83, both illustrations of *Ammonites Theodorii* represent the same specimen.[1]

This oversight was soon afterwards rectified by S. Nikitin,[2] who nevertheless introduced a fresh error respecting *Ammonites Cautleyi*. Adopting Oppel's views he accepted both specimens as belonging to one species, and, moreover, asserted, in contradistinction with the wording of Oppel's description, that the smaller specimen (*Pal. Mitteil.*, plate 78, fig. 2) constituted the inner volution of the body-chamber specimen (plate 78, fig. 1). As far as the generic identification is concerned Nikitin was evidently guided by the smaller specimen, and he declared *Amm. Cautleyi* to be a typical *Hoplites*. Neumayr accepted Nikitin's correction with respect to *Hoplites Theodorii*, but he rightly doubted the correctness of Nikitin's views concerning *Ammonites Cautleyi*.

A closer examination of Oppel's original material leads to an easy solution of the difficulties resulting from these various misinterpretations. The smaller of Oppel's specimens of *Amm. Cautleyi* represents the fragment of an inner volution, but does not, as erroneously asserted by Nikitin, belong to the same individual as the large specimen figured by Oppel under the same name. The body-chamber connected with the smaller specimen does exist, but, unfortunately, was not illustrated by Oppel. A glance at this specimen, which is here illustrated on plate LXXXIV, fig. 2, will at once explain away the improbability that a scientist so intimately acquainted with ammonites as Oppel could have been deceived into uniting into one species two specimens belonging to different genera. Evidently the specimen of a body-chamber which Oppel had in view when writing his description was precisely the one which, owing to some oversight, was

[1] Geographische Verbreitung der Juraformation, *Denkschriften der kais. Akademie der Wissenschaften, Wien* 1885, Vol. 50, p. 92.

[2] *Neues Jahrbuch für Mineralogie*, etc., 1889, II, p. 120.

never figured. With its long oral lappet and its nearly smooth or only faintly ribbed body-chamber this specimen bears indeed a certain resemblance with the body-chamber fragment figured by Oppel and belonging to *Amm. Cautleyi* (compare plate XII, fig. 1). Oppel did not pay sufficient attention to the attrition of the latter specimen which made it appear smoother than it was in reality. As a matter of fact, as shown already on page 104, this specimen of a body-chamber of *Amm. Cautleyi* was provided with sharp ribs and a *Spiticeras* sculpture, whilst the body-chamber belonging to the same individual as the fragment of an inner volution clearly shows on its ventral face the traces of the thickened *Hoplites*-ribs. Comparing with this the inner volutions, we cannot doubt for a single moment that we have to deal with a genuine *Hoplites*, the sculpture of which undergoes a considerable weakening on the body-chamber. Oppel's *Ammonites Cautleyi* must consequently be split up into two species belonging to two different genera—*Spiticeras* and *Hoplites*—and which therefore may retain the same specific designation. In order to render the change in the conceptions more intelligible we represent the different interpretations in the form of a table :—

A. Oppel, 1863.	F. Stoliczka, 1866.	M. Neumayr, 1885.	Nikitin, 1889.	Uhlig, 1905.
Ammonites Cautleyi, pl. 78, fig. 1.	Ammonites spitiensis.	Holcostephanus Cautleyi.	Hoplites Cautleyi.	Spiticeras Cautleyi pl. 12, fig. 1.
Ammonites Cautleyi pl. 78, fig. 2.		Cosmoceras Cautleyi.		Hoplites Cautleyi pl. 84, fig. 2, pl. 78, fig. 4.
Ammonites Theodorii, pl. 78, fig. 3.	Ammonites Theodorii.	Cosmoceras Theodorii.	Hoplites Theodorii.	Hoplites Theodorii pl. 89, fig. 1.
Ammonites Theodorii, pl. 83, fig. 2.		Hoplites Theodorii.		

Having cleared these difficulties, we may now proceed with the description of *Hoplites Cautleyi*. Although we have at our disposition two specimens, Oppel's body-chamber specimen and the fragment figured by F. Stoliczka under the name of *A. Theodorii*, yet we must unfortunately be content with a somewhat incomplete diagnosis of this interesting species; for the body-chamber specimen exhibits only the anterior end of the body-chamber together with a small portion of the inner volution, whilst Stoliczka's specimen only shows the inner volution. The middle stage of growth, precisely that which in other cases is the one most frequently available for investigation and comparison, is therefore unknown.

The immature specimen (plate LXXXVIII, fig. 4) with a diameter of 35 mm. has an umbilical width of 8·5 mm., a volution-height of 17 mm., and a thickness of 13·3 mm. The volutions overlap one another by about half their height. At the lower part of the volution the flanks are flat, further outwards they assume a slight curvature and converge towards each other. The external margin is flattened, the umbilical wall moderately steep. The sculpture consists

of slightly sigmoidal ribs disposed in fascicles of three to four which originate from distinct umbilical tubercles. On either side of the broad and smooth external margin, the ribs are thickened into weak, small tubercles. Such a type of sculpture characterised by the absence of intercalary and branched ribs is already developed even when the diameter measures only 16 mm. Earlier stages of development are not preserved.

The body-chamber specimen exhibits essentially the same type of sculpture in its inner volutions. The dimensions and shape of the shell also agree. The only difference which might perhaps be mentioned is the slightly steeper slope of the umbilical wall and the exceptional appearance of short intercalary ribs. These differences are certainly too insignificant to justify a specific separation. The study of the inner volutions conveys the impression that up to a diameter of about 48 mm. the same type of sculpture was retained. Three-fourths of the succeeding volution corresponding to the middle stage of growth are entirely wanting, while on the remnant of the body-chamber fragment the umbilical wall is not preserved. At one place only one notices a slight thickening in the region of the umbilical wall, indicating that the umbilical tubercles do not entirely disappear on the body-whorl. The ribs become so obsolete as to be merely indicated by faint flat streaks. A distinct thickening evidently answering to the external tubercles of the earlier volutions is only just perceptible near the external margin of the body-chamber, especially in the portion furthest removed from the oral aperture. The external margin is slightly rounded, smooth and only faintly striated. The edge of the oral aperture is somewhat turned up along its whole length; at the sides it expands into a long spoon-shaped ear, and on the external margin it expands anteriorly into a short convex ventral lappet.

The suture is represented only in Stoliczka's specimen, and even then it is indistinct and incomplete. One can recognise that the terminal branch of the first lateral lobe starts from the inner part of the trunk as in the case of the ammonites belonging to the group of *Hoplites varians* n. sp. and *Hoplites ambiguus* Uhlig.

Stoliczka united the specimen of *Hopl. Cautleyi* figured by him with *Hopl. Theodorii* Oppel sp. Not only is such a union inadmissible, but we cannot even detect any close relationship. Whilst *Hoplites Cautleyi* is distinguished by the formation of rib-bundles and by the nearly total absence of intercalary and forked ribs, in *Hopl. Theodorii* the fusion of the ribs at the umbilical suture is a very subordinate feature, while the branching of the ribs constitutes a very important character. The body-chamber of *Hoplites Theodorii* is ornamented with prominent ribs extending on to the external margin, that of *Hopl. Cautleyi* is nearly smooth.

Nikitin connected *Hopl. Cautleyi* with the *mutabilis*-group which was raised to the rank of a genus AULACOSTEPHANUS by Pompeckj and Sutner. The grouping of the ribs into fascicles on the umbilical wall forms indeed an important point of comparison. The ribs of *Aulacostephanus* are nearly straight,

the tubercles exhibiting rather the character of rib-thickenings, the suture has very broad saddles and is comparatively scantily subdivided. *Aulacostephanus* exhibits, therefore, generally rather primitive features. *Hopl. Cautleyi*, on the other hand, exhibits the *Hoplites* characters in a much more advanced degree and is to all appearances a more differentiated form. The ribs are more decidedly sigmoidal. The umbilical tubercles are rounded and clearly marked off from the ribs, the suture is much more complicated.

The strong involution and the smoothness of the body-chamber recall *Hopl. occitanicus* Pictet. This species is distinguished from *Hopl. Cautleyi* by the less pronounced grouping of the ribs which are united only in pairs originating from umbilical tubercles, further by the frequent bifurcation of its ribs on the upper part of the shell and by the feebler development of its umbilical tubercles, these differences being so marked as to establish a wide separation between these two species.

The nearest affinity of *Hopl. Cautleyi* is with *Hopl. teschenensis* Uhlig[1] and *Hopl. varians*. In *Hopl. teschenensis* the umbilicus is as narrow as in *Hopl. Cautleyi*, but the ribs are stronger, more distinctly sigmoidal and less numerous; moreover the fascicles consist of fewer ribs, usually two, at most three. *Hoplites varians* n. sp., *Hoplites subspinosus* n. sp., and *Hopl. ambiguus* Uhlig have at their middle and final stage of growth a sculpture consisting of fascicles similar to those of *Hopl. Cautleyi*. Although it is not possible to arrive at a definite conclusion concerning the degree of relationship owing to the insufficiency of our knowledge, yet there are reasons, already discussed in the introduction to the genus, in favour of uniting *Hopl. Cautleyi* with the *ambiguus*-group rather than with the genus *Aulacostephanus*, notwithstanding the absence of a tubercle-sculpture.

The body-chamber fragment is from Shangra, east of Puling, the smaller specimen is from Spiti.

HOPLITES (NEOCOMITES) aff. NEOCOMIENSIS, d'Orb. sp.

(Plate LXXXVIII, fig. 3 *a*, *b*, *c*.)

Ammonites neocomites, d'Orbigny: Paléont. Française, Terr. Crét., I, pl. 59, figs. 8—10, p. 203.
Ammonites cryptoceras, Pictet et Loriol, 1858, Terr. néocom. des Voirons, pl. IV, fig. 4, p. 20.
Hoplites neocomiensis, P. Lory: Sur les *Hoplites* Valanginiens, etc., 1891, p. 7.
Hoplites neocomiensis, Felix: Palaeontographica, Vol. 37, 1891, pl. XXVIII, fig. 7, p. 183 (from Maruszyna in Galicia).
Hoplites neocomiensis, Sarasin: *Bull. Soc. Géolog. de France*, 1897, 3me série, Vol. XXV, p. 764.
Hoplites neocomiensis, Simionescu: *Beitr. zur Paläontologie Oesterrich-Ungarns*, etc., XI, 1898, page 210.
Hoplites neocomiensis, Uhlig: Cephalopodenfauna der Teschener und Grodischter Schichten, *Denkschrift. k. Akademie d. Wiss., Wien*, 1901, Vol. 72, p. 54, pl. II, fig. 9; pl. III, fig. 1—3; pl. IV, fig. 11.
Hoplites neocomiensis, Sarasin et Schöndelmeyer: Crét. inf. de Chatel-St.-Denis, *Mem. paléont. suisse*, XXVIII, 1901, p, 70, pl. IX, figs. 2, 3.

Several fragments represent a species whose ornamentation is similar to that of the European *Hoplites neocomiensis* and of *Hoplites nivalis*. The shell, which

[1] Cephalopoden F. d. Teschener und Grodischter Schichten, pl. III, fig. 4, p. 56.

in the figured specimen has a volution-height of 28·8 mm. and a thickness of 25·3 mm., has a relatively higher oral aperture, a lower umbilical wall and somewhat flatter flanks than *Hoplites nivalis*. Moreover, the ribs are finer and more crowded and the umbilical tubercles feebler. Hence the present species is certainly different from *Hoplites nivalis*.

The relationship with *Hoplites neocomiensis* d'Orb. sp. is closer. The rather high volutions and the narrow umbilicus of the Indian fossil recall so closely the European species that its identity with the latter still remains possible. The European *Hoplites neocomiensis*, which, notwithstanding numerous illustrations and discussions, is yet far from thoroughly characterised, appears to be more slender than the Indian fossil and, according to Sarasin's figures, exhibits certain differences in the disposition of its suture. A comparison with Sarasin's figure shows that the trunk of the first lateral lobe is essentially longer in the European form than in the Asiatic fossil and that it is narrower above the lateral branches. Still, these differences are, after all, very slight, and for those who prefer a wider conception of species direct identification of the Indian form with the European *Hoplites neocomiensis* will probably be admitted.

In consideration of the fact that our knowledge of *Hoplites neocomiensis* is yet very deficient and that the available fragments are too incomplete to lead to a sufficiently clear conception of the Asiatic form, we must rest satisfied with accentuating the close relationship of the two forms and trust to future discoveries for a final elucidation of their relationship. *Hoplites neocomiensis*, as is well known, is one of the leading zone fossils of the Valanginian of Europe.

Of the five specimens, two fragments, one of which has been figured, are from Hundes (Coll. Walker), three further fragments are from Lochambelkichak, third Stage. Valanginien

Hoplites (Neocomites) nivalis, n. sp.

(Pl. LXVVI[II], fig. 1 a—c, 2 —, 5 a—c.)

The shell is rather flat with a wide umbilicus, and consists of relatively high volutions which overlap one another by about one-fourth to one-third of their height. The volutions reach their maximum thickness in the vicinity of the umbilical wall or a little higher up. The flanks are only slightly arched and descend with a steep and tall umbilical wall towards the umbilical suture. Towards the external margin the cross-section is slightly wedge-shaped. The external margin is broad and flat.

The ribs originate mostly in pairs from the umbilical tubercles. On the body-chamber about one-half of the ribs bifurcate on the upper part of the flanks, the other half remaining undivided. Bifurcation of the ribs appears to be relatively more frequent on the chambered portion of the shell. On the inner volutions the ribs are rather fine and strongly curved forward; on the body-chamber

the inclination of the gently sigmoidal ribs is apparently less; the ribs are rounded, fairly prominent, and separated from each other by wide intervals. The umbilical tubercles are remarkably strongly developed. On either side of the broad and smooth external band the ribs terminate in slight though distinct tubercles.

Two of the specimens exhibit only indistinct traces of the suture, but it is somewhat more completely preserved in a third specimen. The first lateral lobe has a short, broad trunk with a long slender terminal branch and two nearly equal lateral branches. The first lateral saddle is subdivided by an oblique adventitious lobe into a lower exterior and a higher interior segment. The external saddle is tolerably broad and cleft by an adventitious lobe into a smaller external and a somewhat broader inner portion.

The cross-section and costation recall *Hopl. amblygonius* Neum. et Uhl. (=*noricus*). Nevertheless the two species are by no means identical as is evident from the much more massive umbilical tubercles and broader external band of *Hopl. amblygonius*, the ribs of which moreover bifurcate at various levels, while in *Hopl. nivalis* the bifurcation takes place uniformly on the upper portion of the flanks. The specific distinctness of the two forms is rendered still more obvious from the asymmetrical configuration of the first lateral lobe of *Hopl. amblygonius* in contradistinction with the subsymmetrical conformation of that lobe in *Hopl. nivalis*. From *Hopl. Frantzi* Kilian (=*Hopl. Ottmeri* Neum. et Uhlig p.p., Hilsammonitiden, plate XXXV, fig. 1 [*non* plate XXXIV, fig. 1]) *Hopl. nivalis* is distinguished by its wider umbilicus and more frequent bifurcation of the ribs on the upper part of the flanks and by its more copiously laciniated suture-line. *Hoplites neocomiensis* d'Orb. sp. has a narrower umbilicus, a relatively higher cross-section, more densely crowded ribs and much feebler umbilical tubercles. *Hoplites Walkeri* differs by its greater thickness, its rounded cross-section, and more densely crowded ribs. The suture of *Hopl. nivalis* agrees in all its essential features with that of *Hopl. neocomiensis* and *Hopl. Walkeri*, for which reasons these two species can be regarded as its nearest relatives.

Hoplites nivalis is represented by five specimens which exhibit certain slight differences. The most perfect and more complete specimen, with part of its body-chamber preserved, has been selected as the type of the species, and has been figured in plate LXXXVIII, fig. 2. The specimen depicted in fig. 1 of the same plate is distinguished from the type by its somewhat greater thickness and a narrower external band. The thickness of volution corresponding to a height of 31 mm. is 26 mm. in the case of the specimen represented in fig. 1, while in the type it is only 23 mm. The third specimen (plate LXXXVIII, fig. 5) seems to agree in thickness with the type, but its external band is narrower and less smooth: in this specimen the ribs show a tendency to persist across the external band although in a very much reduced condition. The fourth specimen is as thick as the second one, but with a somewhat narrower umbilicus. The fifth specimen is the most completely preserved, but is very badly weathered.

We probably have to deal here with individual variations. Unfortunately all the specimens are so incompletely and poorly preserved that a final decision concerning their mutual relationship can only be arrived at until some new and more complete material is available.

All the specimens are from Lochambelkichak, third Stage.

Hoplites (Neocomites) montanus, n. sp.

(Plate XC, figs. 1 —, a—c.)

Dimensions—

Diameter	82 mm.
Width of umbilicus	25 „
Height of last volution	34·2 „
Thickness of last volution	25 „

The shell is rather flat; the volutions overlap one another by about one-third of their height and have a tall cross-section bevelled off wedge-fashion towards the periphery. The maximum thickness corresponds with the junction of the slightly arched flanks and the steep nearly perpendicular umbilical wall. The external margin is fairly broad and flattened.

The ribs originate on the inner portion of the whorls, mostly in pairs, from distinct umbilical tubercles; they bifurcate above the middle of the volution and terminate on either side of the flattened external band in small conical ventral tubercles. They have a slight forward inclination and are only feebly sigmoidal. On the body-chamber a gradual change in the ornamentation is observed: the more anterior ribs of each fascicle become at first fainter, and finally cease to be connected with the hindmost rib. In its final stage, the ornamentation consists of somewhat swollen strong ribs which, at about half the height of the flanks or a little higher, break up into three secondary ribs. Umbilical and external tubercles are also clearly developed on the body-chamber.

The septal suture advances forward from the external to first lateral saddle, becoming rather decidedly retrograde from the first lateral saddle down to the umbilical suture. The external saddle is not clearly preserved; the first lateral lobe is remarkable for its very broad but short trunk which is prolonged into a remarkably long terminal branch. Of the two main-branches the outer is somewhat larger than the inner one; both are situated nearly on a level. The first lateral saddle is subdivided by an oblique adventitious lobe into a lower and smaller outer and a higher and larger inner segment. The second lateral lobe is much shorter and, owing to the greater development of its outer lateral branch, assumes an asymmetrical form.

The length of the body-chamber is at least three-fourths of a volution; the oral margin is not preserved.

Neocomites montanus is represented by three specimens of which one (fig. 5) differs from the specimen selected as the type (fig. 1) by its somewhat more

strongly inclined ribs and perhaps also by a somewhat greater number of subsidiary ribs, while in the third specimen the subsidiary ribs are somewhat less numerous at the anterior end. These differences are scarcely sufficient to preclude referring all three specimens to the same species.

The present species is distinguished from the closely related *Neocomites neocomiensis* owing to the greater number of branching-ribs. Whilst in *N. neocomiensis* many of the ribs remain undivided, here all the ribs are branched and, consequently, the number of subsidiary ribs is much greater than in *N. neocomiensis*. Further, the umbilicus is wider than in *N. neocomiensis*, and the trunk of the first lateral lobe is shorter and broader. Moreover, the characters of the body-chamber with its swollen main-ribs and numerous branch-ribs prove that the present species is only allied to and not identical with *N. neocomiensis*. Similarly the greater number of branch-ribs distinguishes *N. montanus* from *N. nivalis*, a further difference residing in the more cuneiform shape and greater relative height of the cross-section in *N. montanus*. In *N. nivalis* the ribs unite at the umbilical tubercles even on the body-chamber, while this feature is at least far less frequent in *N. montanus* n. sp. The great number of anteriorly curved branch-ribs vividly recalls *Hopl. cryptoceras* d'Orb.; a closer relationship with this species is, however, precluded by the apparently asymmetrical disposition of the first lateral lobe in the latter species. Moreover, in *Hoplites cryptoceras* d'Ord. the flanks are much flatter and the ribs are somewhat more strongly curved than in *N. montanus*.

Neocomites montanus is from Lochambelkichak, third Stage (Coll. Diener).

HOPLITES (NEOCOMITES) INDOMONTANUS, n. sp.

(Plate XC, figs. 3 *a*, *b*; 7.)

The collection from the Upper Spiti Shales includes three specimens representing a species closely related to *Neocomites montanus*, but distinguished by its more crowded and less prominent ribs. The characters of the inner volutions are unfortunately imperfectly known; all that can be ascertained from available remnants and from the impression of the external margin on the inner surface of the following whorl is that this comparatively greater crowding of the ribs also characterised the inner volutions. The external tubercles are finer than in *N. montanus*, but the umbilical tubercles do not exhibit any essential difference. The flanks are somewhat more distinctly arched, the external band is somewhat broader, the cross-section somewhat less cuneiform than in *N. montanus*. In the larger specimens the volutior height is 29 mm., the thickness 21 mm. The diameter of the smaller specimen measures approximately 57 mm., the umbilical width 17 mm., the volution-height at the anterior end 25 mm., to a thickness of 20 mm. The suture is unfortunately not known. One of the specimens consists of the chambered portion together with part of the body-chamber, the other two are body-chamber fragments. Supposing that the body-chamber belongs to a full

grown individual (an uncertain supposition), *Neocomites indomontanus* must be looked upon as a comparatively small species.

Although on the basis of the available material a complete diagnosis is impracticable, it is sufficiently precise to allow the species to be recognised if again met with.

Two specimens are from Lochambelkichak, third Stage (Coll. Diener), one from Hundes (Coll. T. L. Walker).

Hoplites (Neocomites) calliptychus, n. sp.

(Plate LXXXVII, fig. 2 *a*—*c*.)

Dimensions :—

Diameter	6 m. m.
Width of umbilicus	18 „
Height of volution	25 „
Thickness of last volution	19·7 „

The shell is small, the umbilicus rather narrow. The volutions overlap by one-third of their height. At the anterior end which probably belongs already to the body-chamber the cross-section is elliptical; the greatest breadth occurs half way up the slightly arched flanks, and from this region it diminishes uniformly both inwards and outwards. The external margin is slightly flattened, the umbilical wall slopes obliquely. The inner whorls are proportionately flatter and taller than the body-chamber.

The earlier portion of the shell is decorated with fine and rounded ribs; on the anterior portion of the last whorl the ribs rapidly increase in thickness and decrease in number. Their mode of development shows considerable variations; certain ribs extend from the umbilical wall to the external margin without dividing; others bifurcate half way up the flanks or a little higher or lower; others again originate in pairs from umbilical tubercles and either remain simple or else bifurcate above the middle of the flanks. In one place three ribs originate from one umbilical tubercle. On the anterior portion of the last volution some of the ribs become somewhat thicker and carry small acute tubercles at the point of bifurcation. All the ribs have a decided sigmoidal curvature and are drawn forward on the upper part of the flanks. On either side of the broad, smooth external band they terminate in small tubercles. The external band is slightly sunken along the median line of the chambered portion of the shell.

The suture-line is invisible except for some indistinct traces.

The rather decided curvature of the ribs, the proportionately narrow umbilicus and the small size of this species recall to some extent *Neocomites castellanensis* d'Orb. sp. from the Neocomian of Southern France. The cross-section of *N. calliptychus* is, however, lower and more elliptical, its umbilical wall descends obliquely and not perpendicularly, as it does in *Neocomites castellanensis* and tubercles are developed on the umbilical wall and to a certain extent on the

flanks, whilst they are absent in the French species; it is unquestionable therefore that *N. calliptychus* and *N. castellanensis* cannot possibly represent the same species.

Hoplites calliptychus is distinguished from *Hoplites paraplesius* Uhlig by its somewhat wider umbilicus, its more decidedly sigmoidal ribs, its tubercle-formation, and its lower whorls; from *Hoplites oxygonius* Neum. et Uhl. it differs by its smaller size, its elliptical cross-section, the obliquity of its umbilical wall and the development of tubercles on the flanks. Among the species of the Spiti Shales *N. pycnoptychus* and *N. Walkeri* are its nearest allies. The differences are enumerated in the description of those two species.

Neocomites calliptychus is represented by one solitary specimen from Lochambelkichak, third Stage.

HOPLITES (NEOCOMITES) PYCNOPTYCHUS n. sp.

(Plate LXXXVII, fig. 1 *a*—*c*.)

Dimensions :—

Diameter	56·5mm.
Width of umbilicus	18·8 „
Height of last volution	24 „
Thickness of last volution	17·2 „

Neocomites pycnoptychus is so closely related to *N. calliptychus* that we may dispense with a detailed description and content ourselves with a statement of the differences.

The shell is flatter, the ventral face more rounded than in *N. calliptychus*. The ribs generally exhibit a similar course and arrangement, but they are finer and more numerous. On the umbilical wall the tubercle-like swellings are feebler and fewer, they are entirely absent from the flanks, and on the external margin the rib-terminations consist only of slight acute small swellings, while in *N. calliptychus* they are developed into distinct round tubercles. The external band is comparatively broad as in *N. calliptychus*, and on the chambered portion of the shell it is slightly sunken along the mesal line. On the anterior part of the last whorl the external band becomes slightly convex and the ribs show a tendency to continue across it, a feature not observed in *N. calliptychus*, at least not to the same extent.

The suture is unfortunately still more indistinct than in *N. calliptychus*. The anterior portion of the last volution, on which the ribs assume a more decidedly sigmoidal curvature and are somewhat more distinctly spaced, belongs to the body-chamber; at least no trace of septa is discoverable in it.

Small specimens of *Neocomites oxygonius* Neum. et Uhl. bear a great resemblance to *N. pycnoptychus*; their union is precluded by the closer setting of the ribs, the elliptical cross-section and the obliquity of the umbilical wall in *Neocomites pycnoptychus*.

The species is represented by one solitary specimen from Lochambelkichak, third Stage.

Hoplites (Neocomites) Walkeri, n. sp.

(Plate LXXXVI, figs. 1 *a*—*c*, 2 *a*, *b*; Plate LXXXVII, fig. 3 *a*, *b*.)

Dimensions :—

Diameter		84 mm.
Width of umbilicus		26 „
Height of volution	34·8 mm. (measured on the ribs).	32·5 mm. (measured on the median band).
Thickness of last volution (approximately)	32 mm. (measured from rib to rib).	30·5 mm. (measured across the intercostal spaces).

The shell of this species is similar in shape to that of *Neocomites calliptychus*, but distinctly thicker and more rounded along the external margin. The cross-section has a broad elliptical shape at the anterior end of the last whorl, the external margin being gently rounded and the umbilical wall curved and sloping rather steeply. At the posterior end of the last whorl and probably also in the inner whorls, which are unfortunately not preserved, the flanks and the ventral face are somewhat more decidedly flattened and the cross-section has a more rounded-oblong shape.

The ribs are of the same character, generally speaking as in *N. calliptychus*; but they are somewhat less curved, rather prominent and at the same time not so densely crowded on the anterior portion of the last whorl as in *N. calliptychus*. The umbilical tubercles are well developed; on internal casts they constitute blunt flattish swellings which when the shell is preserved are prolonged into rather long spines. Each umbilical tubercle sends forth either two or, in two of the specimens, frequently three ribs, some of which remain simple, while the remainder bifurcate above the middle of the flanks. In one place the shell is more deeply excavated between two ribs after the manner of a constriction. The external band is rather broad and forms a shallow depression on the posterior portion of the last whorl; further forward this groove becomes less distinct. The tubercles on either side of the external band are not strongly developed and appear only as thickenings of the rib-terminations. The suture is preserved only in one specimen whose reference to *N. Walkeri* is rather doubtful. Moreover, in consequence of the weathered condition of the fossil, one can only distinguish the rough outlines of the suture. The first lateral lobe is somewhat longer than the external lobe; its trunk is rather broad, and the lateral branches are subsymmetrically disposed. The external saddle is not very broad and is subsymmetrically bisected by an adventitious lobe. The first lateral saddle is more slender than the external saddle and stands only little higher. It is subdivided by an adventitious lobe into a lower outer and a higher inner portion.

In three specimens whose size can be gathered from the three illustrations, the anterior end of the last whorl already belongs to the body-chamber, from which it follows that *Neocomites Walkeri*, like the allied *Neocomites calliptychus* and *Neocomites pycnoptychus*, is a species of relatively small dimensions, though somewhat larger than the two species just mentioned.

We have referred to *Neocomites Walkeri* five specimens which do not agree in every respect. The one represented in fig. 1 of plate LXXXVI has more crowded ribs and more massive umbilical tubercles; not unfrequently three ribs originate from one umbilical tubercle; on the posterior part of the last volution traces of lateral tubercles are indicated and the anterior part has its external band even and smooth. The second specimen (fig. 2, plate LXXXVI) includes the commencement of a body-chamber; it exhibits the same type of ornamentation as the first; the ribs, however, are somewhat finer and the umbilical tubercles fainter. In the third specimen (fig. 3, plate LXXXVII) the ribs are less crowded, and not more than two originate from each umbilical tubercle. The external band on the anterior portion of the last whorl is less distinct and the ribs exhibit a tendency to cross the external margin in a reduced condition, forming a shallow arch. The ribs of the fourth specimen are less distinctly curved. The specimens exhibit therefore a series of differences which, with better material, may necessitate their separation into two or even three separate species. The material at present available is too insufficient for establishing definitely this separation.

Neocomites Walkeri is distinguished from *Neocomites calliptychus* by its greater thickness, the closer anterior crowding and less decided sigmoidal curvature of its ribs, its feebler ventral and stronger umbilical tubercles.

Of the specimens described, four are from Lochambelkichak, third Stage (Coll. Diener), and one from Hundes (Coll. Walker).

Hoplites (Neocomites) aff. Walkeri, n. sp.

(Plate LXXXVII, fig. 4 *a—d.*)

The majority of species closely related to *Neocomites calliptychus* are of rather small size; but the form now to be described must have reached considerable dimensions, as the fragment preserved although completely chambered has a volution height of no less than 41 mm., the corresponding thickness being 36 mm. The cross-section has a rounded-rectangular or elliptical shape; the flanks are fairly flat at about half their height and pass gradually into the rounded and rather steep umbilical wall on the one side and on the other side into the external margin.

The ribs show the same disposition as in *N. Walkeri*; on the internal cast they are rather broad and rounded, and feebly projecting, certain ribs being more prominent than others. The stronger ribs swell into tubercles on the umbilical wall. At one place the shell is deeply furrowed between two successive

ribs after the manner of a constriction. On the external margin the ribs form slight swellings; they pass in a shallow arch across the external margin and are reduced along the median zone or obscured.

The most characteristic feature of the suture is the broad and low trunk of the first lateral lobe. The trunk is continued into a long, slender, rather copiously ramified terminal branch. The two lateral branches are only slightly different in size and branch off nearly at the same level. The second lateral lobe is much shorter, and the stronger development of its outer lateral branch gives it an asymmetrical configuration. On the umbilical wall one observes three slender oblique auxiliary lobes, the points of which scarcely reach as low down as the points of the second lateral lobe. The external saddle is broad and subdivided by a long and slender adventitious lobe into two nearly equal portions. The first lateral saddle is conspicuously more slender and more profusely laciniated; it reaches higher up and is cut into by an obliquely disposed adventitious lobe.

The connection of the present species with the group of *Neocomites callipsychus* and *N. Walkeri* is distinctly established by the thickness of the shell, the convexity of its ventral face and the type of ornamentation. Within the limits of the group it evidently comes nearest to *N. Walkeri*, without, apparently, being identical with it. The ribs are more rounded and partly obsolete, the shell is much flatter and much larger. Owing to the insufficiency of the material and the great difference in size of the specimens available for comparison no definite conclusion can be arrived at concerning the specific independence of the present form. The suture-line being distinctly preserved, we have deemed it advisable to figure it and describe it in greater detail (plate LXXXVII, fig. 4*d*).

Locality.—Hundes (Coll. Walker).

Hoplites (Neocomites) Nikitini, n. sp.

(Plate LVIII, fig. 6 *a*, *b*.)

Dimensions :—

Diameter	78 mm.
Width of umbilicus	33 „
Height of last volution	24 „
Thickness of last volution (measured at the ribs)	22·5 „

This form is unfortunately also represented by only one incomplete specimen, yet it exhibits such characteristic features that we do not hesitate to establish it as the type of a new species.

The specimen includes only the body-whorl, the chambered portion of the shell not having been preserved. At the commencement of the body-whorl the flanks are nearly flat, the external margin broad and flat, so that the cross-section assumes almost a rectangular form. The volution-height is here 21·5 mm.,

the thickness 18 mm. Further forward the flanks gradually assume a slight curvature, the cross-section at the upper part of the flanks becomes somewhat broader, the external margin less complanate.

The ribs are rather well marked off from each other; they are not prominent and exhibit a sigmoidal curvature. They start on the umbilical wall partly singly, partly in pairs, their origin in the latter case being from small pointed tubercles. On the posterior portion of the body-chamber the majority of the ribs bifurcate; on the anterior part bifurcation is less frequent. On the flanks two of the ribs show slight swellings only just perceptible. The external band is broad and smooth and rather deeply excavated on the posterior part of the body-chamber where the external tubercles are distinctly developed. At the anterior end of the body-whorl the external margin is slightly convex or at any rate not excavated, the ribs crossing it in the shape of shallow arches, becoming greatly reduced along the median zone, although still recognisable.

The margin of the oral aperture is partly preserved; it is produced on the sides in the shape of a lappet with a broad base. The ribs become much reduced behind the oral aperture. The oral aperture becomes expanded at the margins which diverge outwards.

The species above described is related to *N. calliptychus*, but is distinguished by its flatter flanks, its weaker tubercles, wider-spaced ornamentation, and narrower umbilicus.

One specimen is from Lochambelkichak, third Stage. Two other, very incompletely preserved specimens from Lochambelkichak, third Stage, are closely allied to the present species, but differ from it owing to their less numerous and less strongly curved ribs. We enumerate them as *Neocomites* aff. *Nikitini*.

HOPLITES (NEOCOMITES) ODONTODISCUS, n. sp.

(Plate LXXXV, figs. 1 *a*—*c*, 2 *a*— , 3 *a*, *b*.)

The shell is discoidal and possesses flatter and taller whorls than any other *Hoplites* species from the Spiti Fauna. At a diameter of about 81 mm. the umbilical width is about 24 mm., the maximum thickness 21·8 mm., the volution-height 33·5 mm. The maximum width of the cross-section coincides with the lower part of the roundish-flat flanks; from this region the width decreases more gradually towards the umbilical wall than towards the external margin, in consequence of which the cross-section acquires a very characteristic wedge-like form. The umbilical wall is rather steep and is clearly separated from the flanks by a row of tubercles which constitute the swollen zone from which the ribs originate. The flattened narrow and smooth external margin rises along the median line into an exceedingly feeble but yet perfectly distinct thread-like ridge after the manner of *Hoplites amblygonius*.[1] The external band

[1] Neumayr and Uhlig, Hilsammonitiden, p. 41.

is fringed on either side by a highly ornamental series of acute small tubercles which are elongated in a spiral direction transverse to the course of the ribs.

In one of the specimens (plate LXXXV, fig. 2 *a*) the innermost of the preserved volutions exhibits fine filiform ribs which originate singly at the umbilical suture and bifurcate at about half their height. On the succeeding volution one can already detect some small tubercles along the umbilical wall, the tubercles giving rise to single ribs or to pairs of ribs which exhibit a slight sigmoidal curvature. About half-way up the flanks or a little below, the ribs which are still filiform undergo bifurcation. On the following third volution the ribs become peculiarly broadly rounded; they mostly originate singly from rounded umbilical tubercles and bifurcate about half-way up the flanks. Only a few of the umbilical tubercles give origin to a pair of ribs of which the foremost one remains simple, while the posterior one is bifurcate. The intervals between the ribs are broad and flat and well marked off from the ribs. All the ribs become a little broader towards the external margin and terminate in the small ventral tubercles already referred to.

The suture advances slightly forward from the external margin towards the first lateral saddle, falling back from this point towards the umbilicus. The external saddle is rather broad and is bisected by an adventitious lobe into two nearly equal segments. The first lateral saddle is divided by a somewhat obliquely disposed adventitious lobe into a lower outer and a somewhat higher inner segment and is greatly constricted at its base in consequence of the close approach of the lateral branches of the two lateral lobes. The first lateral lobe has a rather broad trunk and very long slender branches; the second lateral lobe reaches with its apex close to the level of the inner lateral branch of the first lateral lobe and has a somewhat asymmetrical configuration in consequence of the stronger development of its outer lateral branch. Between the first lateral saddle and the umbilical suture are three small oblique auxiliary lobes, the last of which reaches down approximately to the level of the apex of the first lateral lobe.

This species is represented by four, or perhaps five, specimens, none of which is larger than those figured. Since four of them exhibit the commencement of the body-chamber, we may infer that they are full-grown. One of these specimens (plate LXXXV, fig. 2) deviates from the fragment selected as type (fig. 1 of the same plate) by its relatively lower volutions (the volution-height being 29 mm., for a thickness of 21 mm.) and somewhat more massive sculpture. The difference appears, however, too insignificant to establish any specific distinction. Another body-chamber fragment has somewhat broader and flatter ribs. Whether this fragment represents a distinct species can only be decided when we are able to dispose of more abundant material.

Neocomites odontodiscus together with some allied species appears to constitute a small but sharply defined group. The characters of the external margin the flat ribs and the disposition of the small ventral tubercles recall *Hoplites*

amblygonius; but this species is much larger and has more deeply divided ribs; the transition from filiform into coarser ribs takes place more gradually, and there are considerable differences in the cross-section and especially in the suture. The Silesian variety of *Neocomites neocomiensis* appears to stand nearer, for it has flat ribs similar to those of *Neocomites odontodiscus*: but it is distinguished by its narrower umbilicus, its narrower and less sharply marked off costal interstices, the greater number of forked ribs and somewhat differently constructed lobes. The general facies of *Neocomites odontodiscus* vividly recalls *Steueroceras transgrediens* Steuer from the Tithonian of Arroyo Alberjillo (Argentine). Both species have a similar cross-section, show a similar rapid passage from filiform to broad ribs and similar small ventral tubercles on either side of the narrow external margin. There can be, however, no question about specific identity; for the outermost whorl of *Steueroceras transgrediens* is ornamented with ribs, most of which are simple, instead of forked, and they originate singly at the umbilical suture, there being no tubercles. Moreover, the suture differs, the saddles especially being much broader. In the introduction to the genus we have already remarked that *Steueroceras transgrediens* cannot be admitted within the limits of *Hoplites* in the general sense, much less can it be regarded as a *Neocomites*. The resemblance in general appearance between *Steueroceras transgrediens* and *Neocomites odontodiscus* is therefore not due to any close relationship but is merely a case of superficial mimicry due to an accidental convergence in the mode of ornamentation.

Neocomites odontodiscus is represented by specimens from the following localities:—

Lochambelkichak, third Stage, 4 specimens;
South of Ting Jung La, Hundes, 1 specimen.

HOPLITES (NEOCOMITES) n. sp. ind. aff. ODONTODISCUS, n. sp.

(Plate LXXXV, fig. 5 *a*—*d*.)

A small fragment of a body-chamber from Lochambelkichak, third Stage, indicates the existence of a species closely allied to *Neocomites odontodiscus*, though not specifically identical. The inner volution is ornamented with crowded filiform ribs terminating in slight protuberances on either side of the comparatively broad external margin. The body-chamber carries flat convex ribs similar to those of *Neocomites odontodiscus* originating likewise from swellings at the umbilical suture, but they do not exhibit so pronounced a sigmoidal curvature and they mostly split up into three branch-ribs. At the origin of the secondary ribs the main-ribs become remarkably flat and expanded, just like those of the Silesian variety of *Neocomites neocomiensis*. The external margin exhibits the same characters as in *N. odontodiscus*; but the flanks are somewhat flatter, and the cross-section has its greatest width closer to the umbilical wall. The latter

is nearly perpendicular, and is lower than in the case of *N. odontodiscus*. The suture-line is unknown. Evidently this fragment represents a separate new species, the characterisation of which is too deficient to allow the creation of a separate specific name.

Hoplites (Neocomites) n. sp. ind. aff. odontodiscus, n. sp.

(Plate LXXXV, fig. 4.)

We find it necessary to describe yet another body-chamber fragment from Lochambelkichak, third Stage, notwithstanding its imperfect condition, because it helps to form some idea of the very peculiar appearance assumed by the larger-sized forms belonging to the group of *Neocomites odontodiscus* and therefore helps to give a more complete picture of that group. The fragmentary whorl has a height of 44 mm., a breadth of 26 mm. measured between the ribs. The ventral face shows the same character as *N. odontodiscus* with however the ridge-like swelling along the median line still more distinct. The external tubercles are not very large, but they combine to form a sharply defined ridge-like longitudinal swelling; the umbilical tubercles are only feebly developed. The most characteristic features are the flat plait-like ribs and the broad well-defined intervals between them. At one place, one of the main-ribs divides into three subsidiary ribs, the middle one of which is cut into by a shallow longitudinal groove.

The specimen above described can hardly be regarded as representing the full-grown stage of *N. odontodiscus*, because four specimens of the latter species are provided with body-chambers when only of a much smaller size, so that we may well suppose that these body-chambers indicate the full-grown stage of *N. odontodiscus* and that this species is one of comparatively small size. The specimen described above belongs probably to a larger species whose chambered whorls are still unknown.

Hoplites (Neocomites), n. sp. ind.

(Plate LXXXV, fig. 6 *a*, *b*.)

A small fragment of a body-whorl, with narrow, smooth ventral face and slightly rounded flanks represents a further species of *Neocomites*. The cross-section may be described as tall-elliptical, with its greatest width at the middle of the flanks. Four rather narrow ribs inclined forward are preserved; they form tubercles on the ventral margin, and are separated from each other by exceedingly broad intervals. The ribs grow somewhat broader in an outward direction; one of them is cut into by a longitudinal groove, as if this portion of the rib had its origin in two branch-ribs coalescing into a single external tubercle. The inner volutions and the suture are unknown.

We should have left this specimen unnoticed, were it not that it bears unmistakable resemblance to *Hoplites Burckhardti*[1] Mayer-Eymar from the Jurassic-Cretaceous passage beds of Rio Agrio in Argentine. It is true that the Argentinian species has much thicker and lower whorls; moreover, it shows traces of intercalary ribs which are wanting in the Indian fossil so that there can be no question of a relationship amounting to specific identity. On the whole, however, the resemblance is striking. The flat ribs and the broad intercostal spaces apparently connect the fragment described above with the group of *Neocomites odontodiscus*.

Locality.—Lochambelkichak, third Stage.

Hoplites (Neocomites) Theodorii, Opp.

(Plate LXXXIX, figs. 1 *a*—*d*, 2 *a*, *b*.)

Ammonites Theodorii, Oppel: Palāontol. Mitteil., 1863, p. 280, pl. 78, fig. 3 *a*—*c*; pl. 83, fig. 2 *a*, *b*.
Non Odontoceras Theodorii, Steuer: Argent. Jura-Ablagerungen, pl. XX, figs. 7, 5, p. 48.

The following description is mainly based on the very same beautiful specimen of a body-chamber upon which Oppel established his species. The fact that Oppel's illustration is not quite correct has made it necessary to refigure the specimen.

The specimen attains a diameter of at least 130 mm. Oppel quotes the following dimensions corresponding to a diameter of 120 mm.: width of umbilicus 47 mm.,[2] height of last volution above the umbilical suture 42 mm., thickness 32 mm. According to our own measurements, at a point where the diameter is 65 mm., the umbilical width is 21·8 mm., the height of the volution, measured above the umbilical suture, is 26 mm., the thickness approximately 19 mm. It follows from a comparison of these numbers that the ratio of height to thickness of the whorl undergoes very little change during the growth of the individual, but that the umbilicus is considerably wider at the full-grown stage.

The volutions of the discoid shell overlap by something more than one-third; the flanks are rather flat on the lower and middle regions, but become rounded towards the periphery and approach each other in a wedge-like fashion. The cuneate form of the cross-section is especially distinct on the body-chamber. The umbilical wall has a rather steep slope; the external margin is comparatively narrow, being flattened when the shell is immature and becoming slightly convex on the body-chamber.

[1] *Palāontographica*, Vol. 50, pl. X, figs. 17—20, p. 61. Steuer and Burckhardt suggest *Hoplites perornatus* Retowski as the form closest related to *Hoplites Burckhardti*. This view is evidently incorrect, for *Hoplites perornatus* is a form with umbilical and lateral tubercles and long external spines, suggesting a closer relationship with *Hoplites hexagonus*, while *Hoplites Burckhardti* has neither umbilical nor lateral tubercles and its external margin only bears slight tubercles instead of spines.

[2] The umbilical width of the fragment corresponding to a diameter of 120 mm. is only approximately determinable; I should put it down as something like 45 mm. at the outside.

Throughout the entire shell as far as it is preserved. the ribs are sharply filiform to ridge-like. On the upper part of the flanks they assume a forward inclination or a slight sigmoid curvature. Some of them remain undivided, but the majority bifurcate half way up the flanks. On the umbilical wall the ribs originate partly singly, partly in fascicles of two. Slight swellings situated on the umbilical wall, and either projecting as sharp tubercles or else only slightly indicated, affect all the ribs, whether single or fasciculated, being especially prominent on the latter. During the middle stages of growth three to seven independent ribs are intercalated between successive paired ribs. On the body-chamber the formation of fascicles becomes obsolete, and the ornamentation consists only of an alternation of simple and forked ribs. The thickening of the ribs on the umbilical wall is also less pronounced at this stage. During the early and intermediate stages of growth the rib-terminations constitute distinct small round tubercles on either side of the narrow external furrow. With increasing size the furrow grows indistinct and the swollen rib-terminations join with one another across the external margin. On internal casts the junction of rib-terminations assumes the shape of a very shallow arch; but where the shell is preserved the thickened portions of the rib ends are deflected forward to such an extent that they assume a pronounced oblique disposition.

The suture is not preserved.

Certain peculiarities of *Ammonites Theodorii*, especially the characters of the ventral face, induced Oppel to express the opinion that *Ammonites Theodorii* should be associated with *Ammonites Duncani* from the Kelloway Beds, and this view was partly shared by Neumayr, as already remarked by us in the description of *Hoplites Cautleyi*. A more intimate acquaintance with the numerous species of *Hoplites* from the Spiti Shales taken in conjunction with the configuration of the suture-line of the closely allied *Neocomites indicus* leaves no room for any doubt about the *Hoplites* nature of the present form. Owing to the peculiar structure of the ventral face and the sharp perisphinctoid ribs *Hoplites Theodorii* occupies a somewhat isolated position. Among European species, *Neocomites perisphinctoides* Uhlig from the Valanginian of the Carpathian mountains of Silesia is perhaps its nearest relative. The sharp filiform ribs, the slight swellings at the umbilical suture, the occurrence of rib-bundles speak in favour of this connection. Only the ribs of *Neocomites Theodorii* are inclined forward while in *Neocomites perisphinctoides* they are more filiform. The point of bifurcation shows less of a tendency to form swellings in *Neocomites perisphinctoides*, and moreover there exist slight constrictions, features not observable in *Neocomites Theodorii*. Whether the external margin of large-sized specimens of *Neocomites perisphinctoides* becomes similar to that of *Neocomites Theodorii* is uncertain, but the differences enumerated above are sufficient to establish specific distinctness, though with a certain degree of relationship.

The thread-like form of the ribs and their forward inclination in the upper part of the volution recall *Hoplites rarefurcatus* Pictet; but the latter form lacks the rib-bundles as well as the swellings of the ribs on the umbilical wall; the

ribs are more crowded, and the upper part of the volutions does not exhibit the cuneate cross-section observed in *Neocomites Theodorii*.

Steuer has referred to *Hoplites Theodorii* a species from the Tithonian of the Argentine. This identification is incorrect. The ribs of the Argentinian species have no umbilical tubercles, their sigmoidal curvature on the upper part of the volution is less pronounced and they are not grouped into fascicles at the umbilical suture. The umbilicus is somewhat wider, the umbilical wall not so declivous, the maximum thickness is situated near the middle of the whorls, the cross-section tapers only slightly towards the external margin. *Odontoceras Theodorii* Steuer is evidently not closely allied with *Neocomites Theodorii* Oppel sp. Similarly also *Hoplites* cf. *Theodorii* Burckhardt[1] differs specifically from *Neocomites Theodorii* Oppel sp., since the Argentinian form exhibits neither rib-fascicles nor tubercles on the umbilical wall. *H.* cf. *Theodorii* Burckhardt probably belongs to the group of *Hoplites* (*Berriasella*) *privasensis*. True relationship possibly exists with another species of *Hoplites* which Steuer described under the name of *Odontoceras fallax*.

Oppel's original specimen of *N. Theodorii* is from Laptal in Ngari Khorsum.

HOPLITES (NEOCOMITES) INDICUS, n. sp.

(Plate LXXXIX, fig. 3 *a*, *b* ; fig. 4 *a*, *b*, *c* ; fig. 5 *a*, *b* ; fig. 6.)

This species includes several small and imperfect specimens which, although not completely agreeing with one another, are yet distinguished from *Neocomites Theodorii* by certain common characteristics. In contradistinction to the large size of *Neocomites Theodorii*, *Neocomites indicus* appears to be a form of small dimensions, for three of the small specimens have a body-chamber. The relative dimensions closely agree nevertheless with those of *Neocomites Theodorii*. The specimen figured in plate 89, fig. 3, has a diameter of 53 mm., an umbilical width of 15·7 mm. ; the height of its last volution is 21 mm., its thickness 21 mm. A second specimen also provided with its body-chamber, measures 70 mm. in diameter with an umbilical width of 24 mm., a thickness of 20 mm. and a volution-height of 26 mm.

The shape of the shell shows no essential difference from that of *Neocomites Theodorii*. In one of the specimens the ventral edge is still narrower, and the wedge-like shape of the cross-section still more pronounced.

The sculpture deviates from that of *Neocomites Theodorii* in the following points : the ribs are somewhat more strongly curved forward ; they are somewhat coarser and more frequently united into bundles on the umbilical wall. The number of single ribs between each two rib-bundles is one, or at most two ; sometimes two rib-bundles follow one another in immediate succession. The external margin is richly decorated ; the furrow is deep and very narrow so that the ribs almost meet at an angle. The rib terminations are obliquely truncate

[1] C. Burckhardt, Beitrage zur kenntniss der Jura und Kreideformation der Cordillere. *Palæontographica*, Stuttgart Vol. L, 1903, p. 67 pl. X, figs. 21, 22.

and only very slightly swollen. In the largest of the body-chamber specimens the furrow becomes gradually obliterated and the ribs unite across the margin either in an arch or almost at a sharp angle. A third specimen, which otherwise is quite similar, exhibits the same obliquely transverse junction of the ribs which gives such a peculiar appearance to *Neocomites Theodorii*.

The suture is indistinctly preserved in only one small fragment. It approximately corresponds with that of *Sarasinella varians*. The external saddle is rather broad and subdivided by a narrow, somewhat obliquely disposed secondary lobe. The first lateral lobe has a short and broad trunk, and is moderately ramified.

Neocomites neocomiensis d'Orb. sp., amongst European species, recalls at first sight the present form. A closer inspection, however, reveals differences which preclude any very close connection. The ribs of *Neocomites neocomiensis* are distinctly sigmoidal; at first they curve backwards above the middle of the flanks and it is only above that level that they bend forward, whilst the most distinctive feature in the disposition of the ribs in the present species is their persistent forward inclination. Moreover, the external margin is differently constructed: whilst the external margin of *Neocomites neocomiensis* is rather broad and, as appears from the Silesian specimens, smooth even amongst individuals of considerable size, the ventral margin of *Neocomites indicus* is exceedingly narrow and the tendency of the ribs to pass right across the median band is already established at an early stage. The rib-sculpture vividly recalls a species from the Kimmeridgian (?) of Gorodischte on the Volga described by Pavlow[1] under the name of *Hoplites amblygonius* Neum. et Uhlig, which, however, is not identical with the latter species and which therefore we shall designate as *Hoplites volgensis nobis*. The ribs of *Hoplites volgensis* exhibit likewise an anterior sigmoidal curvature though they are not sickle-shaped, while on the external margin they meet at an acute angle as in *Neocomites indicus*. To all appearance the relationship is very close. Pavlow states that the suture agrees exactly with that of *Hoplites amblygonius*. If that should be the case the relationship between *Neocomites indicus* and *Hoplites volgensis* would not be so intimate as we have supposed; for the suture of *Neocomites indicus* does not show that peculiarly asymmetrical configuration of the first lateral lobe which is so characteristic of *Neocomites amblygonius*. Unfortunately Pavlow has not illustrated the suture so that we are unable to test his statement. In any case there can be no question of specific identity between *Hoplites volgensis* and *Hoplites indicus*; for *Hoplites volgensis* lacks the wedge-like attenuation of the external margin and the tuberculate rib-terminations on either side of the mesal groove.

Neocomites indicus is represented by five specimens, two of which are from Lochambelkichak, third Stage, and the remaining three from Hundes.

MACROCEPHALITES, Sutner, SIMBIRSKITES, Pavlow, KOSSMATIA, n. gen.

The *Macrocephalites* group of the Spiti Shales deserves our special attention from a stratigraphical as well as from a palæontological point of view. It is

[1] Les Ammonitides de la zone à *Aspid. acanthicum*, *Mem. Com. Géol.*, Vol. V, 1886, p. 83, pl. II. fig. 6.

all the more regrettable that this group is so scantily represented in the available collections. Our conclusions must be therefore somewhat lacking in the desirable degree of precision, and would be still more uncertain, without the excellent guidance afforded to us by Waagen's standard work on the Fauna of Kachh. Not only did Waagen ascertain the relationship of the Callovian forms of *Macrocephalites* with those of the Oxfordian, but he was also able to compare the members of the *Macrocephalites* group found in the Spiti Shales with those from Kachh, and hence his opinion carries great authority.

The "Macrocephali," which in conformity with the views then prevalent amongst systematic palæontologists, were included within the limits of the comprehensive genus *Stephanoceras*, were divided by Waagen into two groups—the *Macrocephali rectecostati* and the *Macrocephali curvicostati*. With the latter group he also united one isolated form, *Stephanoceras eucyclum* Waagen.[1] The *Macrocephali recti* exactly correspond to the genus *Macrocephalites* as defined by Sutner. As to the *Macrocephali curvicostati*, I firmly believe that they should be linked together with the genus *Simbirskites* from the Lower Cretaceous and that the generic name *Simbirskites* should be extended from the geologically younger forms so as to include also the older *Macrocephali curvicostati*. The isolated form *Stephanoceras eucyclum* Waagen is related to a group which up to the present has been treated as a subdivision of *Perisphinctes*, namely, the group of *Perisphinctes tenuistriatus* Gray and *Perisphinctes Richteri* Oppel. For this group I propose the new generic name KOSSMATIA.

The genus *Macrocephalites*, that is, the *Macrocephali Rectecostati*, is represented in the Fauna of the Spiti Shales by only three badly preserved and incompletely known species—*Macrocephalites* cf. *Maya* Sowerby sp., *M. Waageni* n. sp. and *M. Kitchini* n. sp.

The ornamentation, especially in the two latter species, so strongly recalls that of *Ammonites macrocephalus* that one easily realises why F. Stoliczka[2] was led to identify them with the Oxfordian *Ammonites macrocephalus*. Waagen, however, was able to prove that the *Macrocephalites* forms of the Oxford stage differ from those of the Kellaway by a character common to all of them: in the Oxfordian species, the septa are invariably deflected forward on the lower part of the flanks, the suture forming a very decided arch between the first lateral saddle and the umbilical suture.[3]

This character is exhibited by all three species from the Spiti Shales, and there remains therefore no doubt that they are not of Callovian age, but that they belong to the geologically younger types such as characterise the Oxfordian

[1] Jurassic Cephalopoda of Cutch, pp. 107 and 108.

[2] *Mem. Geol. Survey of India*, Calcutta, 1866, Vol. V, p. 95.

[3] It is well known that in many Ammonoids the septa are radially disposed, as for instance in *Phylloceras*, *Astieria* and many others. The terminations of the saddle are, in this case, disposed approximately along a radius. In other groups, the septa are radially disposed only as far as the first lateral saddle or are even slightly oblique forward while from the first lateral saddle to the umbilical suture the course becomes retrograde, and lags behind the radius, constituting a "pendent lobe" (herabhängende Loben). A. Pavlow applies the term "inverselobate" (from *P. inverselobatus* Neum-Uhlig) to this type of suture.

stage. The stratigraphical position of these forms will be discussed in the concluding chapter of this Memoir.

The species of *Macrocephalites* from the Spiti Shales do not exhibit any close relationship with any of those hitherto known from the European "Terrain à chailles" of the Jura Mountains[1] nor with the types of the Oxfordian Fauna of Czenstochau.[2] Even amongst the Oxfordian forms from German East Africa[3] there are none that bear any striking resemblance to the Himalayan species.

It is not possible, however, to make use of these facts as the basis of trustworthy conclusions, not only by reason of the scantiness of the material from the Spiti Shales, but also because the Jurassics of East Africa are very incompletely known.

Waagen's group of *Macrocephali curvicostati* is characterised by ribs which are deflected forward on the external margin where they form an anteriorly convex arch. The group consists of a number of species, some of which are of Bathonian and Callovian age, while the remainder belong to the Oxfordian. A more detailed examination leads to the conclusion that *Macrocephalites dimerus* Waagen sp., *M. subcompressus* Waagen, *M. magnumbilicatus* Waagen sp., and *M. subtrapezinus* Waagen sp. are closely connected with the *Macrocephali rectecostati*, and that, in these four species, the characteristic features of the *Macrocephali curvicostati* are not nearly so distinct as amongst the geologically younger representatives of the latter group, such as *Macrocephalites nepaulensis* Gray sp., *M. opis* Waagen sp., and *M. fissus* Waagen sp. In these species the ribs are more decidedly deflected forward on the external margin, and the latter is narrower, the cross-section being externally more wedge-shaped.

Now these features are precisely those which characterise *Simbirskites* as defined by Pavlow, a genus chiefly found in the Lower Cretaceous. This is evident from a glance at the numerous figures illustrating this genus, principally in the works of Lahusen, Weerth, Pavlow, A. v. Koenen, Bogoslowsky.

It must be admitted that the characteristic features of *Simbirskites* are more strikingly developed in some forms from the Lower Cretaceous than in the *Macrocephali curvicostati* from the Jurassics of Kachh and the Spiti Shales.

Thus amongst some of the Lower Cretaceous forms of *Simbirskites* the ribs are more decidedly deflected forward along the external margin, and there is a larger number of subsidiary ribs; the wedge shape of the upper part of the cross-section may be more pronounced and the ribs may be swollen into slight small tubercles at the points of branching. But these differences are only gradually developed, and moreover it must be noticed that also in certain species of *Simbirskites* from the Spiti Shales such as *S. Koeneni* the ventral face is tapering and cuneate, while in others, such as *Simbirskites* n. sp. ind., the secondary ribs are numerous and the main ribs thickened.

[1] Tornquist, Oxford-Macrocephaliten, *Abh. Schweizer Paläontol. Gesellschaft*, XXI, 1894. Tornquist in this Memoir identifies a *Macrocephalites* of the "Terrain à chailles" with *M. opis* Sow. from Kachh. This identification does not seem to rest on secure foundations.

[2] *Beitr. zur Paläontologie und Geologie Oesterrich-Ungarns*, Vol. V.

[3] Tornquist, Fragmente einer Oxford-Fauna von Mtaru, Hamburg, 1893, in *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten*, X, part 2.

The somewhat more pronounced specialisation of the Lower Cretaceous species of *Simbirskites* is only what one would expect considering their geologically younger age.

Our hypothesis of a close relationship between the *Macrocephali curvicostati* and *Simbirskites* might be readily tested by a comparison of the suture-lines of the two groups. Unfortunately amongst the available Spiti Shales specimens the sutures are not preserved and Waagen was unable to figure the sutures of any of the Kachh specimens. He declared, however, that amongst the *Macrocephali curvicostati* the line of auxiliary lobes is distinctly deflected forward. This is a peculiarity which occurs in many, though not all the Lower Cretaceous forms of *Simbirskites*. We may therefore rightly conjecture that the suture exhibits the same agreement as the shape and ornamentation.

Hence we have evidently to deal with a continual developmental series which, starting from the older Callovian *Macrocephali curvicostati*, led to the geologically younger Oxfordian *M. curvicostati* and from these to the *Simbirskites* of the Lower Cretaceous; the question then arises as to the exact point where a generic division-line is to be drawn. It is not difficult to recognise that the geologically older *Macrocephali curvicostati* of Waagen are closely connected with the *Macrocephali rectecostati*, as has already been stated. Equally close are the relations of the geologically younger *M. curvicostati* with *Simbirskites*. But it is possible to draw a distinct boundary line on one side of which we place the geologically younger *M. curvicostati* together with *Simbirskites*, leaving on the other side the geologically older *Macrocephali curvicostati* together with the *Macrocephali rectecostati*. The younger *Macrocephali curvicostati* of Waagen already exhibit with perfect distinctness the characteristic mutational tendencies of *Simbirskites* and we are therefore justified in uniting the geologically younger *Macrocephali curvicostati* with *Simbirskites*. Future discoveries may, perhaps, lead to the necessity of separating the geologically younger *Macrocephali curvicostati* as a distinct subgenus. For the present, however, the main point is to express the close connection between the Upper Jurassic and Lower Cretaceous forms and the question of generic discrimination is only a matter of subordinate importance.

A. Pavlow[1] has subdivided the genus *Simbirskites* into the sections "perisphinctoides" (group of *S. versicolor*), "umbonati" (group of *S. umbonatus*) and "discofalcati" (group of *S. discofalcatus*), a classification accepted by A. v. Koenen.[2] The Spiti Shales have yielded only three species of this genus: *S. nepaulensis* Gray sp., *S. Koeneni* n. sp., and *Simbirskites* n. sp. ind., all of which belong to the group of the "discofalcati."

Simbirskites, as is well known, is one of the types characterising the "boreal" (Russian—North German—British) facies of the Lower Cretaceous. Its appearance in the Indian Province and in Upper Jurassic strata constitutes a significant palæogeographical fact, which will be discussed in the concluding chapter to this monograph.

[1] Crétacé inf. de la Russie, *Nouv. Mém.*, Vol. XVI, p. 66.

[2] Kreide Helgolands, *Abhandl. kgl. Gesellschaft der Wissenschaften in Göttingen, Neue Folge*, Vol. II, 1904, p. 10.

The union of *Ammonites tenuistriatus* Gray and *Ammonites Richteri* Oppel-Zittel with *Stephanoceras eucyclum* Waagen, the isolated type of the *Macrocephali curvicostati*, may not, at first sight, appear so well founded as the association of *Simbirskites* with the *Macrocephali curvicostati*. *Ammonites Richteri* and *Amm. tenuistriatus* have hitherto been accepted as genuine forms of *Periphinctes*; but it must be remembered that they occupy a perfectly isolated position. The ribs cross the external margin in the shape of an anteriorly convex arch as in *Simbirskites*. It is true that in several species the points of ramification are situated above the middle of the volutions, but in other species, such as *Ammonites Richteri* var. *longifurcata* and in *Ammonites tenuistriatus*, they lie half way up the volutions. Although the ribs of *Amm. tenuistriatus* are much finer than those of *Simbirskites*, in *Amm. desmidoptychus* they are quite as prominent as in typical form of that genus. The important but unfortunately very poorly preserved specimen represented in plate XCI, fig. 2, clearly shows the manner in which, all along the flanks of the volutions, the ribs tend to assume the shape of posteriorly convex arches. The same tendency is exhibited, although in a lesser degree, by *Ammonites tenuistriatus*. The same feature is more pronounced in *Stephanoceras eucyclum* Waagen; it is also shown by many species of *Macrocephalites* and still more so amongst those of *Simbirskites*.

The fact that ribs of such a characteristic figure are not observed in other Upper Jurassic Ammonoids forcibly suggests the view that the group of *Ammonites Richteri* and *Ammonites tenuistriatus* originates from *Amm. eucyclus* and hence from the *Macrocephalites* stock. A. F. Blanford had already arrived at a similar conclusion, by stating his opinion that *Amm. tenuistriatus* is merely a variety of *Amm. nepaulensis*. Certainty on this point can, of course, only be attained after more complete discoveries; in view of the small extent and the insufficiency of the material now available we must be content to point out the most plausible point of origin of this remarkable group. The developmental tendencies of this group diverge so widely from those of *Simbirskites* and *Macrocephalites* that we are driven to establish for it a new generic name, KOSSMATIA.

Kossmatia n. gen. includes very flat, disc-shaped, rather narrowly umbilicated ammonites with a narrow, rounded, more rarely slightly flattened external margin, and a rounded umbilical wall. On the upper part of the whorls the ribs break up into two to three or even four subsidiary branches, which may become associated with intercalary ribs. If more than two subsidiary ribs are present, they originate at different heights in the same manner as in *Simbirskites*. All the ribs assume a decided anterior inclination on the upper part of the whorls and constitute an anteriorly convex arch on traversing the external margin. In many forms the ribs along the entire length of the flanks form posteriorly convex arches; in others they exhibit a shallow anteriorly convex curvature in the middle region of the flanks. The suture-lines are known only in the case of *Kossmatia desmidoptycha* and *K. Richteri*. The auxiliary lobes are not anteriorly deflected as in *Simbirskites*, nor are they strongly retrograde.

At present we can only mention the following few species as members of this genus, namely:—

Kossmatia eucycla Waagen sp.
" *tenuistriata* Gray sp.
" *desmidoptycha* n. sp.
" *Ruckeri* Oppel sp.[1]

Of these species *K. eucycla* Waag. sp. is from the Jurassic of Kachh, *K. Ruckeri* from the Tithonian of the Alps and Carpathian Mountains, the remainder are from the Spiti Shales.

The species of *Kossmatia*, especially *K. desmidoptycha*, exhibit a certain resemblance to *Paraboliceras fascicostatum*. Since, however, they do not exhibit the slightest trace of parabolar tubercles or fascicles, and since also the characters of the ribs on the external margin are different, the similarity must be due merely to convergence and not to any close relationship. The primitive forms of *Hoplites* constituting the genera *Blanfordia* and *Berriasella* also bear a certain superficial resemblance to *Kossmatia*. But, apart from other characters, the different constitution of the external margin, precludes any possible confusion between *Kossmatia* and either of these groups.

We might perhaps point out that the hitherto isolated small genus *Silesites* Uhlig from the Barremian (Upper Neocomian) of the Alps and Carpathian Mountains bears a striking resemblance to *Kossmatia*. The disposition of the ribs and the shape of the shell show a close agreement. The sutures of *Silesites* are anteriorly deflected in the same manner as those of *Simbirskites*. But there is no complete generic agreement; for *Silesites* is distinguished by the presence of deep constrictions, which are altogether wanting in *Kossmatia*. It is quite conceivable that the remarkable genus *Silesites* constitutes a later development of *Kossmatia*, perhaps its final offshoot.

The unexpected discovery of a continuous connection from *Macrocephalites* to *Simbirskites* and *Kossmatia*, perhaps even to *Silesites*, which has resulted from a study of the material at our disposition, seems at first sight to offer a striking confirmation of the views of those palæontologists who, like Tornquist,[2] are inclined to believe that the genus *Holcostephanus* was derived from *Macrocephalites*. But probably all that they wished to express was the likelihood of a connection between the *recticostati* and certain forms of *Holcostephanus* from the Upper Jurassics. Now that we have been able to demonstrate fairly clearly the connection between the *curvicostati* and the genus *Simbirskites*, which, on its side, is not improbably related to *Polyptychites* and *Craspedites*, we feel all the more ready to admit the likelihood of *Holcostephanus* being derived from the *recticostati*. Here, however, we still lack the conclusive evidence of connecting links; but it is possible that these may be supplied by future discoveries in the Indo-African Province so rich in forms of *Macrocephalites*.

[1] Whether any of the species described by Castillo and Aguilera, such as *Perisphinctes alamitoensis*, belong to this group, as assumed by Siemiradzki, cannot be decided owing to the incompleteness of the illustrations. Neither is it certain, in the absence of the ventral face, whether Burckhardt's *Perisphinctes tenuistriatus* from Molinos Colgados, Argentina, is in any way connected.

[2] Oxfordiauna von Mtaru, *loc. cit.*, p. 10.

MACROCEPHALITES. Sutner.[1]

MACROCEPHALITES cf. MAYA, Sowerby sp.

(Plate LXXVII, fig. 4 *a*—*c*.)

Ammonites Maya, Sowerby: *Transact. Geological Society*, London, IId ser., Vol. V, p. 719, pl. 61, fig. 4.
Stephanoceras Maya, Waagen: Jurassic Cephalopoda of Cutch, *Palæont. Indica*, Ser. IX, Vol. I, p. 119 and ff., pl. 28, figs. 1, 2; pl. XXXI, fig. 2*a*, *b*.
Ammonites nepalensis, H. F. Blanford (*non* Gray): *Journ. Asiat. Soc. of Bengal*, XXXII, Calcutta, 1864, p. 128, pl. I, fig. 6, 6*a*.
Ammonites macrocephalus, F. Stoliczka: *Mem. Geol. Survey of India*, Vol. V, Calcutta, 1866, p. 96.

Dimensions:—

Diameter	36·5 mm.
Width of umbilicus	5·3 „
Height of volution	18 „
Maximum thickness	13·2 „

It is not so much my own personal conviction as the great authority of Waagon which has induced me to mention the name of *Macrocephalites Maya* Sow. in connection with the specimens to be discussed here. One of these specimens (plate LXXVII, fig. 4) has been figured by Blanford as *Amm. nepaulensis* Gray and mentioned as *Amm. macrocephalus* by Stoliczka. Waagen on the other hand has related it to *Stephanoceras Maya*. The specimens undoubtedly come much nearer to *M. Maya* from Kachh than to *Amm. macrocephalus* or *nepaulensis* or any other

[1] There is a specimen of *Macrocephalites* collected by A. v. Krafft bearing the label "Tera Gadh base of Spiti Shales." I supposed therefore that it was derived from the lowermost part of the Spiti Shales and consequently had it figured together with the other *Macrocephalites* forms from the Spiti Shales. In A. v. Krafft's Memoir on the exotic blocks of Malla Johar we find, however, the following remarks (p. 133): "I myself discovered in Spiti in a section near Gieumal, 350 to 400 feet below the Spiti Shales, a well preserved ammonite which is very closely allied to, if not identical with, *Stephanoceras coronatum* Brug., a species also characteristic of the Kelloway." The specimen figured in Pl. LXXVII, fig. 5 *a*—*c*, probably represents therefore the above mentioned ammonite which was found at a horizon far below the Spiti Shales, and, consequently, I have not enumerated it along with the fossils of the Spiti Fauna.

Nevertheless as it has been figured here, I take the present opportunity of recording the following remarks on the subject of this interesting fossil.

The specimen *Macrocephalites* sp. ind. (Pl. LXXVII, fig. 5 *a*—*c*), which cannot be specifically determined with certainty, is immature, its diameter being about 26 mm. with a maximum thickness of 15·8 mm. Owing to its small size and the absence of the suture it is even doubtful whether it represents a *Stephanoceras* from the Lower Oolite or Bathonian or else a genuine *Macrocephalites*, though the latter is more probable.

The wide umbilicus and the round, depressed cross-section of the volution strongly recall the small specimen of *Macrocephalus elephantinus*, Sow., which Waagen has figured in his description of the Jurassic Cephalopoda from Cutch, Pl. 32, fig. 4 *a*—*c*. It cannot, however, be directly identified with this species because *M. elephantinus* frequently exhibits trichotomous ribs, while in the Himalayan specimen they are only dichotomous. A still more closely related form is perhaps *M. lamellosus*, Sow. sp. (Waagen, *loc. cit.* Pl. 33, fig. 1, p. 122; Bukowski, Jura von Czenstochau p. 125, Pl. XXVI, fig. 19), from the *Macrocephalites* horizon; for this species has predominantly dichotomous ribs and a rather wide umbilicus. The ribs of *M. lamellosus* are remarkably sharp, which is not the case with the Himalayan specimen. But it is possible that the greater delicacy of the ribs bears some connection to the smaller size of the specimen. The specimen is the condition of an internal cast, the rock consisting of a grey limestone which contains small ferruginous oolites.

Locality.—Tera Gadh.

known form. Nevertheless by carefully comparing the specimens with Waagen's description and figures one gathers the impression that the identity is not complete. The most striking differences are observed in the umbilical wall of the Himalayan specimens which is lower than that of the type of *M. Maya*, while the inner part of the whorls is more depressed. Otherwise the agreement is quite satisfactory. Although the suture-line is not distinctly preserved, yet one can very clearly detect the anterior deflection of the suture-line from the first lateral saddle to the umbilicus which is so characteristic of the Oxfordian types of the *Macrocephali*. In *M. Maya* the ribs are slightly convex anteriorly on the ventral face.

The discovery of larger specimens must be awaited in order to decide whether there is complete specific identity with *M. Maya* or only a close relationship.

According to W. Waagen *M. Maya* is the geologically youngest representative of the *Macrocephali rectecostati* found in the Jurassics of Kachh where it occurs in the Dhosa Oolite and Kuntkote Sandstone.

The Himalayan specimens were found in the Spiti Valley and according to F. Stoliczka "in the lowest beds of the shales."

Macrocephalites Waageni, n. sp.

(Plate LXXVII. figs. 1, 2 *a*, *b*, 3 *a*—*c*.)

Owing to the scantiness of available material we find ourselves compelled to give a very incomplete diagnosis of this species, which, however, we feel bound to take into consideration on account of the great importance of the genus *Macrocephalites* in any attempt at a stratigraphical correlation of the Spiti Shales.

The best preserved specimen is the one represented on fig. 3, and it is the one which has been chiefly made use of in establishing the character of the species. Its diameter is 39 mm., the width of the umbilicus 6 mm., the height of the volution 20 mm., and maximum thickness 17·6 mm. The larger specimens, figs. 1 and 2, are unfortunately strongly distorted by compression, the outline of the mouth as represented in fig. 2 *b* being restored and therefore not reliable.

The cross-section of the volution is tall-trapezoidal; the maximum thickness occurs at the zone of transition from the flat, somewhat rounded flanks into the steep umbilical wall. The external margin is somewhat distinctly flattened. The large specimen, fig. 1, has a more elliptic cross-section at its anterior extremity; it seems that with increasing size the cross-section gradually tended to assume a slight approach towards an elliptic shape; but to what degree this evolution continued cannot be decided, owing to the poor state of preservation of the specimen.

On the umbilical wall the ribs form an arch whose convexity faces backwards, and they turn forward at about half the height of the flanks. Every main-rib gives off two branch-ribs, to which is added an intercalated rib. Consequently on the upper part of the flanks there are three secondary ribs to every

main-rib. The ribs cross the ventral face without forming a distinct arch. The number of main-ribs on the last volution is 28 to 29; in the specimen, fig. 2, it is somewhat greater.

The sutures are not known in detail, but we have been able to ascertain that they are decidedly deflected forward on approaching the umbilicus.

Macrocephalites Waageni is distinguished from the closely allied *M. Mayo* Sowerby sp., especially by the smaller number of secondary ribs and the less pronounced curvature of the ribs on the external margin; from *M. Macrocephalus* it differs by the stronger development of the ribs on the lower portion of the flanks and by the anterior deflection of the suture line.

The specimen, fig. 3, is, according to the attached label, from the Spiti Valley. Stoliczka remarks that all the specimens were collected near Gieumal in Spiti.

MACROCEPHALITES KITCHINI, n. sp.

(Plate LXXVII, fig. 6 *a—d.*)

This species also admits only of an incomplete diagnosis. It differs from *M. Waageni* chiefly by its thicker and lower volutions. The external margin is broader, the steep umbilical wall higher. The diameter is about 37·5 mm., the umbilical width 7 mm., the volution-height 18·5 mm. The ornamentation generally agrees with that of *M. Waageni*, but the ribs are somewhat coarser.

The suture-line is very well preserved and is strongly deflected forward between the first lateral saddle and the umbilicus. This disposition is not so evident as might be desired on the drawing of the suture, fig. 6 *d*, plate LXXVII, the artist having omitted to add a line representing the projection of the radius.

M. Kitchini is certainly specifically distinct from *M. Waageni*, as is evident from the very different outline of the cross-section. Fresh discoveries must be awaited to allow the framing of a more complete diagnosis. The original type is unfortunately disintegrating from the oxidation of the iron-pyrites which it contains; the older portion of the shell has already suffered severely.

Locality.—Gieumal.

SIMBIRSKITES, A. Pavlow.

SIMBIRSKITES NEPAULENSIS, Gray sp.

(Plate XLV A, fig. 1 *a—c.*)

Ammonites nepaulensis, E. Gray: Illustrations to Indian Zoology, Vol. I, 1830-32, pl. 100, figs. 1, 2.

Ammonites nepaulensis, H. F. Blanford, *in* Salter and Blanford: Palæontology of Niti, 1865, pl. XIV, fig. 1 *a*, *b* (*non* Blanford, 1863).

Stephanoceras nepaulense, W. Waagen: Cephalopoda from Kutch, *Palæontologia Indica*, Ser. IX, Vol. I, p. 136, pl. XXXV, figs. 2, 3.

Ammonites nepaulensis, Gray, *in* G. C. Crick: On Gray's Type-Specimens of Jurassic Ammonites from India, *Proceed. Malacolog. Society*, Vol. V, April 1903, p. 285; Strachey's Cephalopoda from Himalaya, *Geolog. Magazine*, Dec. V, Vol. I, 1904, p. 5.

The figures of *Amm. nepaulensis* from the Spiti Shales hitherto published are too imperfect to give a correct idea of this important species. It has therefore

been re-figured from the original specimen depicted by Blanford in plate 14, fig. 1, of the "Palæontology of Niti," the only one of the extant original specimens of which I was able to obtain a plaster-cast.

According to G. C. Crick's measurements the dimensions of this specimen are as follows: Diameter 121 mm., height of outer whorl 55 mm., height of outer whorl above preceding 38·5 mm., thickness of outer whorl 48 mm., width of umbilicus 29 mm.

The shell is somewhat inflated, with a rather narrow umbilicus. The cross-section is approximately oval, the greatest breadth occurring at about half the height of the volutions. From this level the cross-section tapers in both directions, the decrease in thickness being more gradual inwards than outwards, in consequence of which the shell is slightly cuneate towards the external margin. The external portion is strongly convex and proportionately narrow; the umbilical wall has a steep slope and is clearly marked off from the convex flanks.

The ribs originate as fine striæ on the umbilical wall and become slightly thickened as they pass on to the flanks. On the flanks they curve first backwards and then slightly forward, constituting strong, straight ridges up to half the height of the volution. At this level they reach their maximum thickness and break up into secondary ribs. One subsidiary rib branches off at half the height of the volution, a second one appears higher, so that for every rib present on the lower portion of the flanks, we find three on the upper portion. The subsidiary ribs are slightly inclined forward and, on the ventral face, they form an anteriorly convex arch. The number of main-ribs on the umbilical part of the last volution is 34.

I am unable to state how much of the last volution belongs to the body-chamber, nor can I express any opinion regarding the suture, since I have had no other material but a plaster-cast. H. F. Blanford states that the suture-line is not visible. According to G. C. Crick about two-thirds of the last volution may belong to the body-chamber. The oral margin and the anterior portion of the body-whorl have not been preserved.

With regard to the other two original specimens of *Amm. nepaulensis* from the Spiti Shales I am only acquainted with the figures in Gray's "Illustrations to Indian Zoology," supplemented by the observations of G. C. Crick (*loc. cit.*). There does not appear to be any essential difference between Gray's and Blanford's specimens, so much so that G. C. Crick was at first under the impression that Gray's figures (*loc. cit.*, plate 100, fig. 1), and those published by Blanford (Palæontology of Niti, plate 14, fig. 1) referred to the same specimen. This is not the case as was subsequently discovered by Crick himself, but it clearly indicates that the two specimens belong to the same species. Gray's type-specimen depicted in fig. 2, plate 100 of his work, could not be traced in London.

The form described by Waagen differs from ours owing to the smaller number of main-ribs (34 in our specimen, 29 in Waagen's) and the scarcity of the trichotomous ribs. Moreover, the external margin of our specimen is somewhat narrower, the umbilicus somewhat smaller, the cross-section narrower and

more decidedly tapering towards the external margin than in Waagen's form. Waagen's specimen from the Jurrassic of Kachh may therefore represent a species different from *S. nepaulensis*. As, however, Waagen's decision was arrived at from a direct comparison of the Kachh fossils with specimens from the Spiti Shales, we cannot but abide by it. In any case the Kachh and Himalayan forms even if distinct must be very closely related. According to W. Waagen immature specimens of *S. nepaulensis* have a widely different conformation.

S. nepaulensis (Waagen) occurs in the Kuntkote Sandstone of the Jurassic in Kachh (Uppermost Zone of the Oxfordian).

The exact locality of the figured specimen is not mentioned by H. F. Blanford in his Palæontology of Niti.

According to W. Waagen, *S. nepaulensis* is "one of the most characteristic species in the Spiti Shales in the Himalaya, and occurs there very likely together with *St.* [*Macrocephalites*] *Maya* in the lower region of the shales."

Simbirskites Koeneni, n. sp.

(Plate XLV, fig. 1 *a*—*c*.)

The shell is discoidal with a rather narrow umbilicus and tall whorls. The diameter is approximately 139 mm., the width of the umbilicus about 32 mm., the height of volution at the anterior end 62·4 mm., the maximum thickness measured over the rib 41 mm. The specimen is actually somewhat larger; for there exists a fragment of the foremost portion of the body-whorl which has not been figured owing to its poor state of preservation. The cross-section has on the whole an oval shape; the maximum thickness occurs half way up the flanks. The umbilical wall, the middle region of the flanks and the remarkably narrow external margin are convex, but the upper region of the flanks shows a slight flattening and wedge-like attenuation which gives the shell a very characteristic appearance.

The sculpture consists of strong, rather wide-spaced ribs, which start from the umbilicus, become slightly deflected forward and extend across the flanks with a shallow curvature. At about half the height of the volutions, the main-ribs divide into two weaker secondary ribs; while a third subsidiary rib, sometimes longer, sometimes shorter than the branch-ribs, is also intercalated. All the secondary ribs are strongly inclined forward and they become more massive on approaching the outer edges. The corresponding ribs from opposite sides of the shell coalesce across the external margin in the form of a convex arch strongly deflected forward.

The foremost unfigured portion of the body-whorl exhibits certain changes in the ornamentation: the secondary ribs become somewhat more numerous,

and, together with the main-ribs, become somewhat attenuated. If we correctly interpret this portion of the shell and are not deceived by its state of preservation, the cross-section also undergoes a change, becoming considerably contracted behind the oral aperture.

The chambered nucleus and suture are unfortunately unknown.

Besides the above described fragment of a body-chamber, we have had access to more fragments of body-whorls preserved in the Schlagintweit Collection at Munich. One of these does not exhibit any special feature worth mentioning, but the other is distinguished by the absence of the third secondary rib and the presence of an unbranched main-rib. It possibly represents a distinct species, which, however, would be closely related to *Simbirskites Koeneni*.

A glance at the figure will convince the reader of the close relationship between the present species and *Simbirskites nepaulensis*. *S. Koeneni* is not so densely ribbed; this is why the junction of the third secondary rib with the main-rib is not so distinctly marked as in *S. nepaulensis*. In the case of *S. Koeneni*, the ribs on the flanks and on the external margin are much more strongly deflected forward, the external margin is narrower, the flanks, in their upper region, are more decidedly flattened and more strongly inclined towards each other; the umbilicus is narrower and the shell less inflated than in *Simbirskites nepaulensis*. Amongst the species described by W. Waagen from the Jurassics of Kachh *S. fissus* Sow.-Waag. sp. is to be regarded as the closest ally. The ornamentation of *S. fissus* exhibits such slight differences as compared with that of *S. Koeneni* that I felt inclined at first to unite both species. But the greater thickness, the greater breadth of the external region, the different outline of the cross-section and wide umbilicus of *S. fissus* necessitate a specific separation.

It should perhaps be mentioned that a fossil from the Tithonian of Rodeo viejo in Argentina described by Behrendsen[1] under the name of *Hoplites protractus* is not unlike the Himalayan species. The Argentine fossil differs in its general appearance from the typical members of the genus *Simbirskites* owing to the exceptional massiveness of its ribs; but all the other characters agree remarkably well. It deserves to be carefully re-studied. It deviates essentially from genuine species of *Hoplites*, and its connection with *Simbirskites* is by no means improbable. At any rate, its coarse ribs, wide umbilicus, and low volutions preclude its identification with *S. Koeneni*.

The nearest Indian relative of *S. Koeneni*, *S. fissus*, occurs according to Waagen in the Dhosa Oolite and the Kantkot Sandstone (Lower and Upper Oxfordian).

The figured specimen of *Simbirskites Koeneni* was found between Ting Jung La and Chota Hoti (Coll. Griesbach). The two fragments in the Schlagintweit Collection are from Laptal, Ngari Khorsum. One of these fragments is full of belemnites, and consequently was probably derived from the lowest zone of the Spiti Shales, in which belemnites abound.

[1] Zeitschrift der deutsch. geol. Gesellschaft, 1894, p. 401.

SIMBIRSKITES, n. sp. ind.

(Plate LXXXI, fig. 2 *a*, *b*.)

It is to be regretted that this species is represented only by small internal cast consisting of limonite; in consequence of its poor state of preservation the diagnosis lacks the precision desirable. This form is evidently closely allied to *Simbirskites discofalcatus* Lahusen and *S. Phillipsi* (Roemer) Neumayr-Uhlig,[1] so that those who adhere to a wider conception of species may feel inclined to unite the Himalayan form with one of those species, especially *S. discofalcatus*. I prefer, however, to refrain from adopting this course, not only because the suture of the Indian species is not known, but also because its ribs are not so strongly inclined forward on the upper region of the flanks and are less convex on the external margin, and finally because the shell is somewhat broader at the upper part of the whorls and on the external region, and narrower on the lower part of the flanks than in the case of *S. discofalcatus* and *S. Phillipsi*. The wedge-like attenuation of the upper region of the whorls and the contraction of the external region so characteristic of the Lower Cretaceous species of *Simbirskites* are much less pronounced in the present species and the latter therefore cannot be united with either of the above-mentioned Lower Cretaceous forms. In any case, however, the relationship to *S. discofalcatus* Lahusen is well worth mentioning, and we may look forward with great interest to fresh and more complete finds of this species.

The specimen is from the Kiangur Pass (Coll. Diener).

KOSSMATIA, n. gen.

KOSSMATIA TENUISTRIATA, Gray sp.

(Plate XCI, fig. 3 *a*, *b*.)

Ammonites tenuistriatus, Gray: Hardwicke's Illustrations to Indian Zoology, I, 1830-1832, pl. C, fig. 4.

Ammonites tenuistriatus, Gray: H. F. Blanford *in* J. W. Salter and H. F. Blanford, Palæontology of Niti, 1865, pl. XV, fig. 2 *a*—*c* (*non* pl. XIV, fig. 2); *non* H. F. Blanford, 1863.

Perisphinctes tenuistriatus (Gray): Siemiradzki, Monographie d. Gatt. Perisphinctes, *Palaeontographica* 45, Stuttgart, 1898-1899, pl. XXI, fig. 20, p. 204.

Ammonites tenuistriatus, Gray, *in* G. C. Crick, Jur. Amm. from India, *Proceedings Malacological Soc.*, Vol. V, 1903, p. 288; Cephalopoda in the Strachey Collection from the Himalaya: *Geological Magazine*, Dec. V, Vol. I, 1904, p. 7.

In the "Palæontology of Niti" H. F. Blanford expressed the opinion that the present form is only a variety of *Amm. nepaulensis*. Although our present conception of a variety is much narrower than at the time of our distinguished predecessor, yet we must admit with him that the relationship of the present species to *Amm. nepaulensis* is of the closest character. In any case H. F.

[1] As regards these species, the following works are specially worth consulting: A. Pavlow, *Crétacé inf. de la Russie et sa faune* (p. 78, pl. VI, fig. 1; VII, fig. 2, 3), and A. v. Koenen, *Untere Kreide Helgolands* (p. 28).

Blanford's views regarding the relationship of *Amm. tenuistriatus* are more correct than those of Stoliczka, who placed this species next to *Amm. Sabineanus* The association proposed by Blanford is also better inspired than that suggested by Siemiradzki who united *Amm. tenuistriatus* with the cycle of *Perisphinctes planula* and placed it together with the latter in the subgenus *Ataxioceras* Fontannes.

It is true that the ribs are much finer and more crowded than in *S. nepaulensis* Gray or *S. eucyclus* Waag., but their course, their retrograde curvature along the junction of the lateral and umbilical regions, and their pronounced anterior deflection on the upper part of the flanks and on the external region remind us forcibly of the structural features of *Simbirskites*. Individual ribs remain single, but the majority of them are bifurcate. Trichotomous ribs occur in the small specimen represented on plate. 91, fig. 3. On the external margin the ribs form an anteriorly convex arch strongly deflected forward.

The shell is flat, with a rather tall oral aperture; the flanks are feebly arched, nearly flat; the external region is strongly convex, sloping rather decidedly towards the flanks. The cross-section has the shape of an elongated ellipse; the suture is unknown.

The only material at my disposition for a study of this species consists of plaster-casts of the two specimens figured in plate XV of the "Palæontology of Niti." According to G. C. Crick the larger of these specimens is also Gray's original type. It was figured a third time by J. v. Siemiradzki in his *Perisphinctes* monograph. We cannot avoid adding a fourth illustration of this important species; for although Siemiradzki's illustrations include an excellent figure of the lateral aspect, the very important marginal aspect has been omitted.

The exact locality of the figured specimens is not known. They are probably from the Niti Pass.

Failing a direct comparison with the original types, I hesitate to express any definite opinion regarding the possible relationship of *Kossmatia tenuistriata* to the apparently very similar *Odontoceras permulticostatum* Steuer[1] or *Perisphinctes permulticostatum* (Steuer) Burckhardt.[2] According to Steuer, the ribs on the external margin of the inner volutions are interrupted, and this feature would preclude any close relationship with the Indian species.

KOSSMATIA, n. sp. ind.

(Plate XCI, fig. 2 *a*, *c*.)

Ammonites tenuistriatus, Gray: H. F. Blanford, *Journ. Asiat. Society*, Calcutta, 1863, Vol. XXXII, p. 129 (*non* Blanford, 1865).

This species is represented by an external cast of the chambered nucleus, the body-whorl being preserved as a very incomplete internal cast, but a satis-

[1] Argentinische Juraablagerungen, *Palaeontol. Abhandl., neue Folge*, Vol. III, 1897, p. 56. pl. VI, fig. 2.

[2] Burckhardt, Profils géolog. transvers. de la Cordillère Argentine-Chilienne, La Plata, 1900, p. 47, pl. XXVII, fig. 4.

Jura und Kreide der Kordillere, Palaeontographica, Vol. 50, p. 59.

factory diagnosis is unfortunately out of question, and I have refrained therefore from creating a new specific name.

The ornamentation closely resembles that of *K. tenuistriata*. The ribs are somewhat less crowded; unbranched ribs are much fewer. Moreover, the posterior convexity of the ribs along the flanks is somewhat more distinct than in *K. tenuistriata*. The differences in the shape of the shell are more important. The shell of *Kossmatia* n. sp. ind. has a much wider umbilicus, the volutions are lower and somewhat thicker. The diameter is approximately 71 mm., the width of the umbilicus 31 mm., the height of volution 23 mm., to a thickness of about 21 mm. The differences in the dimensions are so great that it is impossible to unite the present species with *K. tenuistriata* as suggested, although hesitatingly, by H. F. Blanford.

The body-whorl appears to be smooth at its anterior end, but this is perhaps only a deceptive appearance due to its indifferent state of preservation. Blanford states that the body-chamber contains a fine impression of an *Aptychus*. In reality the supposed *Aptychus* is a *Nucula*.

The exact locality is unknown.

KOSSMATIA DESMIDOPTYCHA, n. sp.

(Plate XLVII, fig. 2 *a*—*d*; plate XCI, fig. 4.)

The shell is disc-shaped with a diameter of 92 mm., an umbilical width of 28 mm., a volution height of 40 mm., and a maximum thickness of 25 mm. The volutions have a tall oral aperture, and overlap by nearly half their height. The cross-section has the shape of a very elongated oval, almost an elongated rectangle with rounded off angles. The flanks are so slightly arched as to be almost flat; the umbilical wall is rounded, rather low and steep; the external region is rounded, though somewhat flattened along the medial band.

The inner volutions are very low, with a slow rate of increase, and the ribs which ornament them exhibit a very pronounced anterior deflection. The number of ribs on the innermost distinctly recognisable volution is 25; it is 38 on the next whorl, the following carrying 52, while the last volution, which partly belongs to the body-chamber, has at least 70 densely crowded ribs. On the last whorl the ribs are moderately deflected forward up to half their height, beyond which they break up into fascicles of fine secondary ribs and assume a slight retrograde curvature, bending once more decidedly forward close to the external margin. Each main-rib gives rise to a bundle of 2 to 4 secondary ribs, besides which single intercalary ribs are inserted along the external margin. On the body-whorl there are 36 short secondary ribs to every ten main-ribs. On the external margin, the ribs form an anteriorly convex arch which is reduced or even interrupted along the middle line.

The first lateral lobe is somewhat longer than the external lobe; its trunk is rather broad, the terminal branch long and narrow, the inner principal lateral branch somewhat weaker than the outer one. The second lateral lobe is much shorter and simpler and it is scarcely or not at all obliquely disposed. It is only on reaching the first auxiliary lobe that the suture commences to exhibit a slight downward tendency. The saddles are fairly broad; the inner segment of the external saddle is subdivided into two adventitious inflections by an elongated, oblique adventitious lobe.

The specimen represented on fig. 4 of plate XCI generally agrees fairly well with the large specimen represented in fig. 2, plate XLVII. In the latter instance the main-ribs are specially prominent on the middle portion of the flanks so that it is exceptionally easy to trace their passage into rib-bundles. The specimen depicted in fig. 4 of plate XCI stands somewhat apart; for here the main-ribs are somewhat wider spaced, and the subsidiary ribs somewhat more strongly developed. The discovery of more perfect specimens may perhaps reveal additional diagnostic characters necessitating the creation of a separate species. Judged from a plaster-cast, the specimen figured by H. F. Blanford as *Ammonites tenuistriatus* Gray (?) in plate 14, fig. 2, of the "Palæontology of Niti" is perhaps specifically identical with the form just now referred to. The fragment in question is indifferently preserved. In any case it stands nearer to *Kossmatia desmidoptycha* than to *K. tenuistriata*.

Kossmatia desmidoptycha is very closely related to a form from the Tithonian of Stramberg, which Zittel has united with *Amm. Richteri* and figured under that name. Unfortunately this form[1] is only represented by a fragment; better specimens would probably reveal its specific distinctness from *Amm. Richteri*. In the Stramberg form, too, the main-ribs are very densely crowded and break up into bundles of 2 to 4 fine secondary ribs on the outer region of the flanks. The resemblance to *Kossmatia desmidoptycha* is so great that we should feel inclined to assume specific identity, were it not for certain differences in the shape of the shell. The external region in the Stramberg species is narrower and more strongly arched; the upper portion of the flanks is more strongly inclined and less distinctly marked off from the external margin than in the Indian species. In any case the relationship is very close.

Compared with *Kossmatia tenuistriata*, *K. desmidoptycha* is distinguished by its much stronger main-ribs, breaking up into several branches, while *K. tenuistriata* exhibits nothing but dichotomous and even undivided ribs. Moreover, in the case of *K. desmidoptycha*, the ribs exhibit a slight forward convexity on the middle region of the flanks, which is not observed in *K. tenuistriata*. Finally the volutions of *K. desmidoptycha* are somewhat thicker, while their external and lateral regions are somewhat more flattened.

K. desmidoptycha is represented by 4 specimens. The one figured on plate XLVII, fig. 2, is from Lochambelkichak, Middle Stage, the others are from Kuti, Upper and Middle Spiti Shales (Coll. von Krafft and F. H. Smith).

[1] Zittel. Fauna der Stramberger, Schichten, p. 108, pl. 20, figs. 10, *non* figs. 9, 11, 12.

PERISPHINCTES, Waagen.

As is well known, it is very difficult to arrive at a precise definition and natural arrangement of the forms constituting the genus *Perisphinctes* in the wider sense of the term. Ever since the first foundations of a comprehensive scheme of classification were laid down by Waagen,[1] Neumayr,[2] and Ammon,[3] numerous attempts have been made to evolve an intelligible and orderly arrangement out of the chaotic crowd of forms designated by the group name of "Planulati"; yet in spite of all efforts, it cannot be said that the results so far arrived at are wholly satisfactory. Undoubtedly, however, considerable progress has been made in so far as certain groups have been more sharply defined and in certain instances characterised as subgenera.

Several of the well circumscribed groups which Neumayr had included in his comprehensive genus *Perisphinctes* have now been separated as independent genera, for instance *Proplanulites* Teiss., *Virgatites* Pavlow, *Craspedites* Pavlow, *Pictonia* Bayle. Subsequently the genus *Perisphinctes* which had thereby been rendered somewhat more homogeneous was subdivided by Siemiradzki[4] into five subgenera: *Ataxioceras* Fontannes, *Choffatia* Siemir., *Grossouvria* Siemir., *Biplices* v. Sutner, *Perisphinctes sensu stricto*, and *Procerites* Siemir. To these, Hyatt[5] added the genera *Lithacoceras* (type: *Ammonites ulmensis* Oppel) and *Siemiradzkia* (type: *Ammonites Bakeriae* d'Orb.[6]).

But these attempts at a precise and detailed subdivision of the cycle of *Perisphinctes* are by no means final as is particularly evidenced by a study of the fauna of the Spiti Shales. We have already considered one form, *Ammonites tenuistriatus*, which hitherto has been unhesitatingly accepted as a genuine *Perisphinctes*, but which is, nevertheless, derived from the genus *Macrocephalites* or more exactly *Simbirskites* from which it cannot have originated earlier than the period of the Middle Malm; consequently it cannot have originated from the same stock as *Grossouvria* and other *Perisphinctes* groups whose origin dates back as far as the Bathonian.

Perisphinctes therefore, like so many of the older comprehensive genera of Ammonoids, turns out to be polyphyletic. But with respect to this genus *Perisphinctes* the task of the palæontologist is by no means completed by the establishment of a few subgenera; it is far more important to trace the various branches of this heterogeneous group to their true points of origin, so far as the present state of information renders this possible.

[1] Jurassic Fauna of Kutch. *Palæontol. Indica*, Ser. IX, Vol. I, p. 143.

[2] Acanthicus Schichten, p. 170.

[3] Jurabildungen Zwischen Regensburg und Passau.

[4] Monographie der Gattung Perisphinctes. *Palaeontographica*, Vol. 45, p. 76.

[5] Zittel-Eastman, Textbook of Palæontology, London, 1900, p. 581.

[6] Hyatt connects *Siemiradzkia* (*Amm. Bakeriae* d'Orbigny, Pal. Franaise, Jur. I, pl. 149, fig. 1, *non* pl. 148) with *Aspidoceras*, which does not seem correct: *Ammonites Bakeriae* is related to *Grossouvria*.

The present monograph cannot aim at a full accomplishment of this difficult and gigantic task. All we can do is to follow up, so far as possible, those groups which play a part in the Fauna of Spiti.

A.—The GROSSOUVRIA Group.

We shall commence our investigation with two forms which belong to the genus *Grossouvria*, that is to the well-known group of *Perisphinctes auriger* and *Perisphinctes curvicosta*. Neumayr thought that he could trace back this group to *Perisphinctes Martinsi* from the Lower Oolite; but subsequently Grossouvre recognised that, instead of being related to *Amm. curvicosta*, this species is connected with the group of the *Proceri*. This view has also been adopted by Siemiradzki.[1] The *Grossouvria* stock has therefore no connection with *P. Martinsi*, but makes its appearance suddenly. It is to be hoped that fresh finds will clear up the mystery of its derivation and indicate its origin.

Under the name of *Grossouvria*, J. von Siemiradzki has classified a considerable number of forms, including, amongst others, the group of *Amm. Sabineanus* Oppel. We have found it necessary to separate the *Sabineanus* group which we have raised to the rank of a genus under the name of *Paraboliceras*, because, although allied to *Grossouvria*, it is very distinct from the geologically older types of this genus. Perhaps Siemiradzki has also included some other foreign elements in his genus *Grossouvria*. There is only one species from the Spiti Shales belonging to the genus *Grossouvria*, and as this genus has been sufficiently well described in previous publications, a revision is superfluous. In the following pages we shall content ourselves, therefore, with a detailed diagnosis of the genus *Paraboliceras*, with only some brief references to the genus *Grossouvria*.

The group of *Grossouvria* as is well known is characterised by the strong development of the so-called "parabolas." Parabolas are by no means restricted to this group, but they certainly acquire, in its case, considerable importance. Before attempting a systematic treatment of the *Grossouvria* group, we shall make a few remarks concerning these parabolas so as to explain the terminology adopted in the following descriptions.

The most generally accepted opinion regarding the parabolas is that of L. Teisseyre[2] who made a special study of this feature, and came to the conclusion that they should be regarded as the remnants of former oral margins. In accordance with the views prevailing at the time when he wrote, Teisseyre looked upon the parabolic curves not as the actual margin of the previous oral apertures, but as a limiting line of resorption. According to Teisseyre's opinion, the growth of the marginal portion of the shell was interrupted during the period

[1] Monographie der Gattung Perisphinctes, pp. 71, 327.

[2] Cephalopoden vom Ornatenton d. Gouv. Rjazan: *Sitzungsber. d. kaiserl. Akademie der Wissensch. Wien*, Vol. 88, I, p. 698. Systematische Bedeutung der sogennanten Parabeln bei Perisphinctes: *Neues Jahrb. für Min. Geol. und Pal.*, Supplementary Vol. VI, p. 570.

of construction of new septa, and during these pauses there existed a temporary oral edge which became resorbed previously to growth being resumed. The parabolic curve is supposed to represent that line up to which resorption took place before the recurrence of growth.

The formerly prevalent idea of an extensive resorption of certain parts of the ammonoid shells has not been confirmed by recent researches, and it seems more correct to suppose that the parabolas actually represent temporary oral apertures. The parabolic curves are to some extent homologous with the larger frills which ornament at intervals the shell of *Lytoceras exoticum* as has already been mentioned when dealing with the latter species. In certain forms, especially those belonging to the genus *Paraboliceras*, the number of septa during the main period of development coincides with that of the parabolas; sometimes, however, particularly in the case of *Grossouvria*, the number of septa is fewer. In connection with this one notices that in addition to the parabolas, *Grossouvria* also exhibits anteriorly deflected constrictions which must also be regarded as the traces of the formal oral margins.

Teisseyre distinguishes the following parts in the parabolas: a short, sometimes smooth, sometimes slightly ribbed *external lappet* or *external tongue* which in some cases is elongate-rounded, in other cases truncate; on either side of the external tongue, the small, but rather deep and rounded external parabolic *sinus;* next, the broad, short, rounded *lateral lappets;* lastly, the broad, posteriorly deflected *umbilical sinus.* In many cases the parabolar line is fine; in other instances it swells up on the flanks into a parabolar rib, the umbilical part of which is sometimes strongly thickened. In consequence of its posteriorly deflected disposition, the parabola approaches the preceding rib on the umbilical wall or still more frequently becomes confluent with it, thus giving rise to the formation of rib-fascicles. In this manner each parabola corresponds to a rib-fascicle: hence the presence of fascicles indicates the existence of parabolas even in cases when the latter have not been preserved or where they are hidden by succeeding volutions. Owing to the parabolar rib being, as a rule, deflected forward, while the preceding rib is more radially disposed, they come to enclose a triangular area with its broader base situated outward; this area is occupied by one or two secondary ribs. These short secondary ribs arise from the preceding rib and extend in an outward direction no farther than the external parabolar sinus. In forms where the parabolar ribs are only slightly inclined forward the secondary ribs just referred to are entirely absent, not having developed for want of space between the parabolar rib and previous rib. In this case the parabola is accompanied by two nearly parallel ribs, which coalesce into parabolar tubercles. This feature is beautifully illustrated in the case of *Grossouvria claromontana* Bukowski[1] from the Oxfordian of Czenstochau in Poland and by *Paraboliceras rectecostatum* n. sp. In this species the parabolar rib is so slightly deflected backward that it does not meet the preceding rib,

[1] *Beitrage zur Palaontologie Oesterreich-Ungarns*, Vol. V, pl. 28, figs. 2—4, p. 144.

and thus both ribs start independently at the umbilical suture without forming a fascicle.

When growth was resumed, it commenced at the parabola, the shell developing its regular sculpture, while the external parabolar sinus became filled by shell-substance, the portion of the shell thus produced being either flat or projecting in the manner of a tubercle. As already noticed by Teisseyre the parabolar tubercles which are especially prominent in *Paraboliceras* do not constitute thickenings of the shell-substance, but represent inflated corrugations coinciding with internal cavities, so that the tubercles are just as prominent on internal casts as on specimens with the shell preserved. Nevertheless, the real parabola in *Paraboliceras* can never be observed on internal casts, but only on specimens with the shell well preserved, or in the form of impressions on the dorsal face of the succeeding volution (see *Paraboliceras* sp., plate XLV, figs. 2 *c*, 3 *c*; plate XLIV. fig. 6 *b*).

This mode of preservation clearly shows that the parabola belongs exclusively to the porcellaneous layer. The temporary edge of the oral aperture consisted only of the outer porcellaneous layer which during the further growth of the animal became lined by an inner pearly layer. The parabola could, therefore, leave no trace on the core.

It follows from what precedes that the process of growth was the opposite of that observed in *Lytoceras exoticum*. Whilst in the case of *Lytoceras exoticum*, as has already been explained on page 10 of the present volume, the development of the inner pearly layer takes place previously to that of the outer porcellaneous layer which is subsequently deposited as an external lining outside the former, in the case of *Paraboliceras* it is the outer porcellaneous layer that is formed first and is subsequently lined on its inner surface by the pearly layer. Unfortunately the specimens from the Spiti Shales are nearly all in the shape of external casts, so that it is usually impossible to observe these interesting features which are of so much importance in the elucidation of the biological relations of the Ammonoids.

Teisseyre has shown that in the species from the Dogger the parabolas are few on the inner whorls, but that their number gradually increases during the middle stages of growth, the maximum frequently being reached before the commencement of the final body-chamber. On the middle and the anterior portion of the latter parabolas are wanting. Generally speaking, this is also the rule with *Paraboliceras*, but in this genus considerable fluctuations are noticeable regarding the number of parabolas and the exact stage at which they cease to be produced. In any case two kinds of changes must have taken place in the oral margin during the development of an individual: the first occurred in early youth simultaneously with the formation of the first parabola; the second coincides with the cessation of the construction of parabolas and occurs approximately just before the commencement of the last volution. From here onwards the temporary oral edge ceased to have the form of a parabola. Consequently

the various parts of the final oral edge do not exactly correspond with the equivalent parts of the parabola, for the shape and position of the final external sinus and lateral lappets differ from those of the external parabolar sinus and the lateral lappet of the parabolar curve.

Up to the present palæontologists have not yet been entirely successful in elucidating the real nature and functions of the external parabolar sinuses and parabolar tubercles; they are perhaps connected with the advent of sexual maturity. Similarly we are ignorant concerning the significance of the alternation of ordinary "constrictions" and parabolar curves emphasized by Teisseyre.

We will now proceed to a discussion and comparison of the genera *Grossouvria* Siemiradzki *sensu stricto* and *Paraboliceras* nov. gen.

Almost all the species belonging to the genus *Grossouvria* are of small or moderate dimensions (*Tachygerontes* Teisseyre); their external parabolar sinus is filled up by a plate which is flat or slightly ribbed and only rarely inflated into a kind of tubercle. The parabolar ribs are in most cases scarcely prominent. The parabolas are invariably fewer than the septa, and in addition to the parabolas there always occur "constrictions" which are steeply deflected forward. The maximum development of the parabolas coincides with the more anterior portion of the chambered nucleus and the commencement of the body-chamber. The oral edge of the final body-chamber, the anterior portion of which is devoid of parabolar curves, is drawn out into long, sabre-shaped lateral lappets. The cross-section of the volutions is invariably low, roundish-square or elliptic.

The ribs are curved backwards on the outer part of the flanks and on the external margin. Certain forms exhibit this striking and very characteristic feature in an extreme degree, while in others it is merely evident and in others again scarcely perceptible. In exceptional cases, such as that of *Perisphinctes claromontanus*, there is no trace of a curvature of the ribs.

The disposition of the suture varies considerably. In some forms the external lobe is longer than the first lateral lobe, in others it is shorter. Sometimes the second lateral lobe is well developed, at other times it is hemmed in and impeded in its free development by the close approach of the first auxiliary lobe and first lateral lobe. All the species exhibit a comparatively scanty ramification of the lobes, further a pronounced retrograde deflection of the auxiliary lobes, and an unsymmetrical configuration of the first lateral lobe, the latter feature being due to the stronger development and the higher position of the outer lateral branch.

Most of the forms which we have thus briefly characterised belong, as is well known, to the upper stages of the Lower Oolite, that is, the Bathonian and Callovian; they include *Grossouvria curvicosta* Oppel, *Gr. euryptycha* Neumayr, *Gr. aurigera* Oppel, *Gr. subaurigera* Teisseyre, *Gr. rjasanensis* Teisseyre, *Gr. mosquensis* Fischer, *Gr. scopinensis* Neumayr, *Gr. crassa* Siemir., *Gr. gracilis* Siemir., *Gr. Steinmanni* Par. Bon., *Gr. Teisseyri* Par. Bon., *Gr. lateralis* Waagen, *Gr.*

subnudata Nikitin, *Gr. meridionalis* Siemir., *Gr. pseudomosquensis* Teiss.-Siemir., *Gr. Gleimi* Steinmann, *Gr. de Mariæ* Par. Bon., *Gr. arcicosta* Waagen, and many others.

The form described by Oppel under the name of *Ammonites aurigerus* (*Ammonites Bakeriæ* d'Orbigny, Pal. française, plate 149, fig. 1, plate 148) has been chosen by Hyatt as the type of the genus *Siemiradzkia*, which he places near *Aspidoceras*. Neumayr has already demonstrated that *Aspidoceras* has branched off from the *aurigerus*-group (Ammoniten der Kreide, p. 939); it does not seem proper, however, to place *Ammonites Bakeriae* in *Aspidoceras*, but it is better to leave it in the neighbourhood of *Grossouvria*. Whether it should properly be admitted as a member of that genus, or elevated to the rank of a separate genus, can only be decided after a special investigation.

The Oxfordian forms diverge from the Callovian types in many important respects. The cross-section is frequently roundish, and the ribs are very strongly curved backwards. We may especially mention *Grossouvria frickensis* Mösch, *Gr. mira* Buk., *Gr. Marsyas* Buk., *Gr. variabilis* Lah., *Gr. interrogationis* Siemir., *Gr. præcursor* Waagen, *Gr. Bukowskii* Choffat.

A separate mutational tendency is represented by *Gr. claromontana* and *Gr. mazurica* Bukowski, and by *Gr. birmensdorfensis* Mönch.

Connected with these are certain stunted forms and scaphitoid types from the Kimeridgian, such as *Amm. eumelus* d'Orb., *cyclodorsatus* Mösch, and the genus *Sutneria* Zittel. Larger specimens, however, which undoubtedly belong to the typical forms of *Grossouvria* appear to be very scarce or entirely absent from this stage.

Only one fossil from the Spiti Shales exhibits characters coinciding with the above definition of the genus *Grossouvria*: this is an ammonite which F. Stoliczka referred to *Ammonites curvicosta* Oppel and which is here described under the name of *Grossouvria propinqua* n. sp.

The new genus *Paraboliceras*, on the other hand, is very abundantly represented. It includes the following species:—

Paraboliceras Jubar (Strachey) Blanford sp.
" *rectecostatum* n. sp.
" *cyrtoptychum* n. sp.
" *Sabineanum* Oppel sp.
" *tibeticum* n. sp.
" *himalayanum* n. sp.
" *Haugi* n. sp.
" *polysphinctum* n. sp.
" *mutilum* Oppel sp.
" *Griesbachi* n. sp.
" *Pompeckji* n. sp.
" *spitiensis* n. sp.
" sp. ind. cf. *spitiensis* n. sp.

Paraboliceras n. sp. ind.
„ *fascicostatum* n. sp.
„ n. sp. ind.
„ n. sp. ind. aff. *fascicostatum* n. sp.

In these species the external parabolar sinuses are, without exception, inflated in the manner of tubercles, which are often very distinct and which, in a number of cases, are almost as prominent as the spines of the *armati*. The parabolar ribs are also strongly developed in the majority of cases. Moreover, the parabolar tubercles are very numerous, and in the middle stages of growth their number corresponds with that of the septa. Ordinary constrictions are entirely absent.

In some forms the ribs are rather straight; in others they assume a more sigmoidal curvature; in all forms, however, we observe a more or less pronounced anterior deflection of the ribs on the external margin as well as on the peripheral part of the flanks, this anterior deflection strongly contrasting with the backward curvature of the ribs in the genus *Grossouvria*. With regard to the degree of prominence of the ornamentation one observes every gradation from moderately fine ribs to coarse ribs like those of *Ammonites mutilus* Oppel. Generally speaking the ribs are more sharply defined and at the same time more massive than in the forms from the Callovian and Oxfordian. In every case the ribs of the inner volutions are more decidedly deflected forward than those of the outer whorls. This difference is specially striking in the case or *Paraboliceras rectecostatum*.

Whilst in *Grossouvria* the shape of the cross-section is that of a very much depressed rectangle or sometimes trapeze with rounded angles, in all the forms of the genus *Paraboliceras* it is tall and elongately elliptical, with slightly rounded flanks, rounded, obliquely sloping umbilical walls and a slightly flattened or rounded external margin.

The proportion of volution-height to thickness is usually 3 : 2, rarely 5 : 3 or 4 : 3. In a very few species the shape of the cross-section slightly approaches that of a rectangle with rounded corners, but even then the height is much greater than the width.

Grossouvria sensu stricto only includes small or, at most, medium-sized forms. The species of *Paraboliceras*, on the other hand, with the exception of the medium-sized *P. rectecostatum*, are always of large and even of very large size. The type specimen of *Paraboliceras Sabineanum* Opp. may have attained a diameter of at least 140 mm. at the commencement of the body-chamber. In an undeterminable fragment of a body-chamber from Chidamu the volution height is 70 mm.

The suture agrees with that of the *curvicosta*-group in so far as the outer lateral branch of the first lateral lobe is also placed at a higher level and is more strongly developed than the inner one. The second lateral lobe is, as a rule, stronger and more complex than in *Grossouvria*, the three auxiliary lobes

not so strongly deflected backwards. The greater complexity of the inflections is probably due to the considerable size attained by the species of *Paraboliceras*. Taken as a whole the sutural inflections of *Paraboliceras* are related to those of *Grossouvria* very much in the same way as those of the Neocomian *Hoplites* as compared with the group of their Perisphinctid precursors with ventral furrow.

Unfortunately the body-whorl is never completely preserved, though several specimens exhibit the commencement of the body-chamber. At this stage the sculpture generally exhibits a tendency to become coarser. In the majority of forms the maximum development of parabolar tubercles appears to take place on the penultimate whorl. In individual forms the body-chamber still bears isolated tubercles near its commencement, but they disappear further on. Only in *Paraboliceras fascicostatum* do the tubercles cease to be formed at an earlier stage.

The oral margin is unknown.

The species constituting the genus *Paraboliceras* exhibit considerable differences. A tall cross-section, straight ribs, and numerous strong parabolar tubercles characterise *P. Sabineanum* Oppel sp. and *P. tibeticum*; connected with these species we find a series of forms with thick sigmoidal ribs and strongly convex external margin, including *P. Pompeckji*, *P. himalayanum*, *P. Griesbachi*, and *P. spitiense*. A relatively low and broad cross-section, strong and rather wide-spaced ribs, and a small number of parabolar tubercles constitute the chief characteristics of *P. Jubar*.

Closely related to *P. Jubar* may be placed *P. cyrtoptychum* and *P. rectecostatum*, the latter bearing straight ribs, while in the former they are remarkably curved. *P. mutilum* Opp. represents a crassicostate form, and *P. polysphinctum* is distinguished by the deeply excavated furrows between the rib-bundles. In *P. Haugi* massive trichotomous ribs appear on the body-chamber, and to this species are linked on the one hand species in which the cross-section tends to assume a trapezoidal shape, and, on the other hand, species characterised by a feeble development of tubercles and an early appearance of trichotomous ribs, such as *P. fascicostatum*.

The latter species exhibits a certain amount of convergence towards *Kossmatia desmidoptycha*. One might easily be led to look upon these forms as closely related, if one only took into account the type of ribbing observed in full-grown specimens. On closer inspection it becomes evident that *Kossmatia desmidoptycha* does not exhibit the least trace of parabolas, while the shape of the cross-section and the type of ornamentation bring it close to *Kossmatia tenuistriata* which is unquestionably related to the *Macrocephalites*-stock.

The genus *Paraboliceras* is closely connected with *Grossouvria* by quite a number of important characters, but decidely deviates from it, representing a younger and, as far as we can judge, a more advanced stage of development of the *curvicostati*-stock.

The divergence between the genera *Paraboliceras* and *Grossouvria* is expressed by the shape of the shell and cross-section as well as the ornamentation, *Paraboliceras* being distinguished by the absence of ordinary constrictions, the part played by the parabolas and even in the peculiarities of the suture-line. There is perhaps a greater advance from *Grossouvria* to *Paraboliceras* than there is from certain *Perisphinctes* with a ventral furrow to their descendants, the primitive *Hoplites*, *Blanfordia* and *Berriasella*. All visible characters are affected by this divergence, and this fact not only justifies but necessitates the separation of the younger group as a special genus, *Paraboliceras*.

Up to the present, the genus *Paraboliceras* appears exclusively restricted to the Spiti Shales. The Jurassic of Kachh, so far as known, has not yielded any forms that can be placed in this genus.

PERISPHINCTES (GROSSOUVRIA) PROPINQUUS, n. sp.

(Plate XLIV, fig. 5.)

Ammonites curvicosta Stoliczka, 1866, *Mem. Geol. Survey of India*, Calcutta, Vol. V, p. 105.

Dimensions :—

Diameter	49 mm.
Width of umbilicus	21·2 „
Height of last volution	15 „
Thickness	15·8 „

The specimen determined by Stoliczka as *Ammonites curvicosta* Oppel is indeed very closely related to the species from the Kellaway-Stage, but cannot be specifically identified with it.

The shell has a wide umbilicus and volutions whose cross-section is almost circular. Each volution bears 44 ribs, which, on the older parts of the shell, are fairly straight and radially disposed, while at the anterior end they exhibit a slight curvature. Above the middle of the flanks the ribs subdivide in a regular fashion and pass right across the ventral face without becoming appreciably reduced. The number of parabolas cannot be exactly ascertained, but their nature is clearly discernible in several places. The smooth external arch is rather short and anteriorly truncate; the external parabolar sinus does not exhibit any tubercular thickening, but is flat. The lateral lappet also is nearly smooth and only shows traces of a short rib. The ribs of the parabolar bundles are feebly developed, as is also the true parabolar rib, which is distinctly visible only in the umbilical region. At one place, in the anterior portion of the last volution, there exists a slight constriction in which is situated a short feeble secondary rib.

The disposition of the suture-line and the nature of the body-chamber are both unknown. The specimen is entirely chambered, traces of the antisiphonal

lobe being visible in contact with the external margin of the penultimate volution at the anterior end of the preserved portion of the shell. Slight traces of an outer whorl can be detected on the flanks of the last volution; the specimen was, therefore, larger by at least one complete volution.

P. propinquus differs from *P. curvicosta* owing to the more numerous ribs, amounting to 44, while, according to Siemiradzki, there are only 36 in *Amm.* (*Perisphinctes*) *curvicosta*. The branch-ribs of *P. curvicosta* always exhibit a distinct backward curvature, whilst in the present species, especially at its anterior end, one notices a distinct anterior deflection, after the manner of the *Parabolicerus* species of the Spiti Shales. Finally the cross-section is round, while in *P. curvicosta* it is tall and rounded-oblong or oval. *P. propinquus* shares with the curvicostate types described by Waagen from Kachh the subcircular shape of the cross-section; but the ribs of the latter are strongly curved backwards so that it is not possible to unite it with these types. The affinity of the present species to *P. variabilis* Lahusen[1] is still more decided than its relationship with *P. curvicosta*. In *P. variabilis* the ribs exhibit a slight anterior deflection similar to that observed in *P. propinquus*, but *P. variabilis* has more decidedly flattened flanks and fewer ribs, so that a specific identification with this species is equally out of question. *Perisphinctes tenuis* Siem. and *P. polonicus* Siem. have suborbicular volutions, but their ribs are strongly deflected backward, so that these forms cannot either be taken into account. Amongst the forms of the Oxfordian stage *P. frickensis* Mösch and *P. mirus* Buk. exhibit the same subcircular cross-section as *P. propinquus*; but their ribs are so few and so decidedly sigmoidal that it is not possible to specifically identify the Indian form with either of these species.

The relatively small height of the whorls, the absent or scarcely noticeable anterior deflection of the ribs, and finally the feeble development of the parabolar tubercles connect *P. propinquus* more intimately with the geologically older forms than with the *Sabineanus-Jubar* group (subgenus *Paraboliceras*). A knowledge of the suture would enable us to form a still more definite opinion regarding the classificatory position of *P. propinquus*: the suture of *Grossouvria*, as has already been mentioned in the introduction to the genus, exhibits a more primitive perisphinctoid type than in *Paraboliceras*. Taking palæontological facts, so far as known, into consideration, it seems probable that *P. propinquus* occupies a somewhat lower position in the sequence of the Spiti Shales than the *Sabineanus* group. This matter will be discussed in the concluding chapter of the work.

P. propinquus is represented by one specimen from Chikkim.

[1] *Mem. Com. géol.* Vol. 1, St. Pétersbourg, 1883, pl. X, fig. 4, pp. 68, 84. According to Nikitin (Dép. jur. env. Syzran et Saratow. Pétersbourg, 1888, p. 9) a form figured by Sinzow (*Mém. Com. géol.*, *Pétersbourg*, Vol. VII, 1888, p. 116) as *Aspidoceras perisphinctoides* is identical with *Perisph. variabilis*. According to Siemiradzki *Perisph. erexus* Siemiradzki is also synonymous (Zeitsch. Deutsch. geol Gesellsch., 1894, pl. 38, fig. 5; *Paläontographica*, Vol. 45, p. 116). *P. variabilis* has been lately described by G. Lee from the Southern Jura region. (Denkschr. Schweiz. pal. Ges., Genf., 1905, XXXII, p. 37, pl. 1, fig. 9, 11.)

PERISPHINCTES (PARABOLICERAS) JUBAR (Strachey), H. F. Blanford sp.

(Plate XLIV, fig. 1 *a*, *b*.)

Ammonites Jubar (R. Strachey mss.), H. F. Blanford, 1865, Palæontology of Niti, p. 82, pl. 2*b*, fig. 2 *a*, *b*, *non* pl. 21, fig. 1 *a*—*c*.

Ammonites Jubar (R. Strachey mss.), H. F. Blanford *in* G. C. Crick, Strachey's Cephalopoda from the Himalaya, *Geological Magazine*, new ser., Dec. V, Vol. I, 1904, p. 11.

In the "Palæontology of Niti," H. F. Blanford has figured two specimens under the name of *Amm. Jubar* and, as explained by G. C. Crick, a third specimen was utilised to represent the cross-section. A further specimen was added as var. *multiradiata*. Oppel's work on the fossil Cephalopoda of the Himalaya appeared while the "Palæontology of Niti" was in the press, and Blanford, in an appendix, identified *Ammonites Jubar* with *Amm. Sabineanus* Oppel and discarded his original designation in favour of the name introduced by Oppel.

The reference to a single species of all the forms described by Blanford and Oppel under the names of *Amm. Jubar* and *Amm. Sabineanus* was in perfect agreement with the notions then prevalent as to the wide limits of a species. If we decided to act conformably to such a conception, we would have to unite into a single species not only the forms above mentioned, but all those constituting the subgenus *Paraboliceras*. But any scientist entertaining narrower views on the subject will not hesitate to recognise that the specimens figured by Blanford as *Amm. Jubar* belong to two distinct species.[1] Fig. 2, plate 21, of the "Palæontology of Niti" represents a species with a proportionately low oral aperture, straight, feebly prominent parabolar ribs only slightly deflected forward and few parabolar tubercles, while fig. 1 *a* of the same plate represents a species with tall oral aperture and very prominent and numerous parabolar ribs strongly deflected forward. The latter form is the only one that can be identified with *Paraboliceras Sabineanum*, if we adhere to our conception of a species, while the former has to be separated as an independent species and, as a matter of course, must retain the name of *Paraboliceras Jubar*.

Paraboliceras Jubar thus restricted is represented in the material at my disposition by only one solitary specimen, the dimensions of which are as follows: diameter 76 mm.; umbilical width 28·5 mm.; thickness 25·3 mm.; volution height 28·8 mm. The flanks are only slightly arched; they are distinctly marked off from the flattened external margin, but they pass gradually into the oblique rounded umbilical wall. On the inner volution the ribs are rather strongly deflected forward. At first the parabolar ribs project only slightly, becoming more distinct with increasing age. On the last volution the ribs become very prominent and gradually assume a more radial direction. On the posterior part of the last volution the parabolar ribs succeed each other rather closely and are somewhat more massive than the other ribs; but on the anterior part they are

1 If we take account of the specimen employed for the representation of the ventral face and cross-section (*loc. cit.*), we have in reality to deal with three species.

spaced at wider intervals, so that 4 or 5 branched ribs intervene between successive parabolar ribs which, in this part of the shell, are no thicker than the intercalary ribs. The parabolar bundles consist only of the parabolar rib together with one posterior branching rib. On the external margin the ribs are interrupted and distinctly deflected forward.

The suture-line is not completely preserved. The anterior portion of the last volution belongs to the body-chamber; the exact position of the last septum cannot be ascertained.

The type specimen figured in the "Palæontology of Niti" is not well preserved; nevertheless, judging from a plaster-cast forwarded to me, there can be no doubt that the specimen here figured as *Perisphinctes Jubar* agrees with this type in all essential points.

The figured specimen is from Lochambelkichak, third Stage; Blanford's specimen is from the Niti Pass.

PERISPHINCTES (PARABOLICERAS) RECTECOSTATUS, n. sp.

(Plate XLVI[T] A, fig. 3 *a*, *b*.)

Dimensions:—

Diameter	61 mm.
Width of umbilicus	21 „
Height of last volution	24·5 „
Thickness of last volution	16 „

The shell is discoidal, with wide umbilicus, slightly rounded flanks, distinctly flattened external margin and convex sloping umbilical wall. The volutions overlap by one-fourth of their height. The cross-section is tall and elliptical.

The ribs are mostly straight. The sculpture of the inner volution differs considerably from that of the outer one: on the inner volutions the ribs are filiform, crowded and strongly deflected forward, while on the outer volution they are prominent, few, and radially disposed. The umbilical sinus of the parabolar ribs is only feebly indicated on the last volution, and the parabolar ribs are only slightly more massive than the remainder of the ribs. The disposition of the ribs being radial, the parabolar rib diverges only slightly from the preceding one; the parabolar bundles are consequently narrow and contain only one short intercalary rib. Even this intercalary rib may be wanting, in which case the parabolar bundles consist only of two ribs which become fused in the parabolar tubercle. Between successive parabolar bundles is intercalated a long intermediate rib, branching above the middle of the flanks; short intercalary ribs are also inserted in the external region, so that there are 4 or 5 ribs in the intervals between successive parabolar tubercles on the external margin of the last volution. These ribs traverse the external margin normally, an anterior deflection being only dimly indicated along the median zone, where the ribs are somewhat reduced. There are about 16 rather prominent parabolas on the last volution.

The suture is only incompletely preserved; the anterior portion of the last volution seems to belong to the body-chamber, so that *P. rectecostatum* must be a species of comparatively small size.

Paraboliceras rectecostatum occupies a rather isolated position amongst the bulk of the species. It agrees with *Paraboliceras cyrtoptychum* with respect to the flat shape of the shell and its wide umbilicus, but in *P. cyrtoptychum* the ribs exhibit a characteristic strong curvature, while in *P. rectecostatum* they are remarkably straight. *Paraboliceras Jubar* differs by its thicker volutions, its more strongly deflected ribs, the greater number of intermediate ribs and relative scarcity of parabolar tubercles. The umbilical sinus of the parabolar ribs is more pronounced in *P. Jubar*, and the ribs are more deflected forward on the external margin.

Paraboliceras rectecostatum is the only species of the genus in which the rib-bundles consist of only two long ribs uniting in a parabolar tubercle. In the genus *Grossouvria* this mode of development of the rib-bundles is more frequent, being especially the rule in *Grossouvria claromontana* Bukowski[1] from the Oxfordian of Czenstochau in Poland. Although this latter species bears a strong resemblance to *Paraboliceras rectecostatum*, it is certainly not closely related, for the Oxfordian species exhibits distinct constrictions and its body-chamber bears dichotomous ribs, the cross-section exhibiting the shape of a rectangle with rounded corners: in fact *Grossouvria claromontana* is in every respect a typical member of its genus, while *P. rectecostatum* is a genuine *Paraboliceras*.

Paraboliceras rectecostatum is represented by a single specimen from the Schlagintweit Collection, the exact locality of which is unknown.

PERISPHINCTES (PARABOLICERAS) CYRTOPTYCHUS, n. sp.

(Plate XLIV, fig. 2.)

The present species is allied to *Paraboliceras Jubar* (Strachey) Blanford on account of its low volutions. The dimensions cannot be exactly stated because it is distorted by compression and incompletely preserved. All that can be said is that at a diameter of 66 mm. the umbilical width is 23·2 mm., the volution-height 27 mm., and the greatest thickness, measured over the ribs, 20·3 mm. The cross-section is oval, the external margin being rounded, the flanks slightly arched, while the umbilical wall, which insensibly graduates into the flanks, slopes down with a very flat surface towards the umbilical suture.

The parabolar tubercles and consequently the rib-bundles are remarkably numerous in this species. The number of main-ribs intercalated between successive fascicles is frequently only two, sometimes even only one. The ribs are generally very well marked and prominent.

[1] Jurabildungen von Czenstochau, *Beiträge zur Palaeontologie Oesterreich-Ungarns*, Vol. V, 1886, p. 144, pl. XXVIII, figs. 2—6.

The parabolar ribs are not much more massively developed than the remainder, but nevertheless exhibit a very characteristic appearance in consequence of their remarkable length and the strong curvature of their umbilical portion, which is posteriorly convex. The anterior and posterior declivities of the parabolar ribs are unequal at their umbilical end: anteriorly they slope down very gradually, while their posterior declivity is exceedingly steep, so much so as to make them almost overhanging. The former oral edge can be very clearly recognised on a great many of the parabolar ribs. On the upper portion of the whorls the ribs are fairly regularly branched, and they are deflected forward on the ventral face which, however, is unfortunately very badly preserved. The parabolar tubercles project only slightly, as is particularly noticeable at the posterior end of the preserved portion of the outer whorl; on the anterior portion they seem to become fewer and are perhaps entirely wanting.

Only weathered traces of the suture can be recognised.

Paraboliceras cyrtoptychum is distinguished from *P. Jubar* by the greater convexity of the external margin, the greater curvature of the ribs, the striking curvature of the umbilical portion of the parabolar ribs, and the greater number and the lesser prominence of the parabolar tubercles. The sculpture of the anterior portion of the last volution recalls *Paraboliceras Haugi*, but the ornamentation of the inner volutions as well as the shape of the shell are so different that a confusion between the two species is quite out of question.

Paraboliceras cyrtoptychum is represented by a single specimen from Kuti (Upper and Middle Spiti Shales; Coll. A. v. Krafft).

Perisphinctes (Paraboliceras) Sabineanus, Oppel sp.

(Plate XLIV, fig. 3; plate XLVIII, fig. 3 *a*—*c*.)

Ammonites Sabineanus, Oppel: Palaeontolog. Mitteil., 1864, I, p. 288, pl. 82, fig. 1 *a*—*c*, *non* fig. 2 *a*, *b*.
Ammonites Jubar (Strachey mss.), Blanford: Palæontology of Niti, 1865, p. 82, and Postscript, p. 106 and ff., pl. 21, fig. 1 *a*—*c*, *non* pl. 20, fig. 2.
Ammonites Sabineanus, Stoliczka. *Mem. Geol. Survey of India*, Calcutta, 1866, Vol. V, p. 101 and ff.
Perisphinctes Sabineanus, Siemiradzki: Monogr. Beschr. der Gattung Perisphinctes, *Palaeontographica*, Vol. 45, p. 110, pl. XX, fig. 2 (denoted as *Perisphinctes Jubar* in the explanation to the plates).

Under the name *Ammonites Sabineanus* Oppel described two specimens which do not completely agree with each other. A more detailed study of these specimens together with the more copious material at my disposition have convinced me that Oppel's two original types cannot possibly be united into a single species. The reasons for this conclusion are as follows: in one of Oppel's specimens (plate 82, fig. 1) the umbilicus is wider and the ribs are straight, and only slightly deflected forward; the other specimen (plate 82, fig. 2) has a somewhat narrower umbilicus and more decidedly sigmoidal ribs. In the suture-line of the former, the second lateral lobe is symmetrically constructed; in the latter the second lateral lobe is rendered unsymmetrical owing to the stronger

development of the exterior lateral branch. The disposition of the anterior portion of the shell further confirms the specific distinctness of the two forms. In the first form the sculpture at the commencement of the body-chamber, where the height of the volution is 50 mm., consists of rib-fascicles with very strong parabolar tubercles in the intervals between which there occur three long straight, closely packed intermediate ribs, the latter remaining either simple or else splitting up only in the vicinity of the external margin. In the umbilical region the parabolar ribs are considerably stronger than the long intermediate ribs, and the umbilical sinus curves decidedly backwards.

In the second form, the change of character of the ornamentation in the anterior part of the shell is quite different. The umbilical sinuses are shallower, and the parabolar ribs are at first only slightly stronger than the long intermediate ones. When the volution-height has reached 34 mm., the parabolar ribs become rather suddenly prominent, recede from each other, and only one long intermediate rib makes its appearance.[1] Consequently the anterior portion of the shell acquires a developmental tendency which cannot be reconciled with the possibility of a return to the sculpture of the first form. In other words, it is impossible to reconstruct the anterior portion of the chambered nucleus and the living-chamber of the second form according to the pattern suggested by the ornamentation of the first form.

This is confirmed by a specimen in the Schlagintweit Collection, which is described here under the new name of *Paraboliceras Haugi*, but which is certainly very closely related to the second form (*vide* plate XLVIII A, fig. 1). At an early age the ribs evince already a strong tendency towards becoming thicker and receding from each other, in consequence of which the shell acquires a sculpture consisting of strong, widely spaced ribs breaking up into numerous branches on the external margin, a type of sculpture essentially different from that of *Amm. Sabineanus* Oppel.

At its full-grown stage, the second form evidently undergoes a similar development, and hence, taking into account other differences, it becomes necessary to refer Oppel's original co-types of *Amm. Sabineanus* to two different species.

In accordance with the customary procedure the name *Perisphinctes Sabineanus* should be reserved for the specimen figured in the first instance, that is, the one depicted in fig. 1 *a*—*c*, plate 82, of Oppel's work. For the second form, shown in fig. 2 *a*, *b* of the same plate, I propose the new name *Perisphinctes* (*Paraboliceras*) *himalayanus*. Briefly summarising the chief characters of *Paraboliceras Sabineanus* in the sense accepted by us, the species is distinguished by rather flat flanks, a complanate ventral face, a slanting and rounded umbilical wall, crowded, straight, ribs only slightly deflected forward, and very massive parabolar tubercles. The parabolar ribs are mostly strongly developed, and

[1] It is precisely this most important anterior portion of the shell which, unfortunately, has been omitted in the "Palæontol. Mitteilungen."

have a rather deep umbilical sinus; the parabolar bundles consist as a rule of only three ribs. At the full-grown stage, there usually intervene between successive parabolar bundles three long ribs of which, as a rule, only one is branched in the vicinity of the external margin. In some specimens the ramification of the ribs takes place quite close to the external margin, in others it occurs closer to the middle of the flanks. On the external margin the ribs are more or less deflected forward, becoming reduced or obliterated along the median zone. The lateral lobes have broad trunks, the second lateral lobe exhibiting a subsymmetrical configuration.

In addition to Oppel's type specimen, *Paraboliceras Sabineanum* includes one large specimen of at least 144 mm. diameter which agrees perfectly with it, the only difference being a slightly more pronounced deflection of the ribs. In the specimen represented in fig. 3, plate XLIV, the differences are somewhat greater. The parabolar ribs are somewhat more prominent and the flanks of the volutions somewhat more convex. Close to the anterior extremity there occur no less than six long intermediate ribs between successive parabolar fascicles. This, to a certain extent, is compensated by the fact that further back only one or two long intermediate ribs occur in a similar position. The suture-line is only indistinctly preserved; the second lateral lobe is somewhat more asymmetric than in Oppel's type, but the lobe-trunks show the same broad development. Moreover, the ribs are somewhat more strongly deflected forward on the external margin.

The specimen figured by Blanford as *Amm. Jubar* in plate 21, fig. 1, of the "Palæontology of Niti" (and refigured by Siemiradzki, *loc. cit.*) represents a very similar variety.

The young specimen depicted in plate 48, fig. 3 *a*—*c*, most probably belongs to the same species. This specimen shows that up to a diameter of 12 mm. the volutions are as broad as high, or relatively somewhat broader. From that stage onwards they rapidly increase in height so that at a diameter of 22 mm. the volution-height is 9 mm., the breadth being only 7·8 mm.

We may point out that Oppel's figure exaggerates somewhat the smoothness and flatness of the external margin. In the cross-sectional diagram 1 *c* the ventral face is not sufficiently rounded and the umbilical wall is somewhat too steep.

The distinguishing features between *Paraboliceras Sabineanum* and its nearest relative, *Paraboliceras tibeticum*, are referred to in the description of the latter species.

Paraboliceras Sabineanum is represented by no less than ten specimens. Oppel's specimen is from Shangra east of Puling in Ngari Khorsum; the specimen, plate XLIV, fig. 3, from Laptal in Southern Hundes; the immature specimen, plate XLVIII, fig. 3, from Chidamu; the large specimen from Kuti (Upper and Middle Spiti Shales, A. v. Krafft). Besides these, there are two smaller specimens (Coll. Smith), one from Lilingthi, Upper Spiti Shales (A. v. Krafft), one from

Lochambelkichak (Stage III). The Schlagintweit Collection also contains a specimen exhibiting an injury at the commencement of the body-chamber which has been healed up during the life of the animal. The exact localities of the latter specimen and of the one illustrated by Blanford are unknown. There are two more immature specimens, one from the Upper or Middle Spiti Shales of Kuti, the other, with a healed-up wound, from some uncertain locality in Spiti, but neither of these exhibit sufficiently distinctive characters to decide with certainty whether they belong to this species.

Perisphinctes (Paraboliceras) tibeticus, n. sp.

(Plate XLVI, fig. 2 *a*—*c*.)

The relationship of the present species to *Paraboliceras Sabineanum* is so close that only after much hesitation was I able to arrive at a definite decision regarding the separation of the two forms. The differences between the two may be stated as follows. *Paraboliceras tibeticum* has a narrower umbilicus and comparatively higher and somewhat more overlapping volutions. During the earlier stages, up to a diameter of at least 28 mm., the thickness of the volutions somewhat exceeds or at least equals their height, whilst the corresponding volutions of *P. Sabineanum* are higher than broad. The ribs exhibit the same general disposition as in *P. Sabineanum*, but they are not so decidely deflected forward, and the parabolar ribs are scarcely stronger than the other ribs, while, in the case of *P. Sabineanum*, the parabolar ribs are distinguished by their greater massiveness. The umbilical sinus is shallower than in *P. Sabineanum*. The pronounced flatness of the external margin and the slight convexity of the flanks are common to both species.

It cannot be denied that the differences between *P. tibeticum* and *P. Sabineanum* are by no means striking. Should future discoveries yield specimens intermediate between the two forms, *P. tibeticum* will have to be united with *P. Sabineanum*, from whose diagnosis it will then be necessary to omit the massive development of the parabolar ribs, the relatively great width of the umbilicus and the slender form of the earlier volutions. The chief distinctive characters of *P. Sabineanum* would then be its crowded straight ribs and the persistence of the intermediate ribs beyond the commencement of the body-chamber.

P. tibeticum is represented by a single specimen, the anterior end of which apparently belongs to the commencement of the body-chamber. The dimensions of the specimen are:—

	120 mm
Diameter	34·5 „
Width of umbilicus	58·3 „
Volution-height	32·2 „
Maximum thickness	

Locality.—Chidamu.

PERISPHINCTES (PARABOLICERAS) HIMALAYANUS, n. sp.

(Plate XLVI. fig. 1 *a*—*d*.)

Ammonites Sabineanus, Oppel: Palæontolog. Mitteil., I, pl. 82, fig. 2 *a*, *b*, *non* fig. 1 *a*—*c*.
Ammonites Sabineanus, Stoliczka: *Mem. Geol. Survey of India*, Vol. V, p. 101 and ff.

When dealing with *P. Sabineanum* we have already stated our reasons for specifically separating the second form placed by Oppel in his *Amm. Sabineanus*. It has been shown that apart from certain differences of subordinate value, this second form which we have named *P. himalayanum* exhibits a different type of ribbing whose peculiarities become especially apparent on the body-chamber and the adjoining end of the chambered nucleus. We include in the present species two large specimens, the dimensions of which are here tabulated:—

	a. Oppel's specimen.	*b*. Pl. XLVI, fig. 1.
Diameter	83 mm.	107 mm.
Width of umbilicus	27·8 „	30 „
Volution-height	34·2 „	46·3 „
Maximum thickness	22·5 „	31·5 „

The shell is discoidal and consists of slightly convex volutions overlapping by a little more than one-third in specimen *b* and by nearly one half their height in specimen *a*. In the latter specimen the external margin is somewhat more flattened than in the former.

The filiform ribs are slightly deflected forward up to a diameter of 83 mm. in specimen *a*, and up to a diameter of 100 mm. in specimen *b*; at this stage the number of long ribs per volution is 76 and 70 respectively. Towards the anterior extremity, the ribs gradually assume a more sigmoidal form. Most of the ribs ramify in the outer region of the flanks; on the external margin they are strongly deflected forward and along the median zone they become reduced or obsolete. The parabolar tubercles appear to be less numerous on the inner whorl than on the last volution; at all events they increase in number as the shell grows larger. They are not so strongly developed as in *Paraboliceras Sabineanum*; they frequently show very clearly the manner in which the parabolar tubercles originate from the fusion of two parabolas. The parabolar fascicles are not so sharply marked out from the remainder of the ribs as in *P. Sabineanum*, because the parabolar ribs are scarcely more prominent than the ordinary ribs and because they are not so strongly curved backwards in their umbilical portion so that they do not always unite with the preceding rib to form a fascicle. The scarcity of well-defined parabolar fascicles is especially noticeable in specimen *b*. Above the middle of the flanks individual parabolar ribs show a slight thickening.

The foremost portion of the shell exhibits the change in the sculpture which has already been referred to when discussing the differences between this species and *P. Sabineanum*. The parabolar ribs recede still farther from each other and form massive ridges; the shell is deeply excavated between the parabolar ribs

and only one long intermediate rib intervenes in each interspace. The body-chamber is unknown.

The suture-line differs from that of *Paraboliceras Sabineanum* mainly on account of the asymmetrical development of the second lateral lobe consequent on the atrophy of its inner lateral branch. The first lateral lobe has a moderately broad trunk, a long slender terminal branch, and two lateral branches of which the outer one is inserted higher up and much more strongly developed than the inner one. The second lateral lobe is followed by three obliquely disposed auxiliary lobes, of which the last one is divided into two branches. The broad saddles are symmetrically divided by long adventitious lobes.

The differences between *Paraboliceras himalayanum* and *P. Sabineanum* have been discussed when dealing with the latter species. Similarly we refer to the description of *P. Griesbachi* and *P. Haugi* for a discussion of their relationship to the present species.

It follows from the preceding description that the two specimens which we include in *P. himalayanum* do not agree in every point. We need only add that the characters of specimen *b* tend strongly towards *P. Griesbachi*, whilst those of specimen *a* are equally inclined towards *P. Haugi*. It is not impossible that with more copious material we would have to distribute the specimens in a different manner.

Specimen *a* (Oppel, *Pal. Mitt.*, plate 82, fig. 2) is from Shangra east of Puling in Ngari Khorsum; specimen *b* (plate XLVI, fig. 1) is from Jandu, Hundes.

PERISPHINCTES (PARABOLICERAS) HAUGI, n. sp.

(Plate XLIV, fig. 4 *a*, *b*; plate XLVIII A, fig. 1 *a*, *b*.)

To this species we refer three specimens, one of which, owing to its poor state of preservation, has not been taken into account in the following description, while the remaining two, although not completely agreeing with each other, do not nevertheless afford sufficient grounds for a specific separation.

In the smaller specimen (plate XLIV, fig. 4) the breadth and height of the innermost volutions are equal up to a diameter of 14 mm. With increasing growth, the height increases quicker than the thickness, so that at a diameter of 21 mm. the height is 10 mm., to a thickness of only 8·3 mm. At a diameter of 52 mm. the height and thickness of the volution are respectively 23 and 14 mm. At this stage the shell is very flat, and the cross-section of the volutions relatively very tall; but in the subsequent stages the height no longer increases at such a rapid rate, so that, when the diameter has reached 87 mm., the volution-height measures 35 mm., while the corresponding maximum thickness is 23·5 mm. At this stage the cross-section shows an approximately elliptical outline with the external margin distinctly flattened, while the flanks are slightly arched and the umbilical wall is rounded and slopes downwards as a rather flat declivity. The larger specimen (plate XLVIII A, fig. 1) has a diameter of

100 mm., corresponding with an umbilical width of 35 mm., a volution-height of 42 mm., and maximum thickness of about 28 mm. In this specimen, also, the external margin is decidedly flattened and the flanks are only slightly convex. In both specimens the volutions overlap by about one-third of their height.

On the inner volutions the ribs are somewhat strongly deflected forward, but later on one only observes a slight curvature particularly noticeable on the middle of the flanks. A little above the middle of the flanks the ribs break up fairly regularly into two branches, and on the ventral face they are rather strongly deflected forward and reduced along the median zone. Parabolar tubercles are already noticeable in the innermost volutions where they occur in considerable number; with increasing growth they become fewer, increasing once more as growth proceeds still further. At this stage, when the diameter has reached about 62 mm., the rib-fascicles follow one another in rapid succession, the parabolar ribs become more prominent, the shell becomes more deeply excavated between the parabolar bundles, one bifurcate rib intervening in each of the interspaces between successive parabolar fascicles. Further forward, probably in the vicinity of the body-chamber or actually at its commencement, the parabolas once more become scarce and the ornamentation consists of very strong, ridge-like, rather wide spaced ribs each of which ramifies into three branch-ribs on the upper part of the flanks.

The suture-line is unknown.

The present species is very closely related to *Paraboliceras himalayanum* from which it differs owing to its less crowded ribs, its flatter external margin, and the greater massiveness and wider spacing of the ribs on the anterior portion of the shell. As has already been observed when dealing with *Paraboliceras Sabineanum*, the latter species when full grown exhibits a similar tendency towards a change in the ornamentation, but this tendency becomes evident somewhat later than in *P. Haugi* and is not so pronounced. The larger specimen of *P. himalayanum* deviates from *P. Haugi* by its strongly convex external margin and the characters of its ribs, so that one experiences no difficulty in distinguishing these two species from one another.

The locality of the larger specimen in the Schlagintweit Collection is not known; the smaller specimen is from the Laptal Shales, Camp Sangcha; the third specimen is from Kuti. Byans.

PERISPHINCTES (PARABOLICERAS) POLYSPHINCTUS, n. sp.

(Plate XLVIII A, fig. 2 *a—c*.)

Dimensions :—

Diameter		112 mm.
Width of umbilicus		38 „
Height of the last volution		44 „
Maximum thickness	(approximately)	28 „

In its externa. form the shell does not essentially differ from *P. Haugi*; only the volutions are not quite so thick, and the external margin is more convex.

The ornamentation of the inner volutions is only preserved in indistinct traces, from which it may be ascertained that the ribs are rather flat and more distantly spaced than in *P. Haugi*, somewhat after the style of *P. mutilum* Oppel. During the middle stages of growth the parabolar tubercles succeed one another very closely, and the parabolar fascicles are separated by deeply excavated broad interstices, in which one observes at most one short intercalary rib. The ribs are rather massive. The parabolar tubercles are moderately developed, and not infrequently exhibit a double parabola. On the last volution there are at least 24. On the external margin the ribs are slightly deflected forward and they are reduced along the median zone.

The way in which the deeply excavated, almost constricted, smooth part of the shell appear between the rib-bundles strongly recalls the "Polyploci" and "Virgati." It is interesting to note the occurrence of this type of ribbing in the *Grossouvria*-group, and for this very reason the specimen has been made the type of a new species, although a complete diagnosis is impracticable owing to its somewhat deficient state of preservation.

P. Haugi generally exhibits a type of costation which is not unlike that of *P. polysphinctum* in so far as the ribs are prominent and wide-spaced. But the broad and deep interstices between the rib-fascicles are only just indicated in *P. Haugi*, while in the present species they are very pronounced. The ribs of *P. Haugi* are much sharper and, especially on the inner volution, much fewer than in *P. polysphinctum*.

The remarkable *Paraboliceras mutilum* Oppel sp. is evidently one of the nearest relatives of the present species. In *P. mutilum* the sculpture experiences a still more extreme development; the volutions are somewhat lower, the umbilicus wider, the ribs are much more decidedly sigmoidal, and deflected backwards on the external margin, while in *P. polysphinctum* they are deflected forward.

The exact locality of the specimen, which forms part of the Schlagintweit Collection, is not known.

PERISPHINCTES (PARABOLICERAS) MUTILUS, Oppel. sp.

Ammonites Sabineanus, Oppel: 1864, Palæontologische Mitteilungen, I, p. 289, pl. 84, fig. 3.

I have no other specimen at my disposal but the actual type upon which Oppel established this remarkable species. I am therefore unable to add much fresh information concerning this fossil. Oppel clearly recognised the close relationship between the present species and his *Ammonites Sabineanus* and expressed the opinion that it may simply represent a pathological modification of that species. Nevertheless Oppel himself drew attention to the symmetry of the shell and its strikingly regular ornamentation as militating against such a supposition. The change from the strictly normal, though somewhat prominent and somewhat strongly deflected ribs of the innermost whorl to the massive ribs of the outer volution is so gradual, that we cannot see any sufficient

grounds for regarding this species as anything else but a thick-ribbed form such as occur in almost every group of ribbed ammonites.

When the diameter has scarcely reached 45 mm., the flanks carry only rib-fascicles, the long intermediate ribs having already disappeared, so that the deeply excavated furrows between the rib-fascicles are quite smooth. It is only in the vicinity of the external margin that one or two short subsidiary ribs become intercalated between the rib-bundles. The last volution has fourteen rib-bundles; on the posterior portion of the last volution each rib-bundle is connected with a stout tubercle.

Whether this type of ornamentation also characterised the anterior portion of the last volution cannot be ascertained, since the external margin of this part has not been preserved.

The ribs are considerably reduced on the external margin, but scarcely so much as is shown in Oppel's illustration.[1]

The most remarkable circumstance about this species is the disposition of the ribs which, instead of being deflected forward as in all the other species from Spiti, are deflected somewhat backward. In *P. mutilum*, that part of the ribs which in every other species assumes, on the external margin, a forward curvature, does not seem to be developed. At one place, the sculpture exhibits some slight irregularities.

The shell is very flat with a wide umbilicus. The volutions are elliptical in cross-section and overlap up to one-fourth or one-fifth of their height.

The suture-line is only partly visible. As already marked by Oppel, it approaches that of *Ammonites Sabineanus*, from which it differs owing to the narrower saddles.

Paraboliceras mutilum deviates so much from all other species of the same genus by reason of the excessive massiveness of the ribs that a detailed enumeration of its diagnostic characters appears to be superfluous. The only point to which we desire to call attention is that the shape of the shell and the type of ornamentation of *Paraboliceras mutilum* indicate that its closest allies must be *P. Haugi* and *P. polysphinctum*.

Paraboliceras mutilum comes from the Spiti Shales of Spiti (Schlagintweit's Collection in Munich).

Perisphinctes (Paraboliceras) Griesbachi, n. sp.

(Plate XLVIII, fig. 1 *a—d*.)

The only available specimen of this species is unfortunately incomplete and partly distorted by pressure. The diameter is about 130 mm., the umbilical width 38 mm., the height of volution at the anterior margin 51 mm., the thickness 40·5 mm. The volutions have a regular elliptic cross-section with gradually sloping rounded umbilical wall and rounded external margin. They overlap by

[1] The artist appears to have overlooked the fact that the smooth band along a portion of the external margin has been caused by weathering.

more than one-third of their height, the greatest thickness occurring about half way up their flanks.

The crowded ribs are not very prominent, and are distinctly sigmoidal. The preserved half of the outer volution, the anterior end of which appears to belong to the body-chamber, bears nine pairs of very prominent parabolar tubercles. The parabolar fascicles usually consist of four ribs, which, however, are not sharply separated from the intermediate ribs. The umbilical portion of the foremost parabolar ribs is only slightly thickened; in single instances a slight thickening of the parabolar ribs is also observable in the upper third of the height of the volution. The number of long intermediate ribs between successive parabolar fascicles averages three on the outer half of the last volution. Nearly every one of these ribs bifurcates close to the external margin. On the external margin the ribs are only slightly deflected forward and they are somewhat reduced along the median zone. The portion of the external margin situated between successive parabolar tubercles and corresponding with the external lappet remains smooth.

On the inner volutions, the characters of which are only imperfectly known, parabolar ribs are very feebly developed, and the parabolar tubercles, which at a later stage constitute a prominent feature, are scarcely indicated even when the diameter has already reached 58 mm.

The suture-line agrees remarkably well in all essential points with that of *Paraboliceras Sabineanum* from which it is only distinguished by the broader trunk of the first lateral lobe.

Paraboliceras Griesbachi is very closely related to *P. spitiense*, from which it differs owing to the smaller number of the long intermediate ribs between successive parabolar rib-fascicles, by the greater massiveness of its ribs, and by the shape of its cross-section. The maximum thickness of *Paraboliceras Griesbachi* occurs at half the height of the volutions, whilst in *P. spitiense* it is shifted somewhat further outwards. The present species differs from *Paraboliceras himalayanum* by its somewhat more crowded ribs, its lower and thicker volutions, and the configuration of the first lateral lobe, the trunk of which is more slender in *Paraboliceras himalayanum* than in *P. Griesbachi*.

Paraboliceras Griesbachi is represented by a single specimen from Jandu in Hundes (Coll. Griesbach).

PERISPHINCTES (PARABOLICERAS) POMPECKJI, n. sp.

(Plate XLVIII, fig. 2 *a*—*c*.)

Dimensions :—

Diameter	78 mm.
Width of umbilicus	22·3 „
Height of volution above umbilical suture	35 „
Maximum thickness (approximately)	26 „

The shell is flat and discoidal with a narrow umbilicus. The volutions overlap by half their height and exhibit a tall elliptical cross-section. The flanks

are flatly arched; the external margin is flattened and distinctly marked off from the flanks; the umbilical wall is rounded, but has a steep slope. The last semi-volution carries six pairs of parabolar tubercles, each of which is clearly derived from two parabolas. The parabolar fascicles consist of three ribs, of which the most anterior one, that is, the true parabolar rib, is strongly curved backwards in the umbilical region where it assumes the form of an elevated ridge. The posterior declivity of these ridges is somewhat steeper than the anterior one. In certain fascicles the parabolar rib disappears in the upper region of the volution without reaching the parabolar tubercle. Between successive parabolar bundles there are five long filiform intermediate ribs which are very thin at the umbilicus where they all originate with the exception of the rib situated immediately behind a parabolar fascicle which originates a little higher up. Many of these ribs remain simple, others bifurcate in the vicinity of the external margin; occasionally there occurs a short intercalary rib.

The ribs exhibit a comparatively shallow sigmoidal shape, but they are strongly deflected forward on the ventral face and somewhat reduced along the median zone. Between the parabolar tubercles the external margin is smooth over those portions which correspond with the external lappets.

Only the larger features of the suture-line can be made out, and these correspond with the sutural features of *Paraboliceras Sabineanum.*

Paraboliceras Pompeckji is very closely related to *P. Griesbachi* and *P. himalayanum.* It differs from *P. Griesbachi* owing to its narrower umbilicus, its somewhat flatter flanks, and the more abrupt transition from the external margin into the flanks. Moreover, the intermediate ribs of *P. Pompeckji* are not so strongly curved, but are more decidedly deflected forward on the external margin. Especially characteristic of *P. Pompeckji* is the much greater prominence of the parabolar ribs in the umbilical region. *Paraboliceras himalayanum* differs from the present species owing to the large number of parabolar tubercles, the small number and wider spacing of the intermediate ribs, and the much feebler development of the parabolar ribs in their umbilical portion. Moreover, the flanks of *P. himalayanum* are somewhat more perfectly rounded and the junction of the flanks and ventral face is less abrupt than in *P. Pompeckji.*

Paraboliceras Pompeckji is represented by a single specimen from Kibber in Spiti.

Perisphinctes (Paraboliceras) spitiensis, n. sp.

(Plate XLVII, fig. 1 *a—c.*)

The type specimen of this species is very well preserved in parts, though one portion of the shell has been distorted by pressure in a manner which precludes an accurate measurement of its dimensions. The diameter is approximately 121 mm., the umbilical width 35 mm. At the well-preserved anterior end, the volution-height is 48·2 mm., the maximum thickness 34·1 mm. The

external margin is more decidedly convex than in any other form of the same genus, and the cross-section although elliptical in its general outline differs nevertheless from that of all the other species owing to the situation of the maximum thickness which occurs somewhat above the middle of the height.

The ribs are very crowded and distinctly sigmoidal, and their uniformly thread-like appearance is very striking. Individual ribs remain simple, while others bifurcate either close to the external margin, or in the lower region of the volutions. On the external margin they are strongly deflected forward and only slightly reduced along the median zone.

The parabolar tubercles, although strongly developed, do not appear to be numerous. Wherever preserved the parabolar ribs are scarcely more prominent than the other ribs.

The suture-line has unfortunately not been preserved. In the figured specimen the foremost portion seems to belong to the body-chamber, a slight flattening of the ribs being perceptible at the broken anterior end.

It is impossible to confound *Paraboliceras spitiense* with any other species. *P. Griesbachi* and *P. Pompeckji* are its nearest allies, *P. spitiense* being distinguished from both these species owing to its finer and more crowded ornamentation, the feeble development of its parabolar ribs, the frequent branching of the ribs on the lower region of the volution, the small number of parabolar tubercles, the greater convexity of the ventral face and the peculiar cross-section.

Paraboliceras spitiense is represented by one specimen from the neighbourhood of Jandu on the Sherik river in Hundes (Coll. Griesbach). A second specimen possibly belonging to the same species, and consisting of a poorly preserved fragment of a body-chamber, is preserved in the Schlagintweit Collection.

PERISPHINCTES (PARABOLICERAS) sp. ind. cf. SPITIENSIS, n. sp.

(Plate XLV, fig. 2 *a—d.*)

The Spiti collection includes another species closely related to *P. spitiense* and represented by a small fragment of a body-chamber with a volution-height of 55 mm. and a thickness of 38·2 mm. The cross-section is elliptical, the external margin strongly convex. As in the case of *P. spitiense*, the crowded ribs have a thread-like appearance, and bifurcate at a low level, but they are more decidedly curved. The cross-section also exhibits slight differences so that the fragment in question can scarcely be specifically identical with *P. spitiense*, although it must be closely related. The exact relationship of the two forms can only be elucidated when more complete material becomes available.

The inner margin of the fragment reveals some of the features of the external region of the preceding whorl. Judging from the hollow impression left by it, one gathers that its external margin was rounded and more abruptly marked off from the flanks than in the case of the preserved volution. On the inner volution the parabolar tubercles are distinctly but not strongly

developed. The impression of the inner volution also indicates that the external lappet is short and anteriorly truncated.[1]

The specimen is from Chidamu (Coll. Diener).

Perisphinctes (Paraboliceras), n. sp. ind.

(Plate XLV, fig. 3 *a.—c.*)

Another species of *Paraboliceras* is represented by a small fragment of a body-chamber, on the dorsal face of which the impression of the preceding volution is indicated with remarkable sharpness.

The cross-section is approximately elliptical; the maximum thickness, however, does not lie at the middle of the volution, but somewhat lower. The volution height is 60 mm., the greatest thickness 46 mm. The flanks bear slightly curved ribs, which are somewhat steeper on the posterior than on the anterior side. On the external margin the ribs are deflected forward, forming a pronounced arch; the number of ribs increases externally, partly through ramification, partly through intercalation. On the external margin the ribs form arches which are anteriorly convex and become obsolete along the median zone. Parabolar tubercles are not developed on the preserved portion of the living chamber; but the corresponding segment of the preceding volution exhibits the outline of the two parabolas which are of particular interest, as they exhibit very clearly the impression of the boundary line of the external lappet. We have already discussed this feature in the introductory remarks to the genus to which we refer the reader. On the inner volution the parabolar tubercles are closely spaced, there being only four intermediate ribs on the ventral face between successive tubercles.

Judging from the type of costation and the shape of the cross-section this species must be allied to *Paraboliceras spitiense*, *P. Griesbachi*, and *P. himalayanum*. From *P. spitiense* it is distinguished by its stronger, less curved and less numerous ribs, probably also by more numerous parabolar tubercles; from *P. Griesbachi* by the greater regularity of the ribs which are more strongly deflected forward on the external margin; and from *P. himalayanum* by the lower and less deeply overlapping volutions.

As in the case of the preceding species, a complete elucidation of this form cannot be expected until fresh material becomes available.

The specimen is from Chidamu (Coll. Diener).

Perisphinctes (Paraboliceras) fascicostatus, n. sp.

(Plate XLV A, fig. 2 *a—d.*)

The type specimen of the present species is unfortunately incomplete so that the dimensions can only be approximately stated. The greatest diameter is probably about 90 mm. At a diameter of 77 mm. the umbilical width is 22·8 mm., the volution-height 33 mm., the greatest thickness about 23 mm. The flanks

[1] The outline of the external lappet has unfortunately been overlooked when drawing the figure.

are so slightly arched as to be almost flat, the external margin is slightly flattened and fairly distinctly marked off from the flanks, and the umbilical wall is rounded but rather steeply sloping. The maximum thickness coincides with the umbilical wall. The volutions overlap by about one-third of their height.

The ornamentation consists of numerous ribs slightly deflected forward, whose number increases, on the upper part of the shell, to such an extent by ramification and intercalation that for every long rib we have about three secondary ribs.

The number of the long ribs on the last volution amounts to 50. The ribs which are scarcely visible at their origin at the umbilicus, curve backwards on the umbilical wall in a shallow arch and assume a forward direction along the flanks. Half-way up the flanks they curve slightly backwards, while on the external margin they are slightly deflected forward and are reduced along the median line. This species is characterised by the feeble development of the parabolas. More than half of the last volution is without rib-bundles and parabolar tubercles, and even the inner half of the last volution bears only three rib-bundles and as many pairs of parabolar tubercles. On the next inner volution there are eight rib-bundles and parabolas.

The suture-line is not clearly preserved in all its details; but so much can be made out as to establish that in its essential features it does not deviate from the usual sutural type of the genus *Paraboliceras*. The relatively strong development of the auxiliary lobes appears to be characteristic of the species.

In a general way this species deviates so much from the majority of species of *Paraboliceras* that a casual observer might readily feel induced to place it among the genuine species of *Perisphinctes* with trichotomous ribs. But on closer examination, the presence of parabolar tubercles, the deflection of the ribs on the external margin, the shape of the shell, and the characters of the suture-line clearly indicate that we are dealing with a strongly modified *Paraboliceras*. The most closely allied form is *P. Haugi*, a species in which trichotomous ribs are developed on the anterior portion of the last volution. Whilst, however, in the case of *P. Haugi*, this developmental stage is only reached at a diameter of 90 to 100 mm., it is exhibited by *Paraboliceras fascicostatum* when the diameter is no more than 45 mm. Owing to its numerous and prominent parabolar tubercles, especially during the middle stages of growth, *P. Haugi* exhibits most typically the normal *Paraboliceras* sculpture. In *P. fascicostatum*, however, this type of ornamentation loses a great deal of its characteristic appearance, and the trichotomous ribs become the leading feature in the ornamentation of the shell. Moreover, *P. Haugi* has a wider umbilicus, and it is somewhat thicker and more decidedly flattened on the external margin.

PERISPHINCTES (PARABOLICERAS) n. sp. ind. aff. FASCICOSTATUS. n. sp.

(Plate XLIV, fig. 6 *a*—*b*.)

The cross-section of this species is not oval as in the other species of *Paraboliceras*, but has a nearly rectangular shape. The flanks are nearly flat, and they

are sharply marked off from the flattened ventral face; the umbilical wall is low and has a rather steep slope. The volution height is 29 mm., the maximum thickness lies at the junction of the flanks and umbilical wall and amounts to 19·5 mm. The flanks bear slightly sigmoidal ribs which are feebly deflected forward. To every long rib correspond three short secondary ribs on the peripheral part of the flanks and on the external margin; of these secondary ribs two originate by ramification and one by intercalation. The secondary ribs are rather strongly deflected forward, and they are reduced along the median zone of the external margin. Owing to the reduced size of the umbilical wall, the posteriorly convex umbilical portion of the ribs is shorter than in the other species of the genus *Paraboliceras*.

Regarding the nature of the inner volutions all that can be made out is what is shown by the impression of the external margin of the penultimate whorl on the inner margin of the body-whorl. We are thus able to ascertain that, in this inner part of the shell, the flanks are somewhat more convex than on the body-chamber, and it is also evident that there occurred numerous parabolar tubercles between which were intercalated three to five secondary ribs which were slightly deflected forward.

The present species belongs to the group of *Paraboliceras fascicostatum* as is evident from the sculpture of the body-chamber. As in the case of *P. fascicostatum*, the primary ribs break up into three secondary ribs, but they are less crowded, somewhat more strongly curved, and much more decidedly deflected forward on the external margin. The flanks are flatter, the umbilical wall lower, the external region more decidedly flattened, and the cross-section more rectangular. Finally, the parabolas on the inner volution appear to be more numerous.

The incompleteness of the specimen precludes the creation of a new specific name. The exact locality is not known.

PERISPHINCTES (PARABOLICERAS), n. sp. ind.

Another specimen related to *Paraboliceras fascicostatum* and preserved in the Schlagintweit Collection is here mentioned merely with a view to emphasize the fact that this peculiar group is copiously represented in the fauna of Spiti. It differs from *Paraboliceras fascicostatum* owing to the more pronounced sigmoidal curvature of the ribs which are more decidedly deflected forward on the external margin, more deeply subdivided on the flanks and more strongly thickened on the lower portion of the volution. In consequence of its indifferent state of preservation we have refrained from creating a new specific name, though the specimen unquestionably represents a new species.

PLATE XIX.

Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) OCTAGONUS Strachey-Blanford sp.

Page 204. Internal cast, retaining a portion of the body-chamber. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. From Kibber. (See also plate XX, fig. 2.)

Fig. 2 *a*—*c*. HOPLITES (ACANTHODISCUS) POLYACANTHUS n. sp.

Page 208. Specimen with the greater part of the shell preserved. Natural size. 2*a*, Lateral view. 2*b*, Cross-section. 2*c*, View of the external periphery. From Lochambelkichak, 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).

1a.

2b

2c

2a

W. Lapoldt del et lith.

Albert Berger print

PLATE XX.

Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) OCTAGONUS **Strachey-Blanford sp.**

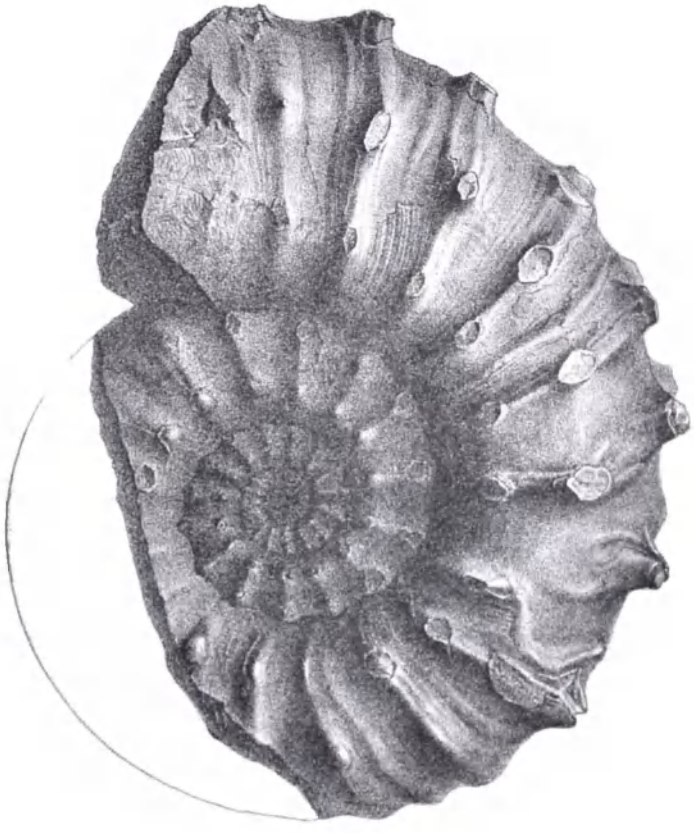
Page 204. Specimen with most of the shell preserved, exhibiting a portion of the body-chamber. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. From Kibber in Spiti.

Fig. 2. HOPLITES (ACANTHODISCUS) OCTAGONUS Strachey-Blanford sp.

Page 204. External periphery of the specimen represented in plate XIX, fig. 1. From Kibber in Spiti.

2.

1a.



1b.

W. Liepoldt del. et lith.

Albert Berger print.

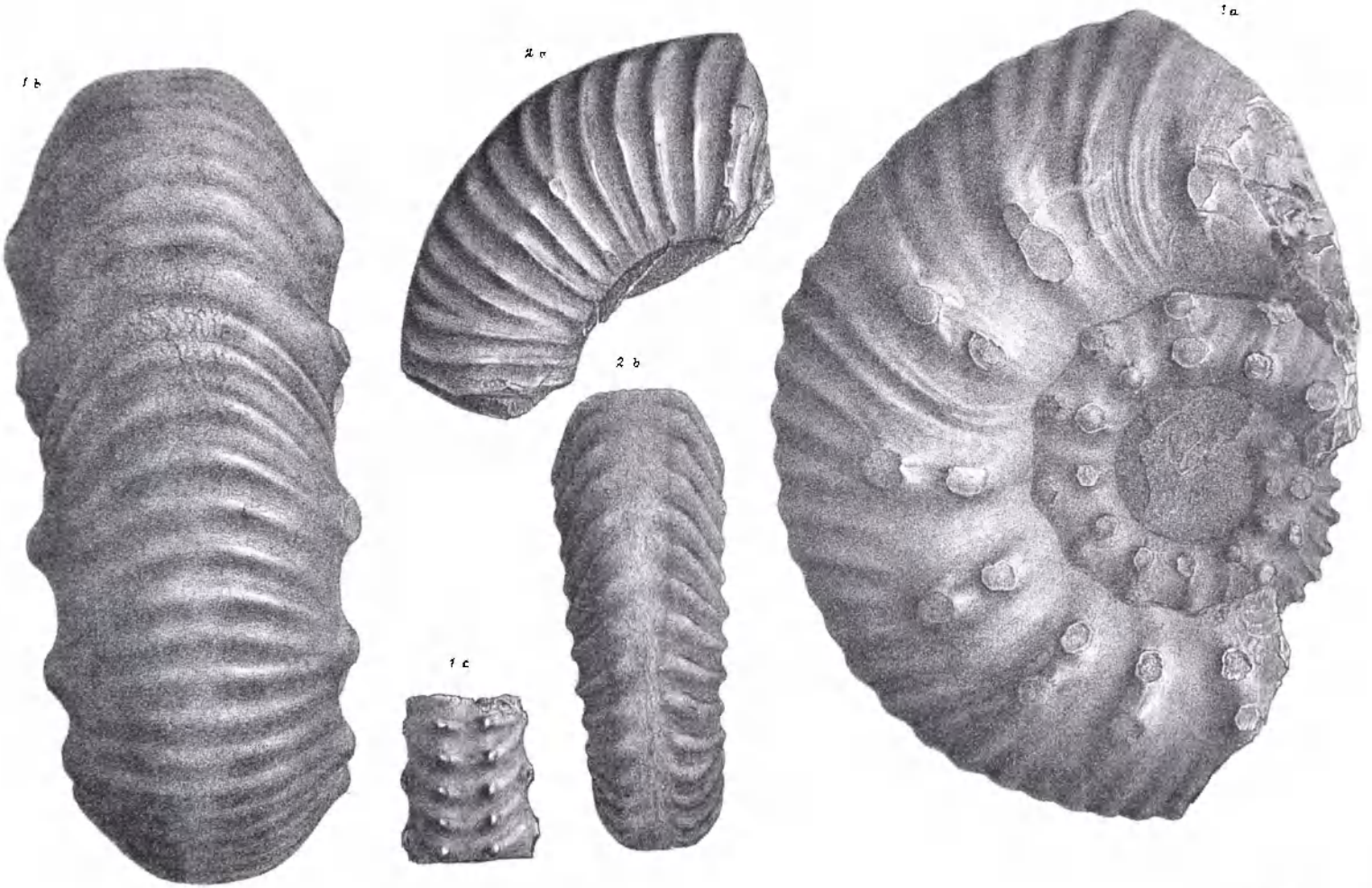
PLATE XXI.

Fig. 1 *a*—*c*. HOPLITES (ACANTHODISCUS) ACANTHINUS n. sp.
Page 210. Specimen partly retaining the shell. Natural size. The ultimate whorl belongs to the body-chamber. 1*a*, Lateral view. 1*b*, View of the external periphery of the ultimate whorl. 1*c*, View of the external periphery of the penultimate whorl. From Lochambelkichak, 3rd Stage.

Fig. 2 *a*, *b*. HOPLITES (ACANTHODISCUS) aff. MICHAELIS Uhlig.
Page 223. Specimen mostly preserved as an internal cast, and probably forming part of the body-chamber. Natural size. From Lochambelkichak, 3rd Stage.

Geol. Surv. of India.

JURASSIC FOSSILS (HIMALAYA).



Albert Berger print

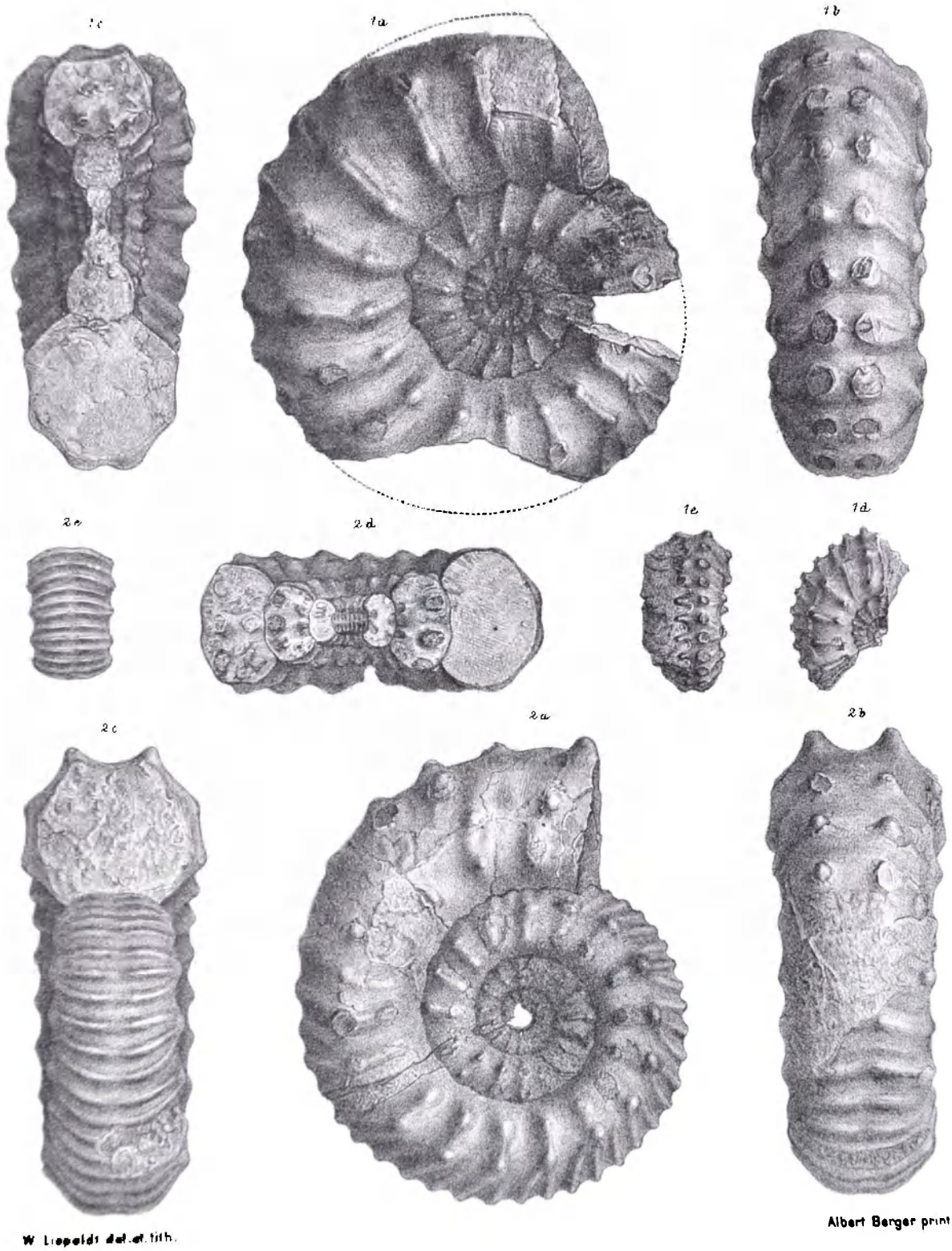
W. Liepold1 del. et lith.

PLATE XXII.

Fig. 1 *a*—*e*. HOPLITES (ACANTHODISCUS) OCTAGONUS Strachey-Blanford sp.
Page 204. Somewhat thicker variety. The anterior part of the ultimate whorl belongs to the body chamber. Natural size. 1*a*, Lateral view. 1 *b*, View of the external periphery. 1*c*, Cross-section. 1*d*, Lateral view of the inner whorls. 1*e*, Peripheral view, internal volution. From Kibber in Spiti.

Fig. 2 *a*—*e*. HOPLITES (ACANTHODISCUS) HUNDESIANUS n. sp.
Page 211. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Apertural view. 2*d*, Cross-section of the inner whorls. 2*e*, Peripheral view, internal volution. North of Ting Jung La (Pass), Hundes.

JURASSIC FOSSILS (HIMALAYA).



W. Leopold del. et lith.

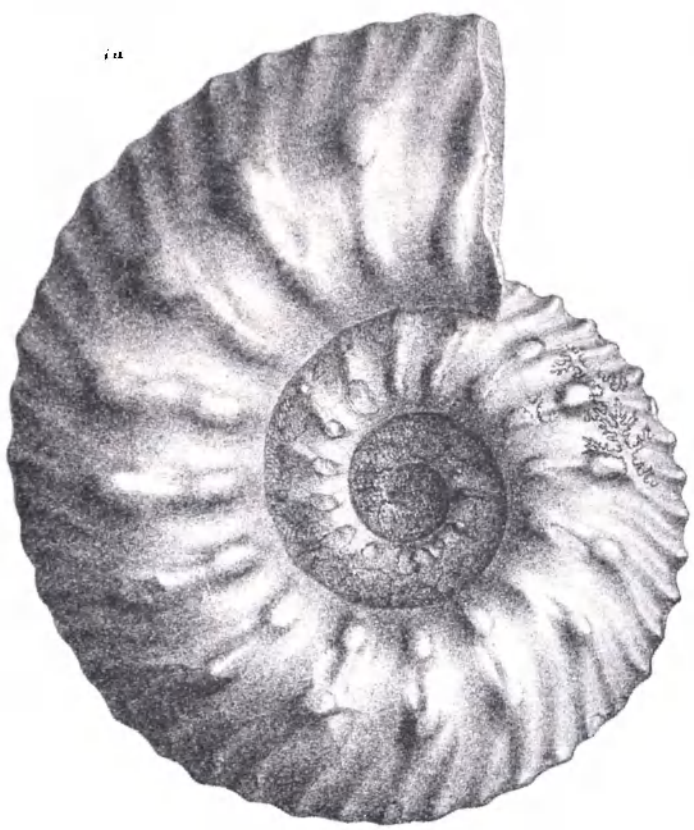
Albert Berger print

PLATE XXIII.

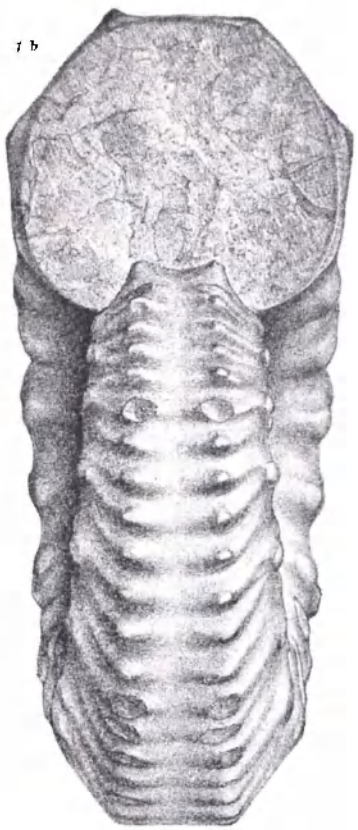
Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) SUBRADIATUS n. sp.
Page 208. Internal cast with a portion of the body-chamber preserved. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. (See plate XXVI.) From Lochambelkichak, 3rd Stage.

Fig. 2 *a*—*c*. HOPLITES (ACANTHODISCUS ?) HIMALAYANUS n. sp.
Page 227. Specimen with the shell partly adhering. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. From Lochambelkichak, 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).



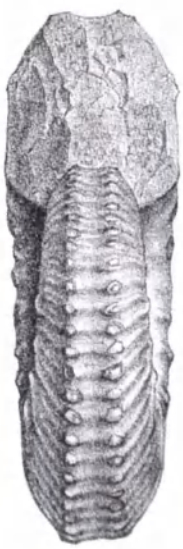
1 a



1 b

2 c

2 a.



2 b

R. Mayer del. et lith.

Albert Berger print.

PLATE XXIV.

Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) ASIATICUS n. sp.
Page 225. Specimen with the shell partly adhering. Natural size. The body-chamber probably begins at the point where the last whorl is broken. 1*a*, Lateral view. 1*b*, Apertural view. Lochambel beds, Lochambelkichak, 3rd Stage.

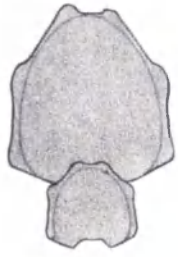
Fig. 2 *a*, *b*. HOPLITES (ACANTHODISCUS) TIBETANUS n. sp.
Page 224. Specimen mostly preserved as an internal cast. The anterior part of the last whorl probably belongs to the body-chamber. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. From Lochambelkichak, Lochambel beds.

Fig. 3 *a*—*c*. HOPLITES (ACANTHODISCUS) SMITHI n. sp.
Page 219. Internal cast. Natural size. The ultimate whorl belongs probably to the body-chamber. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Cross-section. From Lochambelkichak, ~~Lochambel beds~~. 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).

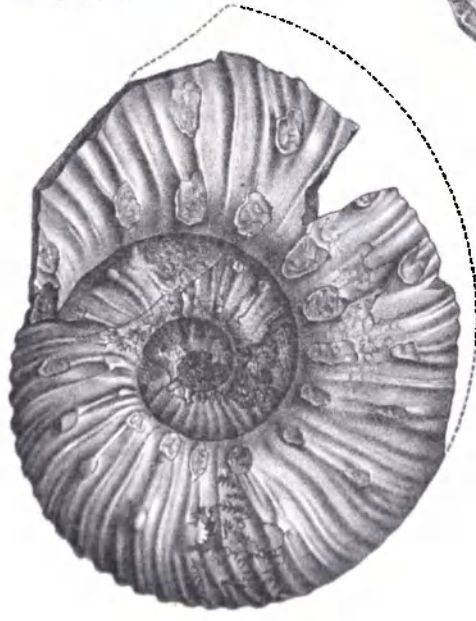

1b


1a


1c


3a


3b


2a


2b

R Meyer del et lith.

Albert Berger print.

PLATE XXV.

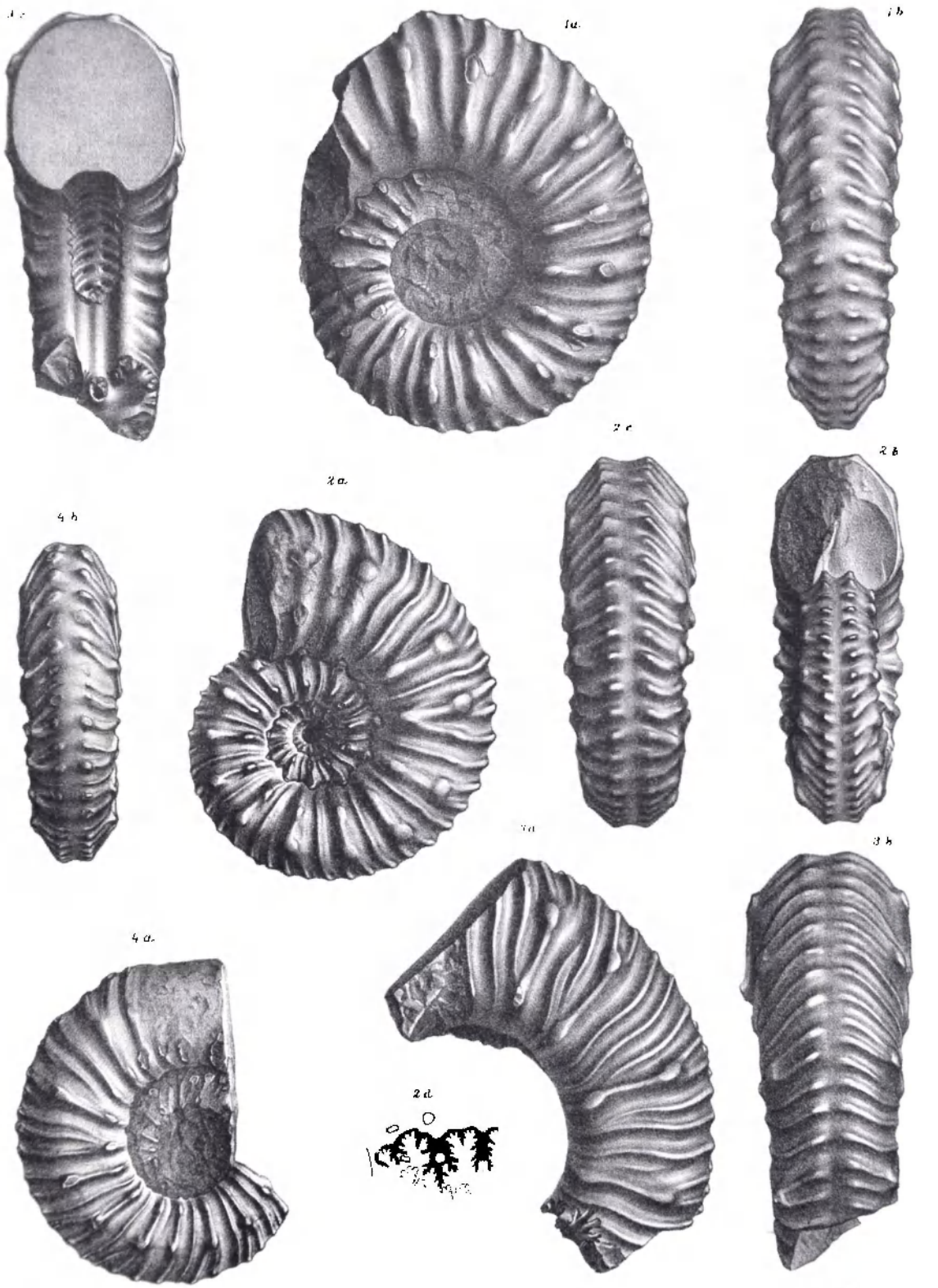
Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) LA TOUCHEI n. sp.
Page 217. Internal cast of a chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. From Lochambelkichak, ~~Lochambel beds~~. 3rd Stage.

Fig. 2 *a*—*d*. HOPLITES (ACANTHODISCUS) HOOKERI H. F. Blanford.
Page 215. Internal cast. Natural size. Half the last whorl belongs to the body-chamber. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. Lochambelkichak, ~~Lochambel beds~~. 3rd Stage

Fig. 3 *a*, *b*. HOPLITES (ACANTHODISCUS) aff. HYSTRICOIDES Uhlig.
Page 220. Fragment of the body-chamber. Internal cast. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. Lochambelkichak, ~~Lochambel beds~~. 3rd Stage

Fig. 4 *a*, *b*. HOPLITES (ACANTHODISCUS) ACANTHOPTYCHUS n. sp.
Page 218. Specimen mostly preserved as an internal cast. The most anterior part of the ultimate whorl belongs probably to the body-chamber. 4*a*, Lateral view. 4*b*, View of the external periphery. Lochambelkichak, ~~Lochambel beds~~. 3rd Stage

JURASSIC FOSSILS (HIMALAYA).



R Mayer del. et. lith.

Albert Berger print.

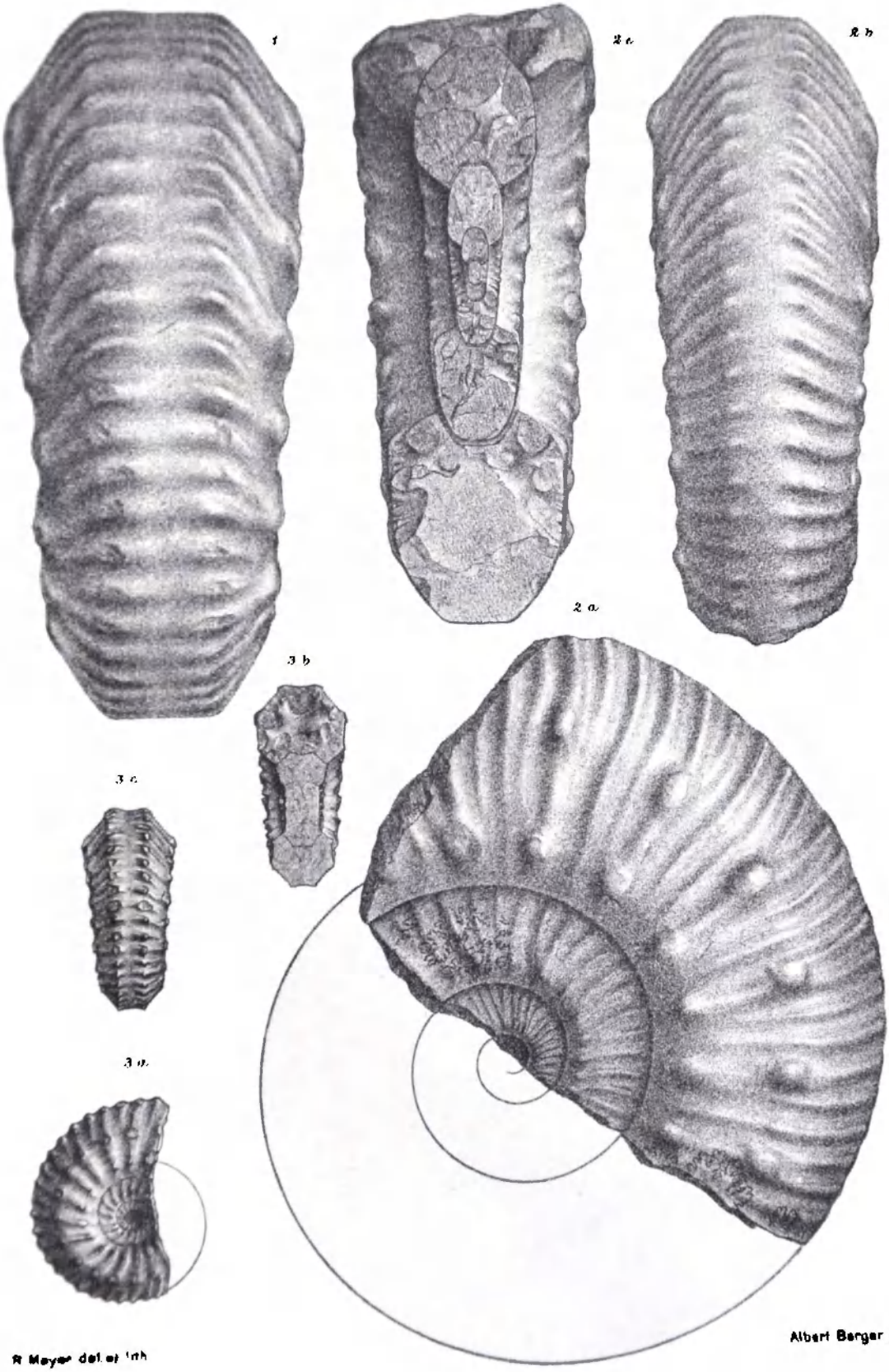
PLATE XXVI.

Fig. 1. HOPLITES (ACANTHODISCUS) SUBRADIATUS n. sp.
Page 208. View of the external periphery of the specimen figured in plate XXIII. From Lochambelkichak, 3rd Stage.

Fig. 2 *a—c*. HOPLITES (ACANTHODISCUS) SPITIENSIS n. sp.
Page 221. Fragment. Natural size. The ultimate whorl belongs to the body-chamber. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. From Lochambelkichak, 3rd Stage.

Fig. 3 *a—c*. HOPLITES (ACANTHODISCUS) n. sp. ind. aff. SUBRADIATUS n. sp.
Page 214. Young specimen. Natural size. 3*a*, Lateral view. 3*b*, Cross-section. 3*c*, view of the external periphery. From Spiti Valley.

JURASSIC FOSSILS (HIMALAYA).



R Meyer del. et lith

Albert Berger print.

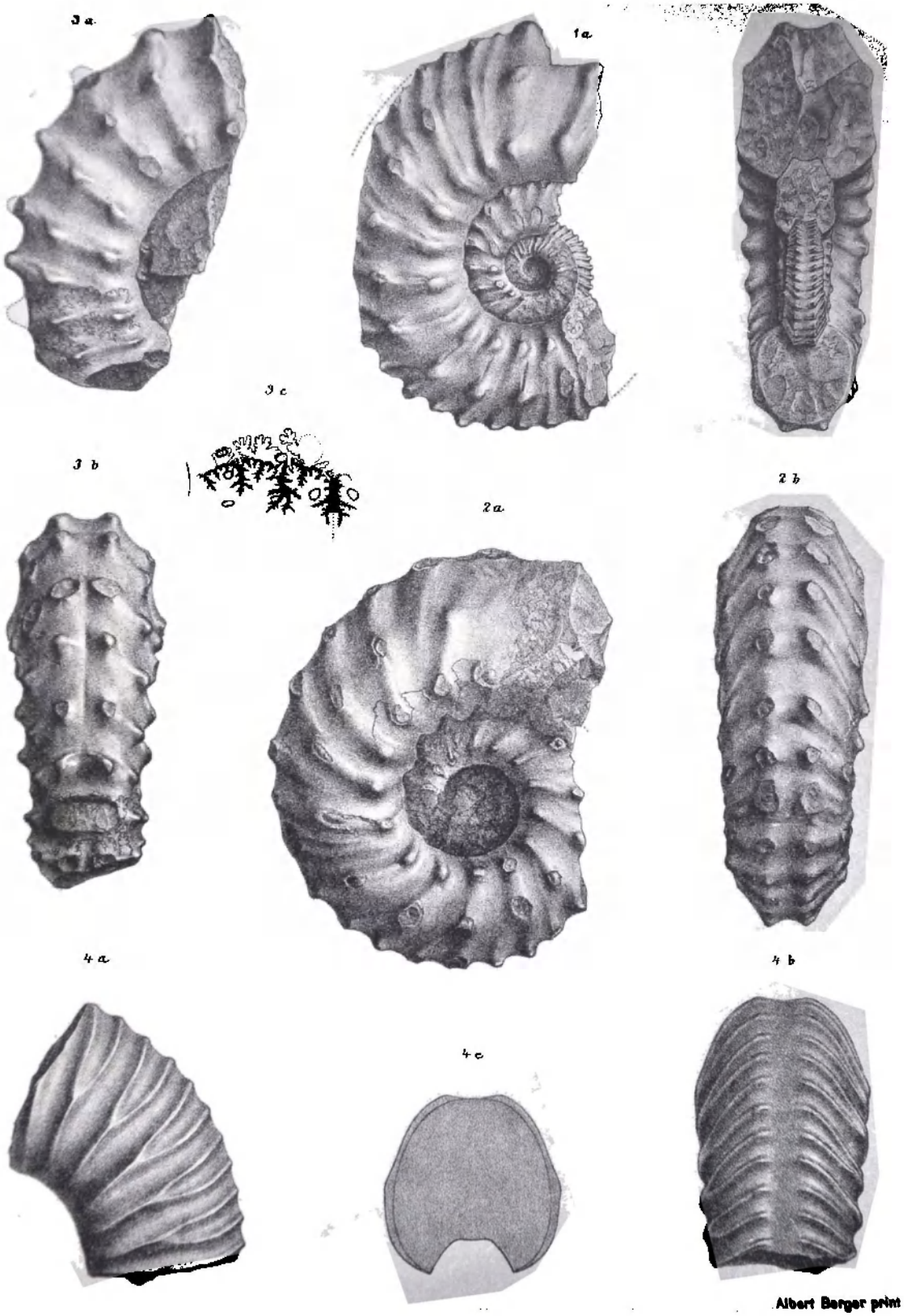
PLATE XXVII.

Fig. 1 *a*, *b*. HOPLITES (ACANTHODISCUS) OCTAGONOIDES n. sp.
Page 207. Chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. Lochambelkichak, 3rd Stage.

Fig. 2 *a*, *b*. HOPLITES (ACANTHODISCUS) OCTAGONOIDES n. sp.
Page 207. Internal cast consisting of iron pyrites. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. Lochambelkichak, 3rd Stage.

Fig. 3 *a*—*c*. HOPLITES (ACANTHODISCUS) OCTAGONUS Strachey-Blanford.
Page 204. Internal cast with a part of the body-chamber preserved. Natural size. This is the original specimen of Blanford's figure in *Journ. Asiat. Soc.* XXXII, pl. I, fig. 5 *a*—*c*. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Suture. Spiti Valley.

Fig. 4 *a*—*c*. HOPLITES (BLANFORDIA) n. sp. aff. ACUTICOSTA n. sp.
Page 203. Fragment belonging probably to the body-chamber. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Cross-section. Spiti Valley.



Albert Berger print

PLATE XXVIII.

Fig. 1 *a—d.* HOPLITES (BLANFORDIA) CRICKI n. sp.
Page 191. Internal cast including the commencement of the body-chamber. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Lochambelkichak, 3rd Stage.

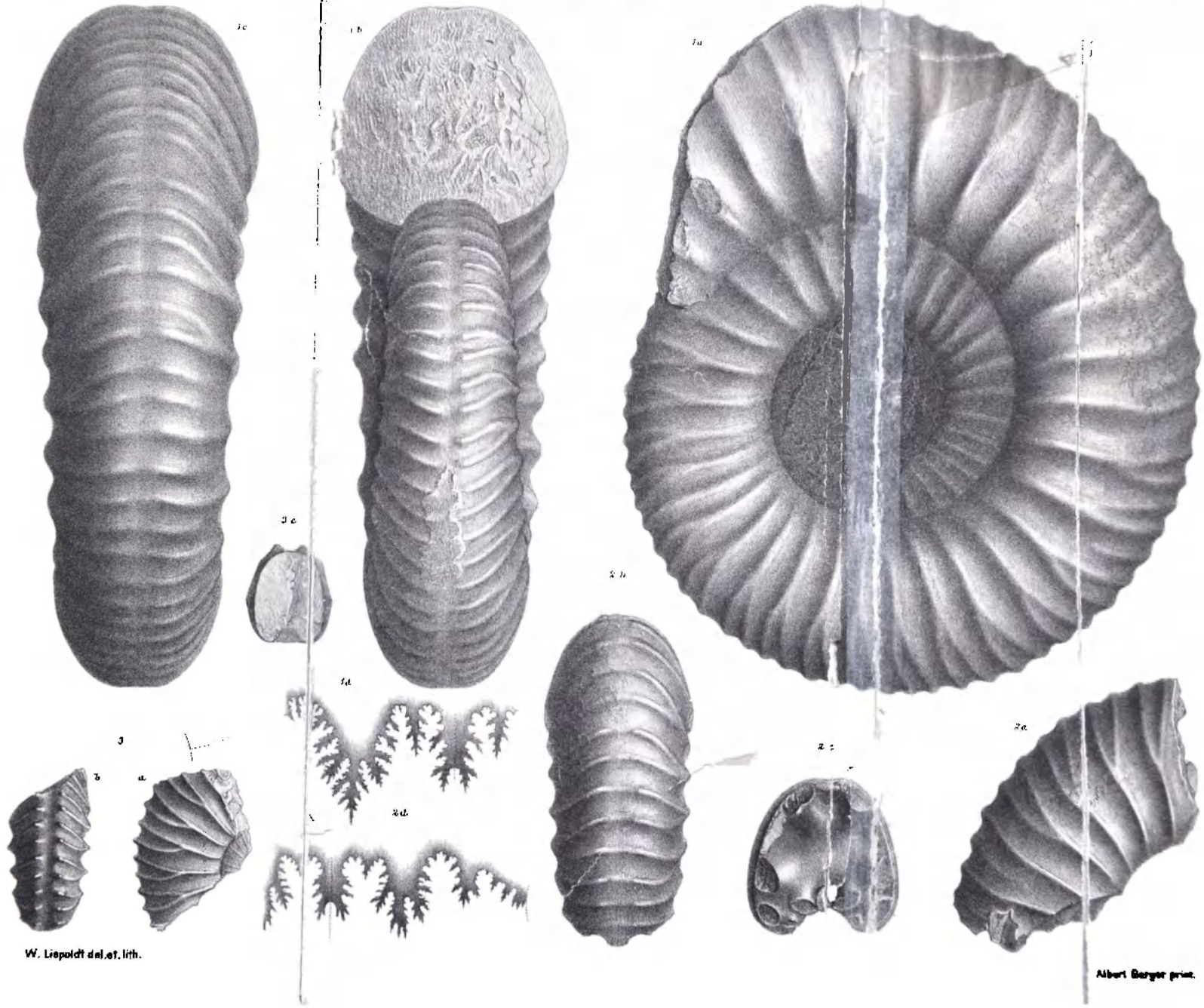
Fig. 2 *a—d.* HOPLITES (BLANFORDIA) n. sp. ind. aff. WALLICHI Gray sp.
Page 190. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Apertural view. 2*d*, Suture (the first lateral saddle is not correctly drawn). From Spiti Valley.

Fig. 3 *a—c.* HOPLITES (BLANFORDIA) n. sp. aff. ACUTICOSTA n. sp.
Page 203. Internal cast. Natural size. The specimen belongs probably to the body-chamber. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Cross-section. From the Spiti Shales.

Geol. Surv. of India.

JURASSIC FOSSILS (HIMALAYA).

Pl. XXVIII.



W. Liepoldt del. et. lith.

Albert Berger print.

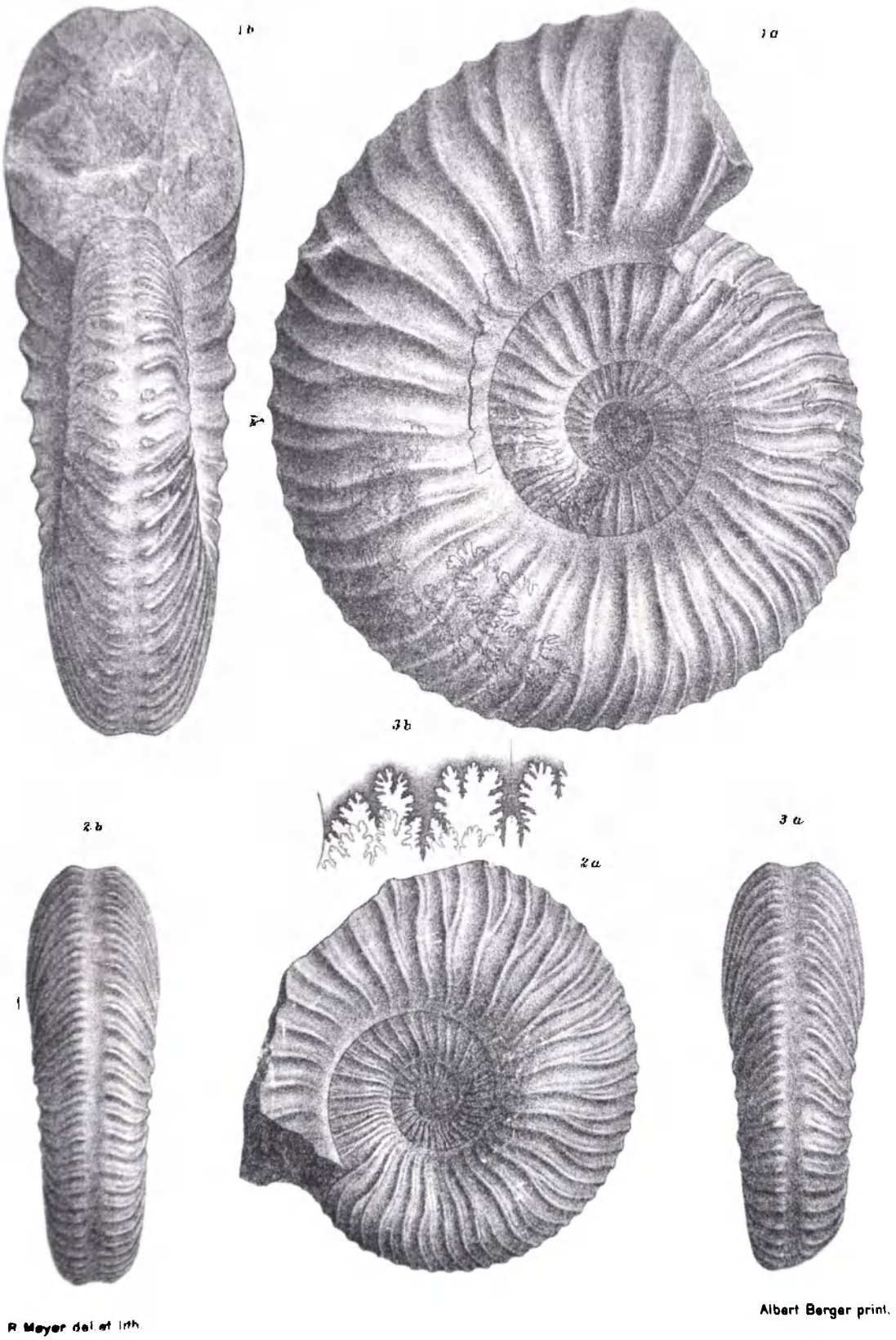
PLATE XXIX.

Fig. 1 *a*, *b*. HOPLITES (BLANFORDIA) WALLICHI Gray sp.
Page 186. Specimen with the shell partly adhering. Natural size. One quarter of the last whorl belongs to the body-chamber. From Lochambelkichak, 3rd Stage.

Fig. 2 *a*, *b*. HOPLITES (BLANFORDIA) WALLICHI Gray sp.
Page 186. Internal cast. Natural size. Lochambelkichak, 3rd Stage.

Fig. 3 *a*, *b*. HOPLITES (BLANFORDIA) WALLICHI Gray sp.
Page 186. 3*a*, View of the external periphery. 3*b*, Suture. For a lateral view of this specimen see plate XXXI, fig. 2. Spiti Valley. (See also Plate XXX, figure 1, and Plate XXXI, figures 1, 2.)

JURASSIC FOSSILS (HIMALAYA).



R Meyer del et lith.

Albert Berger print.

PLATE XXX.

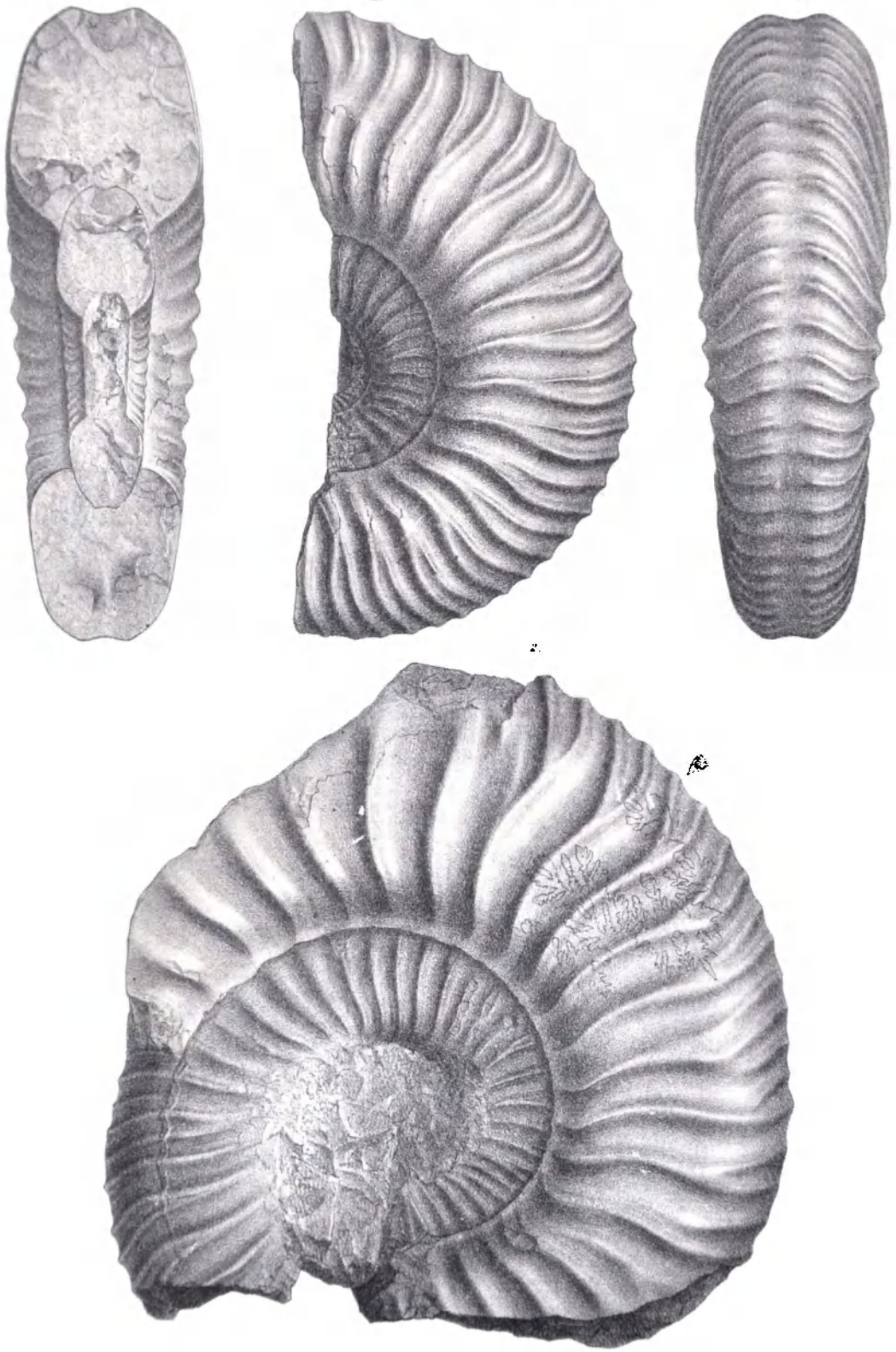
Fig. 1 *a*—*c*. HOPLITES (BLANFORDIA) WALLICHI Gray sp. Var. C

Page 186. Chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, Cross-section. 1*c*, View of the external periphery. From Lochambelkichak, 3rd Stage. (See pl. XXIX, pl. XXXI, figs. 1, 2.)

Fig. 2. HOPLITES (BLANFORDIA) APPLANATUS n. sp.

Page 193. Internal cast, with part of the body-chamber preserved. Natural size. The ultimate suture is drawn in the figure. (See also pl. XXXI, fig. 3 *a*—*c*.) From Lochambelkichak, 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).



R Mayer del. et lith.

Albert Berger print.

PLATE XXXI.

Fig. 1 *a*—*c*. HOPLITES (BLANFORDIA) WALLICHI Gray sp.

Page 186. Internal cast belonging probably to the body-chamber. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. From Kibber in Spiti. (See pl. XXIX and XXX.)

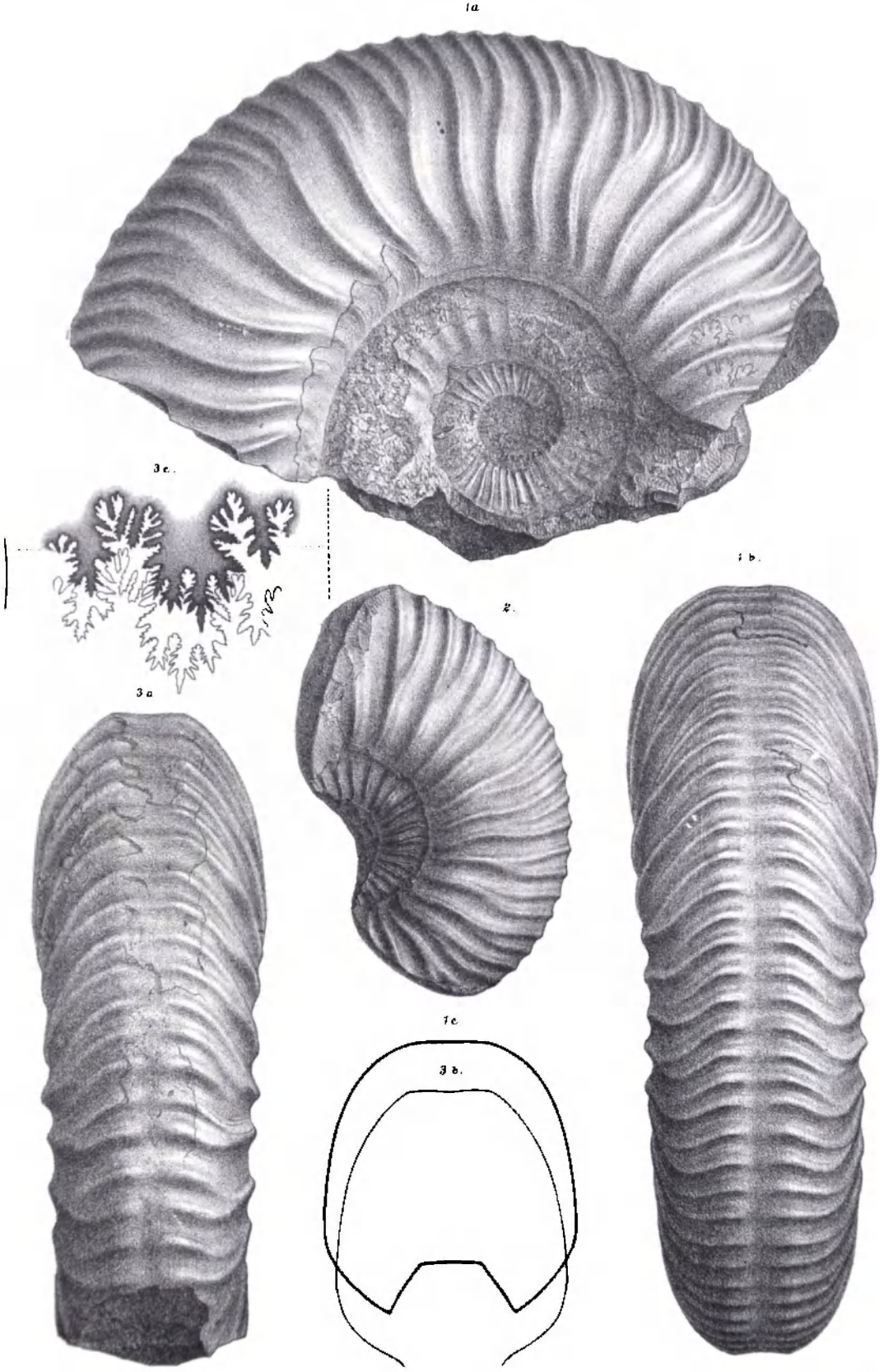
Fig. 2. HOPLITES (BLANFORDIA) WALLICHI Gray sp.

Page 186. Internal cast. Natural size. Lateral view. The suture and external periphery are represented in pl. XXIX, fig. 3 *a*, *b*. From Spiti Valley.

Fig. 3 *a*—*c*. HOPLITES (BLANFORDIA) APPLANATUS n. sp.

Page 193. External periphery, cross-section and suture of the specimen represented in pl. XXX, fig. 2. Natural size. From Lochambelkichak, 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).



R. Meyer del. et lith.

Albert Berger print.

PLATE XXXII.

Fig. 1 *a—d.* PERISPHINCTES (AULACOSPHINCTES) HOLLANDI n. sp.
Page 355. Internal cast, almost entirely chambered. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. 1*d*, Suture, with the internal inflections. North of Ting Jung La (Pass), Hundes.

Fig. 2 *a*, *b*. PERISPHINCTES (AULACOSPHINCTES) RAREPLICATUS n. sp.
Page 353. Internal cast. Natural size. The ultimate whorl belongs to the body-chamber. 2*a*, Lateral view. 2*b*, Cross-section. North of Ting Jung La (Pass), Hundes.

Fig. 3 *a*, *b*. PERISPHINCTES (AULACOSPHINCTES) cf. NATRICOIDES n. sp.
Page 356. Internal cast. Natural size. The ultimate whorl belongs to the body-chamber. 3*a*, Lateral view. 3*b*, Apertural view. From Shalshal, Middle Stage.

Fig. 4 *a—d.* PERISPHINCTES (AULACOSPHINCTES) PARVULUS n. sp.
Page 365. Internal cast. Natural size. Half of the ultimate whorl belongs to the body-chamber. 4*a*, Lateral view. 4*b*, Apertural view. 4*c*, View of the external periphery. 4*d*, Suture. From Shalshal, Middle Stage.

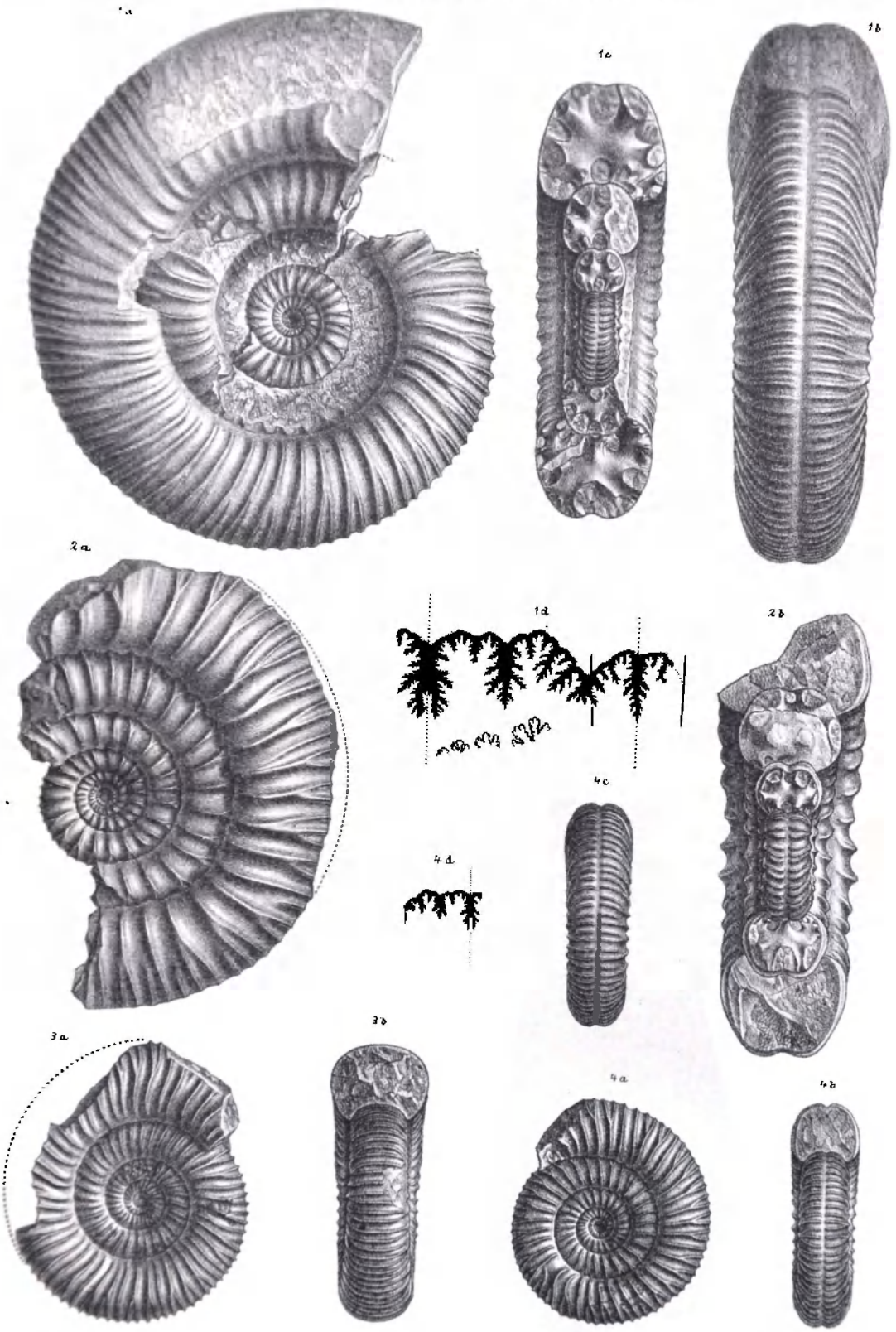

1a
1b
1c
1d
2a
2b
3a
3b
4a
4b
4c
4d

PLATE XXXIII.

Fig. 1 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) SPITIENSIS n. sp.
Page 352. Specimen for the most part preserved as an internal cast. Natural size. The anterior part of the ultimate whorl belongs probably to the body-chamber. (Original type of Stoliczka's *Ammonites Parkinsoni*). 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. From Gieumal.

Fig. 2 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) MORICKEANUS Oppel sp.
Page 351. Internal cast. Natural size. The anterior part of the ultimate whorl belongs to the body-chamber. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. From Gieumal.

Fig. 3 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) SPITIENSIS n. sp.
Page 352. Internal cast. Natural size. The ultimate whorl belongs mostly to the body-chamber. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Cross-sections of the ultimate whorl. From Chidamu.

JURASSIC FOSSILS (HIMALAYA).

1b

1a

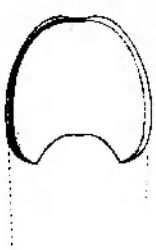
1c

2c

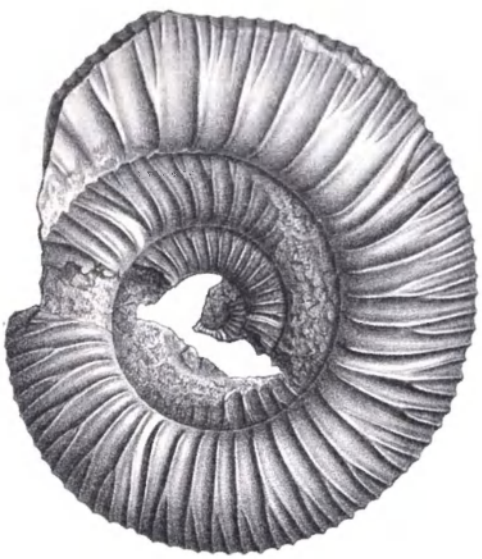
2a

2b

3a



3c



3b

R. Mayer del. et lith.

Albert Berger print.

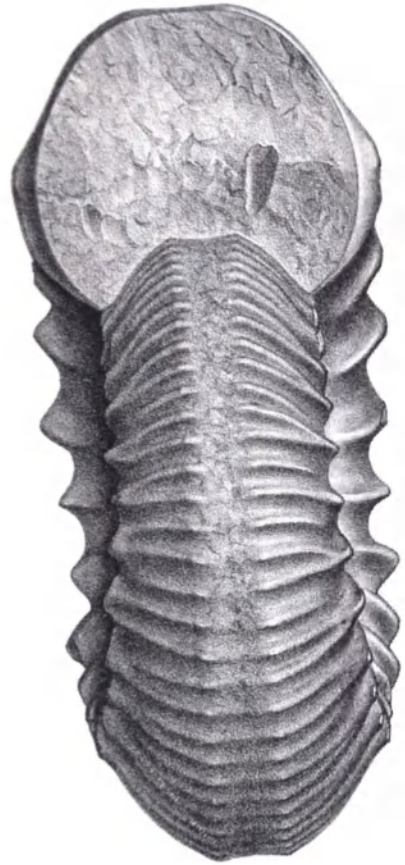
PLATE XXXIV.

Fig. 1 *a—d.* HOPLITES (BLANFORDIA) BOEHMI n. sp.
Page 195. Specimen chambered up to the end. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Lochambelkichak, 3rd Stage.

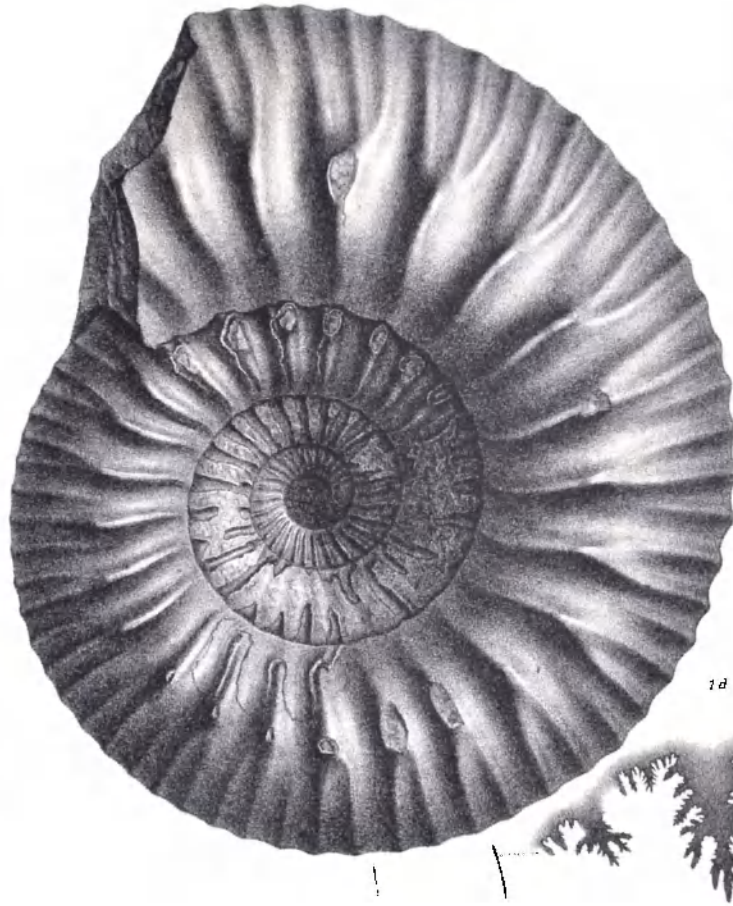
Geol. Surv. of India.

JURASSIC FOSSILS (HIMALAYA).

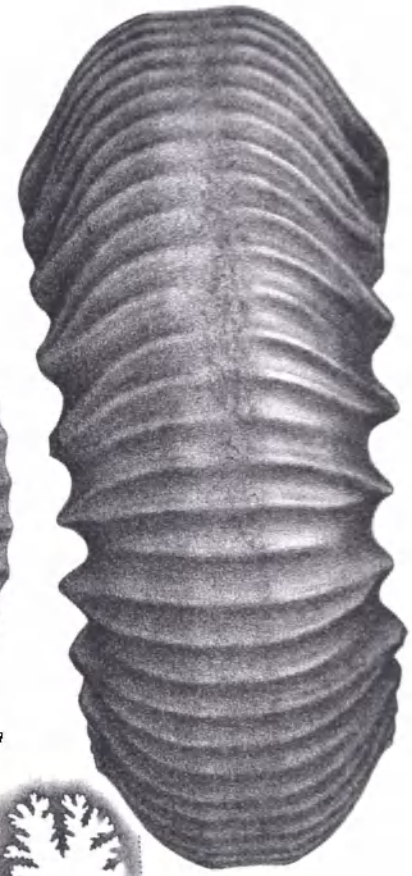
1 b



1 a



1 c



1 d

Albert Berger print.

PLATE XXXV.

Fig. 1 *a—c*. HOPLITES (BLANFORDIA) LATIDOMUS n. sp.
Page 196. Internal cast, chambered up to the end. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. From Lochambelkichak.

Fig. 2 *a—d*. HOPLITES (BLANFORDIA) CURVATUS n. sp.
Page 200. Chambered internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Suture. 2*d*, Cross-section. From Chanambaniali.

JURASSIC FOSSILS (HIMALAYA).

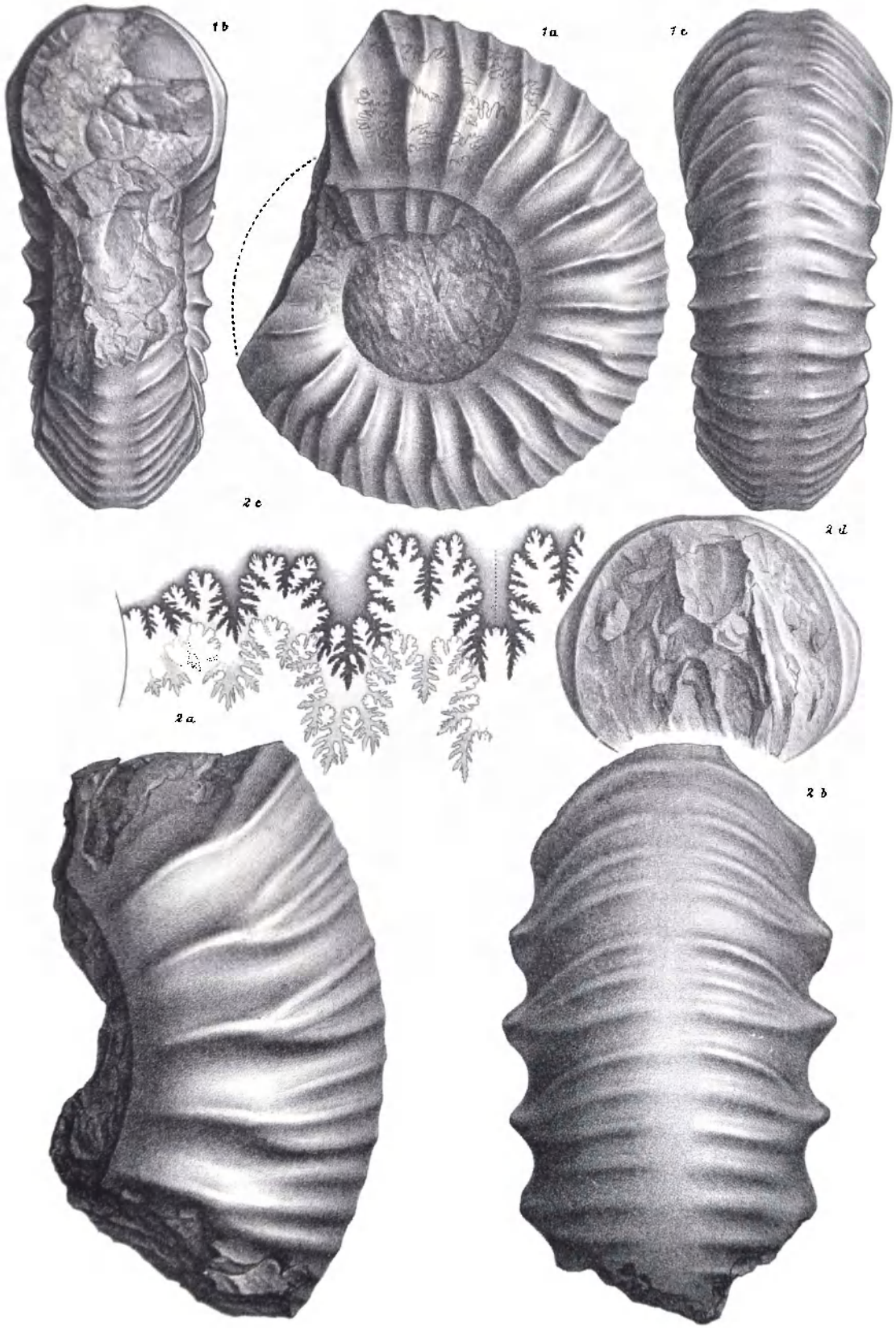
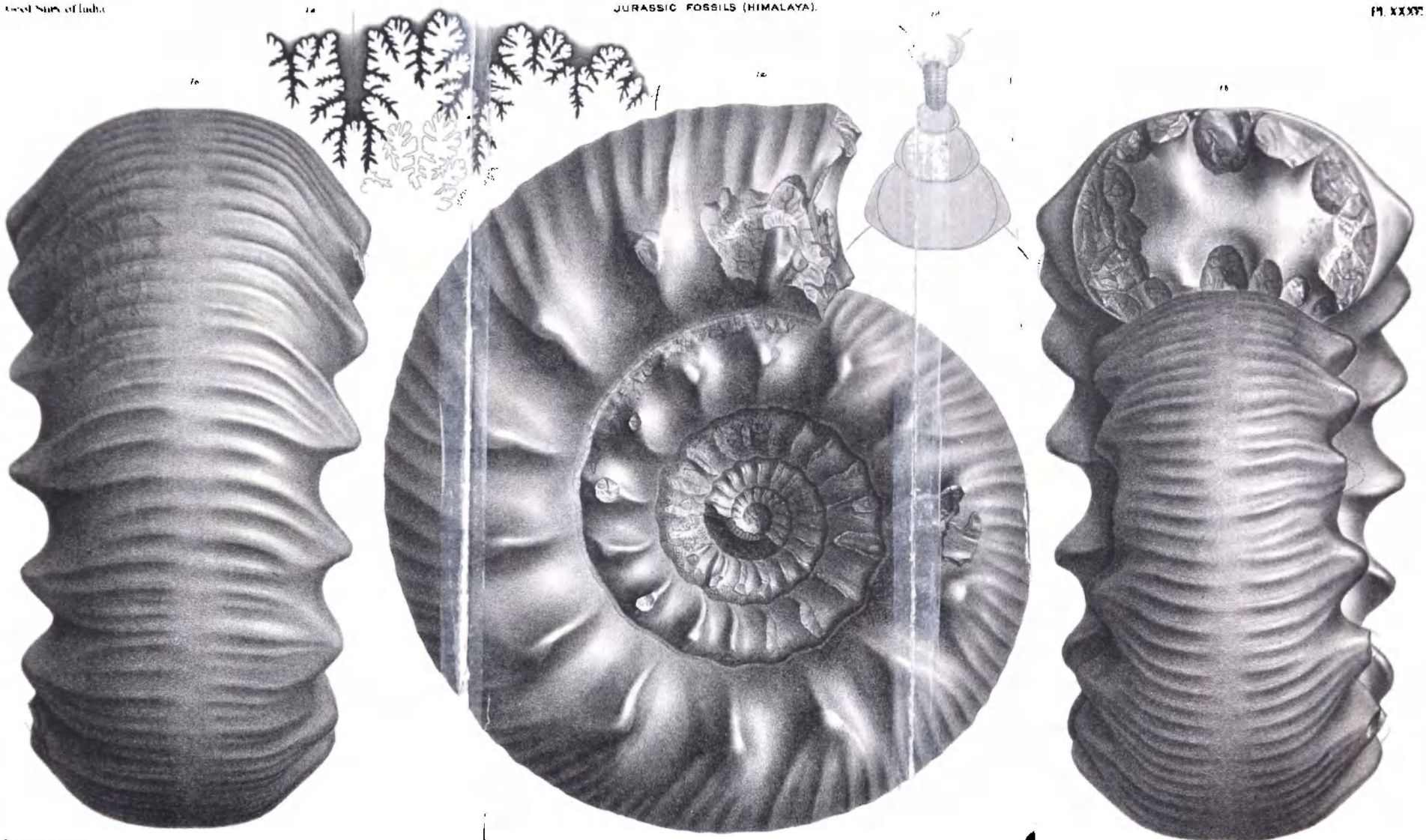


PLATE XXXVI.

Fig. 1 *a*—*e*. HOPLITES (BLANFORDIA) CELEBRANT n. sp.

Page 199. Chambered nucleus with the shell partly adhering. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Cross-section. External periphery with the weak furrow and the external tubercles of an inner whorl. 1*e*, Suture (correct only in the general outlines). From Lochambelkichak, 3rd Stage.



R. Mayer del. et lith.

Albert Berger print.

PLATE XXXVII.

Fig. 1 *a—c.* HOPLITES (BLANFORDIA) MIDDLEMISSI n. sp.

Page 197. Internal cast, chambered up to the end. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. From Lochambelkichak, 3rd Stage.

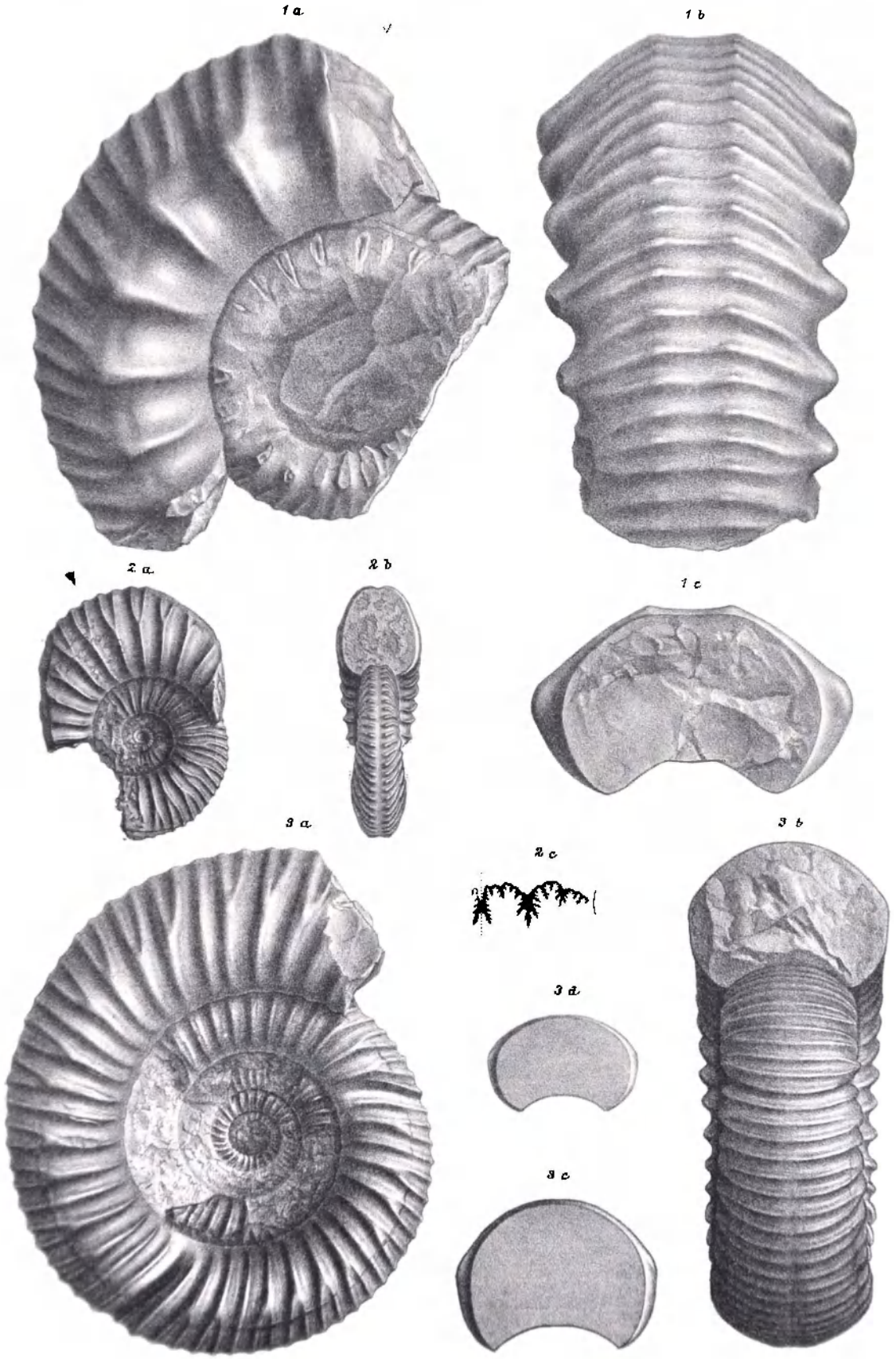
Fig. 2 *a—c.* HOPLITES (BLANFORDIA) ACUTICOSTA n. sp.

Page 201. Internal cast. Natural size. The anterior part belongs to the body-chamber. (Original type of Blanford's *Ammonites Wallichi Journal Asiatic Society*, Vol. XXXII, pl. I, fig. 4 [non pl. III, fig. 2, 3]. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, Suture. From Spiti Valley.

Fig. 3 *a—d.* PERISPHINCTES (AULACOSPHINCTES) KOSSMATI, n. sp.

Page 361. Almost entirely chambered specimen with the shell adhering and chambered nearly to the end. Natural size. 3*a*, Lateral view. 3*b*, Apertural view. 3*c*, 3*d*, Cross-sections. From Kibber.

JURASSIC FOSSILS (HIMALAYA).



R Mayer del. et lith

Albert Berger print

PLATE XXXVIII.

Fig. 1 *a—d.* HIMALAYITES STOLICZKAI n. sp.
Page 146. Internal cast of a chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. This is Stoliczka's original specimen of *Ammonites hyphasis*, figured in *Mem. Geol. Survey*, Calcutta, V, pl. X, fig. 2, p. 97. From near Gieumal.

Fig. 2 *a*, *b*. HIMALAYITES HYPHASIS Blanford sp.
Page 149. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. From Spiti Valley.

Fig. 3 *a—d*. HIMALAYITES HYPHASIS Blanford sp.
Page 149. Internal cast, with part of the body-chamber preserved. This is Blanford's original specimen of *Ammonites hyphasis* Blanford figured in *Journ. Asiat. Soc.* XXXII, pl. IV, figs. 2, 2*a*, 2*b*. Natural size. 3*a*, Lateral view. 3*b*, Apertural view. 3*c*, View of the external periphery. 3*d*, Suture. From Spiti, the exact locality is not given.

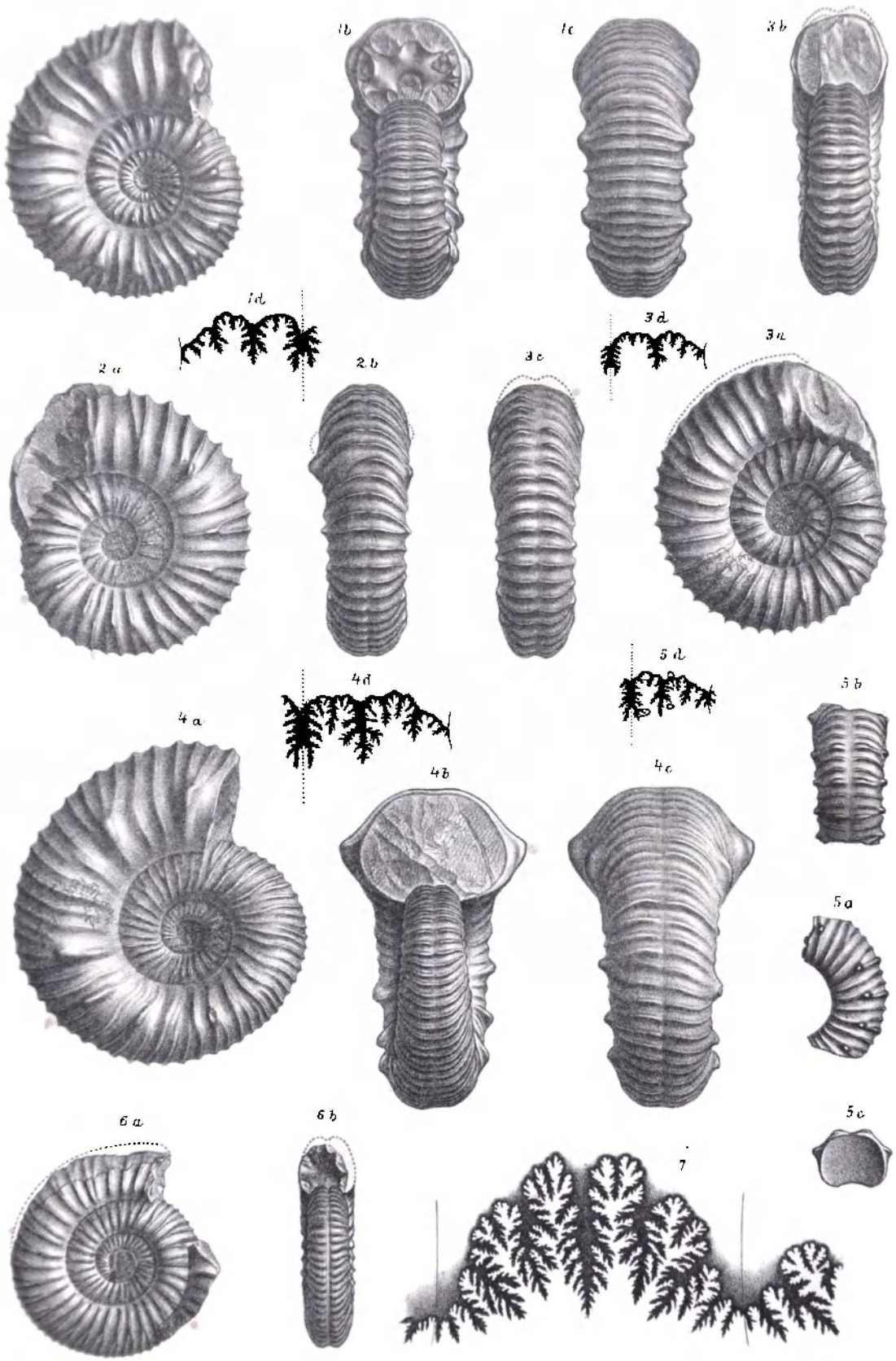
Fig. 4 *a—d*. HIMALAYITES VENTRICOSUS n. sp.
Page 145. Internal cast, with part of the body-chamber preserved. Natural size. 4*a*, Lateral view. 4*b*, Apertural view. 4*c*, View of the external periphery. 4*d*, Suture. From Lochambelkichak.

Fig. 5 *a—d*. HIMALAYITES n. sp. ind.
Page 150. Internal cast. Natural size. 5*a*, Lateral view. 5*b*, View of the external periphery. 5*c*, Cross-section. 5*d*, Suture. From Spiti Shales, Locality not noticed.

Fig. 6 *a*, *b*. PERISPHINCTES (AULACOSPHINCTES) MORICKEANUS Oppel sp.
Page 351. Internal cast. Natural size. 6*a*, Lateral view. 6*b*, Apertural view. From Jandu, Sherik river.

Fig. 7. HOLCOSTEPHANUS (SPITICERAS) sp. ind.
Page 395. Internal lobes of a badly preserved fragment. Natural size. Spiti Valley.

JURASSIC FOSSILS (HIMALAYA).



P. Mayer del et lith.

Albert Berger print.

PLATE XXXIX.

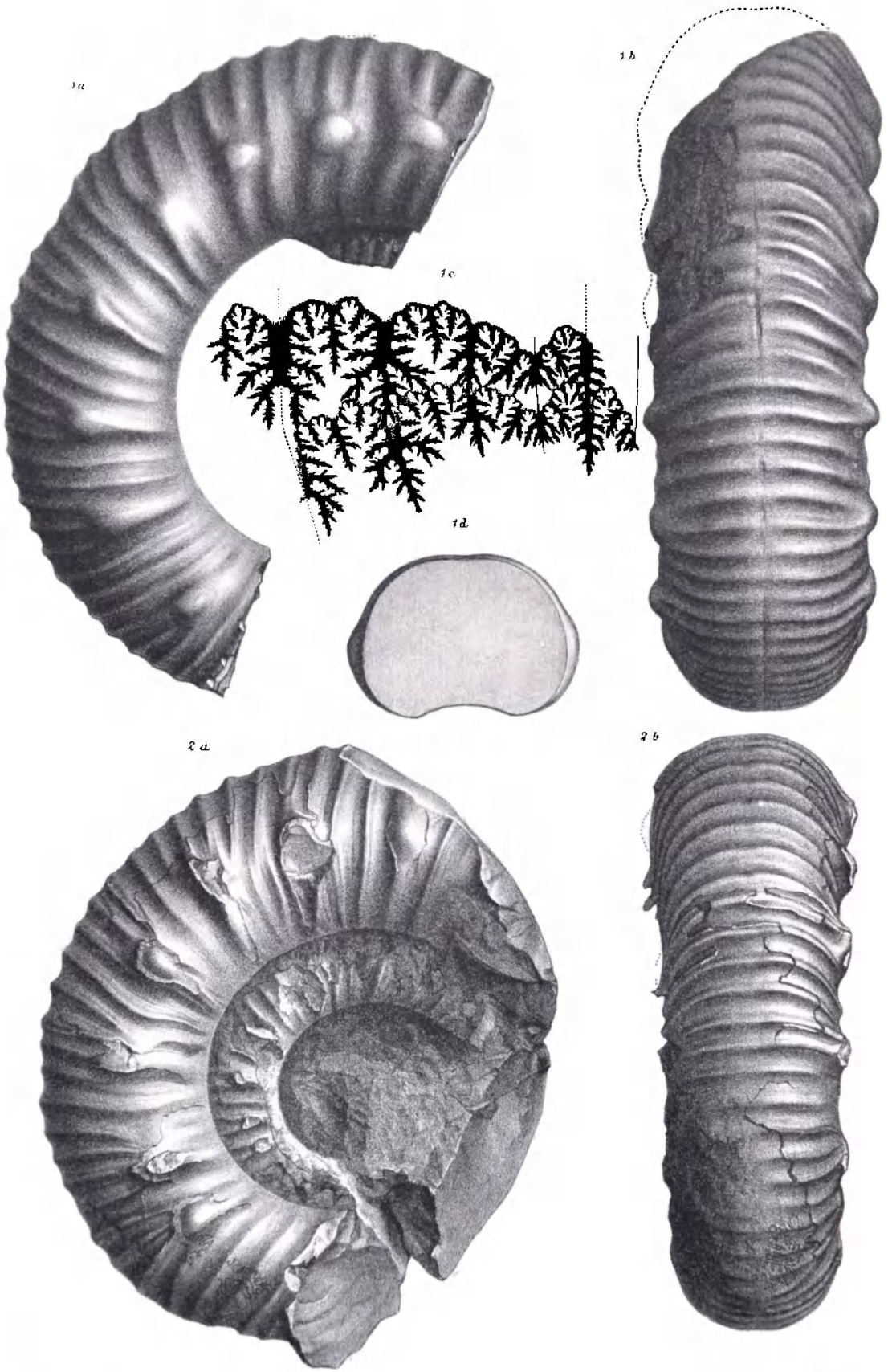
FIG. 1 *a*—*d*. HIMALAYITES HOLLANDI n. sp.

Page 144. Internal cast of a chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Two consecutive sutures, with internal lobes. 1*d*, Cross-section. From Spiti Shales.

FIG. 2 *a*, *b*. HIMALAYITES SEIDELI Oppel sp.

Page 140. Specimen with shell adhering. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. From Lochambelkichak, 3rd Stage.

JURASSIC FOSSILS (HIMALAYA).



R Meyer del et lith. Albert Berger print.

PLATE XL.

FIG. 1 *a—d.* HIMALAYITES SEIDELI Oppel sp.

Page 140. Chambered nucleus with most of the shell preserved. Natural size. 1*a*, Lateral view of the right-hand side. The shell exhibits here an injury. 1*b*, Lateral view of the left-hand side, with normal sculpture. 1*c*, Apertural view. 1*d*, View of the external periphery. From Lochambelkichak, 3rd Stage.

FIG. 2 *a—d.* HIMALAYITES DEPRESSUS n. sp.

Page 148. Internal cast, with part of the body-chamber preserved. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. 2*d*, Suture. From Spiti Valley.

JURASSIC FOSSILS (HIMALAYA)

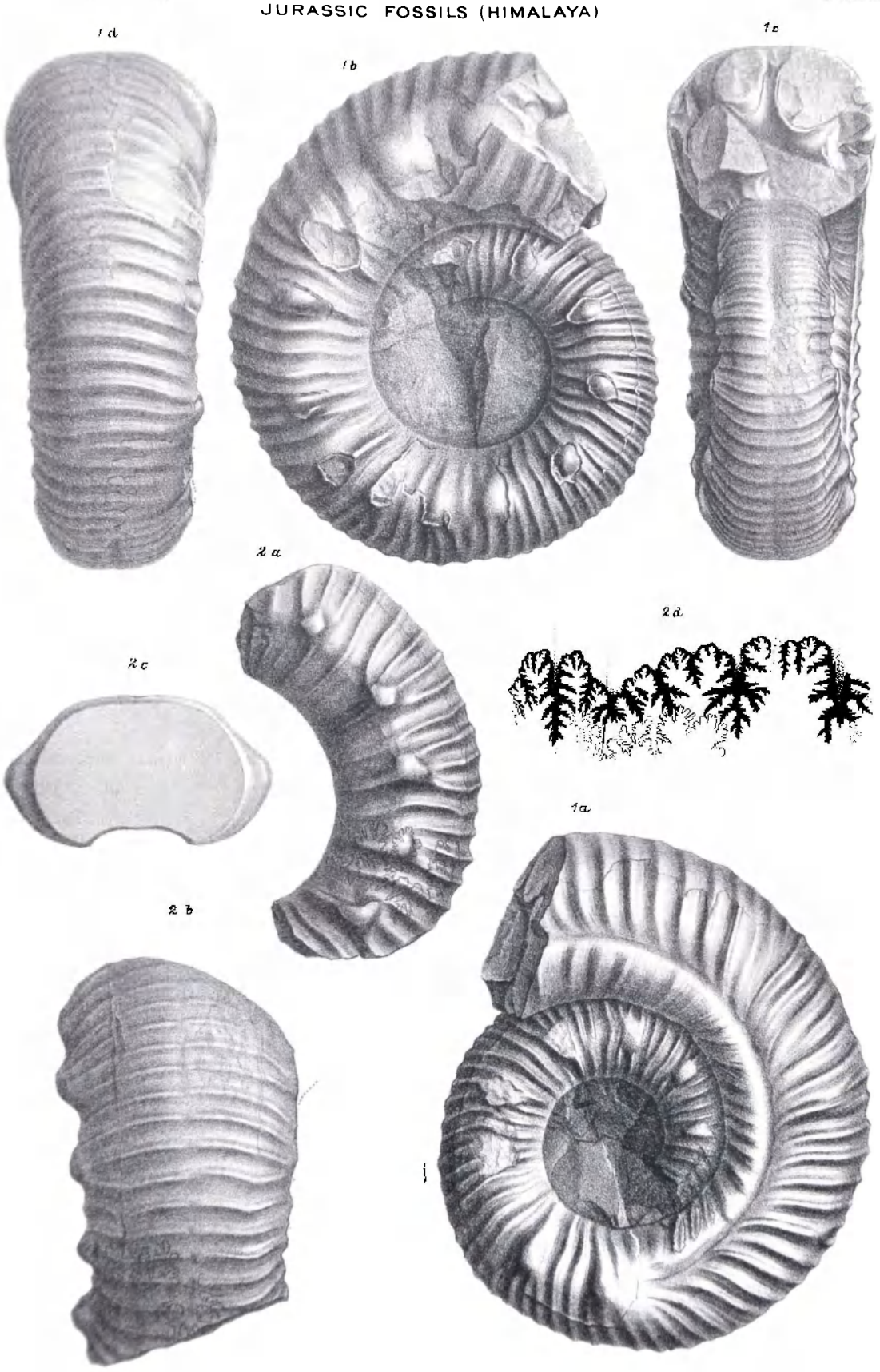


PLATE XLI.

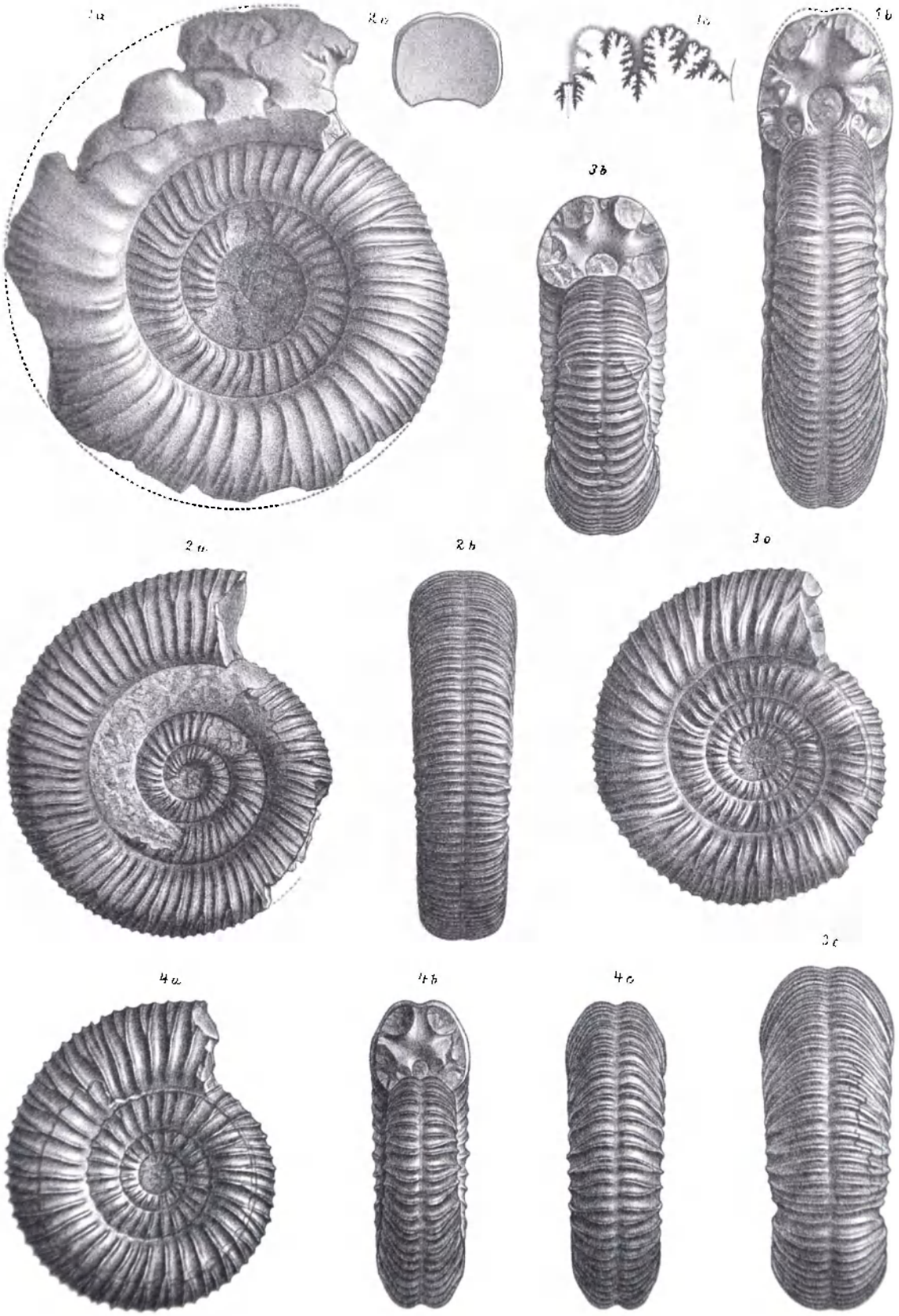
FIG. 1 *a—c*. PERISPHINCTES (AULACOSPHINCTES) SPITIENSIS n. sp.
Page 352. Internal cast of a chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, Suture. From Jandu, Sherik river.

FIG. 2 *a—c*. PERISPHINCTES (AULACOSPHINCTES) NATRICOIDES n. sp.
Page 356. Internal cast of a chambered nucleus. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. From Chidamu.

FIG. 3 *a—c*. PERISPHINCTES (AULACOSPHINCTES) PACHYGYRUS n. sp.
Page 358. Internal cast of a chambered nucleus. Natural size. 3*a*, Lateral view. 3*b*, Apertural view. 3*c*, View of the external periphery. North of Ting Jung La.

FIG. 4 *a—c*. PERISPHINCTES (AULACOSPHINCTES) LA TOUCHEI n. sp.
Page 357. Internal cast of a chambered nucleus. Natural size. 4*a*, Lateral view. 4*b*, Apertural view. 4*c*, View of the external periphery. From Chidamu.

JURASSIC FOSSILS (HIMALAYA).



P. Mayer del et lith.

Albert Berger print.

PLATE XLII.

FIG. 1 *a—c.* HOLCOSTEPHANUS (ASTIERIA) cf. SCHENKI Oppel. sp.
Page 130. Internal cast of the posterior part of the body-chamber. 1*a*, Lateral view. 1*b*, Cross-section. 1c, View of the external periphery. From Lochambelkichak, 3rd Stage (Neocomian).

FIG. 2 *a—c.* HIMALAYITES HOPLITIFORMIS n. sp.
Page 151. Internal cast of the posterior part of the body-chamber. 2*a*, Lateral view. 2*b*. View of the external periphery. 2*c*, Cross-section. From Spiti valley.

FIG. 3 *a, b.* PERISPHINCTES (AULACOSPHINCTES) cf. HOLLANDI n. sp.
Page 355. Internal cast. Natural size. The anterior part of the ultimate whorl belongs to the body-chamber. 3*a*, Lateral view. 3*b*, View of the external periphery. From Jandu, Sherik river, Hundes.

FIG. 4 *a—c.* PERISPHINCTES (AULACOSPHINCTES) LINOPTYCHUS n. sp.
Page 358. Internal cast with body-chamber preserved. Natural size. 4*a*, Lateral view. At the broken anterior end of the body-chamber is a slightly visible constriction, which probably accompanies the apertural margin. This was overlooked by the artist. 4*b*, Apertural view. 4*c*, View of the external periphery. From North Kumaon.

JURASSIC FOSSILS (HIMALAYA).

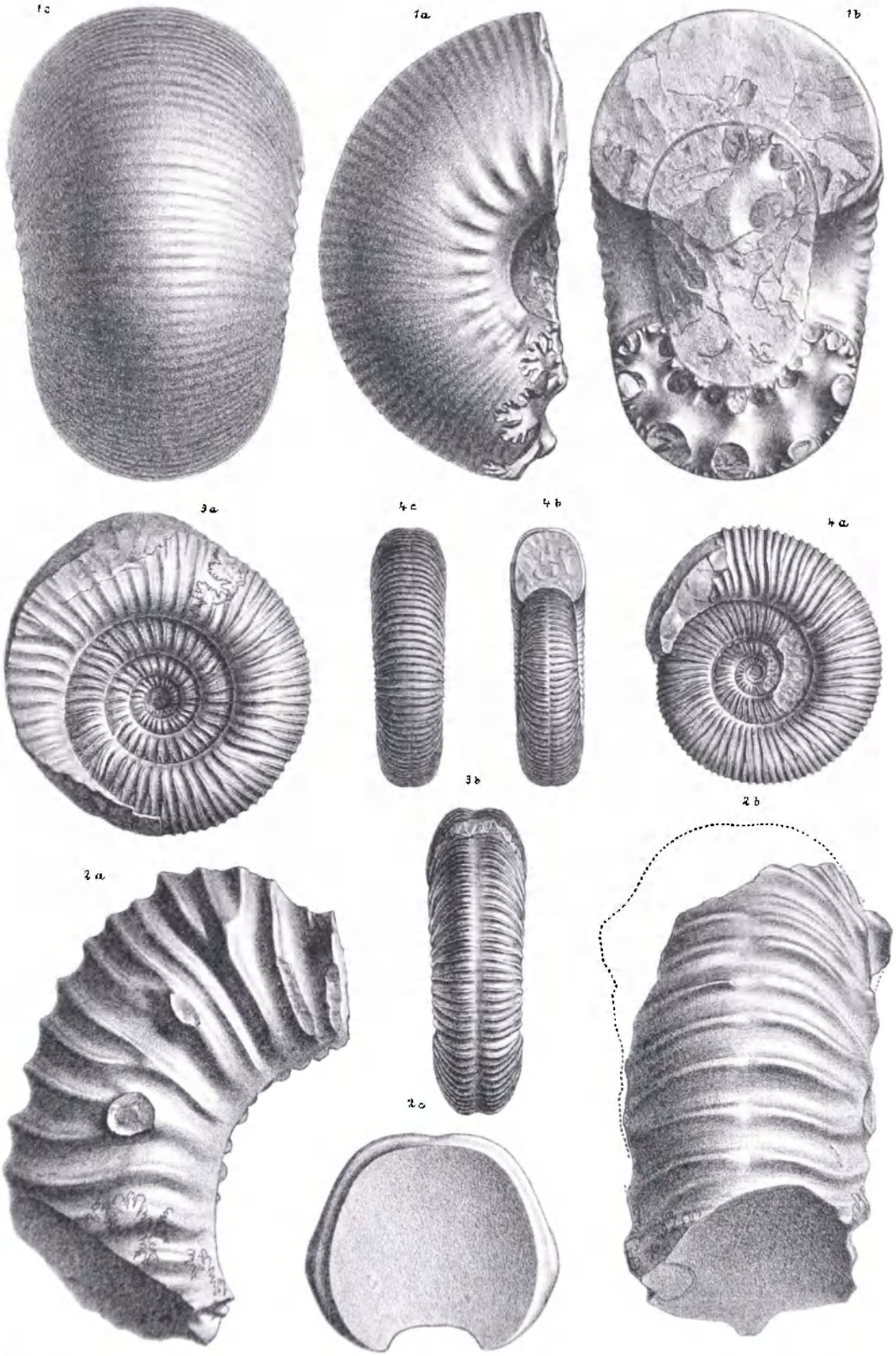


PLATE XLIII.

FIG. 1 *a—c*. OPPELIA (STREBLITES) KRAFFTI n. sp.

Page 44. Specimen with most of the body-chamber and part of the shell preserved. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery of the body-chamber. The suture and a section of the keel are represented in the text. From Kuti, Upper and Middle Spiti Shales.

FIG. 2 *a—d*. OPPELIA (ŒCOTRAUSTES) ADELA n. sp.

Page 72. Chambered nucleus. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. The keel is provided with small tubercles conspicuous only on few parts and overlooked by the artist. From Tera Gadh, base of the Spiti Shales (Coll. Krafft).

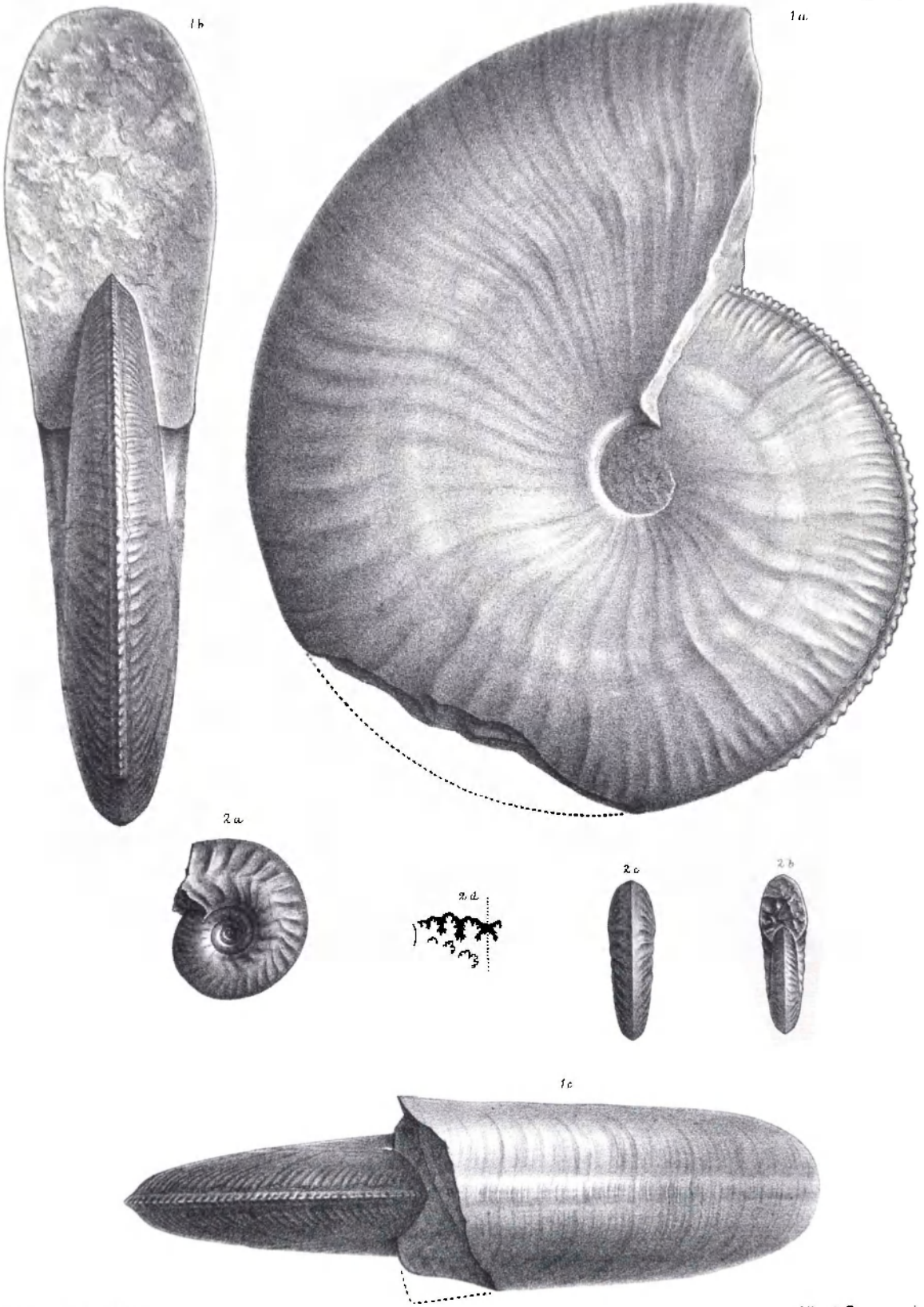

1b
1a
2a
2d
2c
2b
1c

PLATE XLIV.

FIG. 1 *a*, *b*. PERISPHINCTES (PARABOLICERAS) JUBAR (Strachey) Blanford sp.
Page 289. Specimen with part of the shell preserved. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. From Lochambelkichak, 3rd Stage.

FIG. 2. PERISPHINCTES (PARABOLICERAS) CYRTOPTYCHUS n. sp.
Page 291. Specimen with most of the shell preserved. Natural size. Lateral view. From Kuti, Upper and Middle Spiti Shales.

FIG. 3. PERISPHINCTES (PARABOLICERAS) SABINEANUS Oppel sp.
Page 292. Internal cast with part of the body-chamber preserved. Natural size. Lateral view. See also pl. 48, fig. 3.

FIG. 4 *a*, *b*. PERISPHINCTES (PARABOLICERAS) HAUGI n. sp.
Page 297. Internal cast, with part of the body-chamber preserved. Natural size. 4*a*, Lateral view. 4*b*, Cross-section. From Laptal Shales, Camp Sangcha.

FIG. 5 *a*, *b*. PERISPHINCTES (GROSSOUVRIA) PROPINQUUS n. sp.
Page 287. 5*a*, Lateral view. 5*b*, Apertural view. From Chikkim.

FIG. 6 *a*, *b*. PERISPHINCTES (PARABOLICERAS) aff. FASCICOSTATUS n. sp.
Page 305. Internal cast of a part of the body-chamber. Natural size. 6*a*, Lateral view. 6*b*, Peripheral view, internal volution. Schlagintweit Collection, Munich.


1a


1b


2


3


4b


4a


5a


5b


6 b


6 a

Albert Berger print

R. Meyer del. et lith.

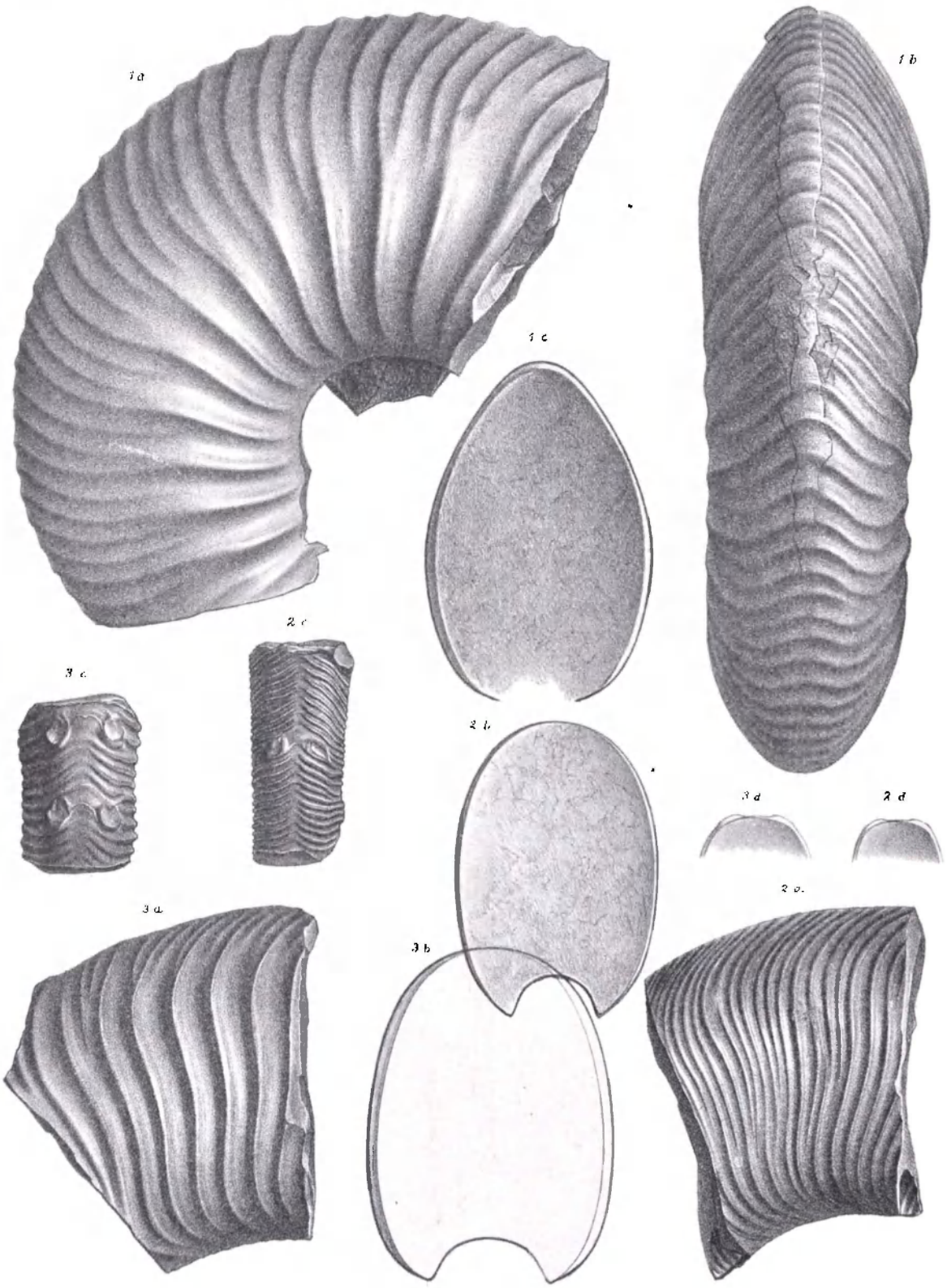
PLATE XLV.

FIG. 1 *a*—*c*. SIMBIRSKITES KOENENI n. sp.
Page 273. Fragment of body-chamber. Internal cast. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. Between Ting Jung La and Chota Hoti.

FIG. 2 *a*—*d*. PERISPHINCTES (PARABOLICERAS) sp. ind. cf. SPITIENSIS n. sp.
Page 303. Fragment of a body-chamber. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, Cross-section. 2*c*, Peripheral view, internal volution. 2*d*, Cross-section, internal volution. Chidamu.

FIG. 3 *a*—*d*. PERISPHINCTES (PARABOLICERAS) sp. n. indet.
Page 304. Fragment of a body-chamber. Internal cast. Natural size. 3*a*, Lateral view. 3*b*, Cross-section. 3*c*, Peripheral view, internal volution. 3*d*, Cross-section, internal volution. Chidamu.

JURASSIC FOSSILS (HIMALAYA).



R. Mayer del. et. lith.

Albert Berger print.

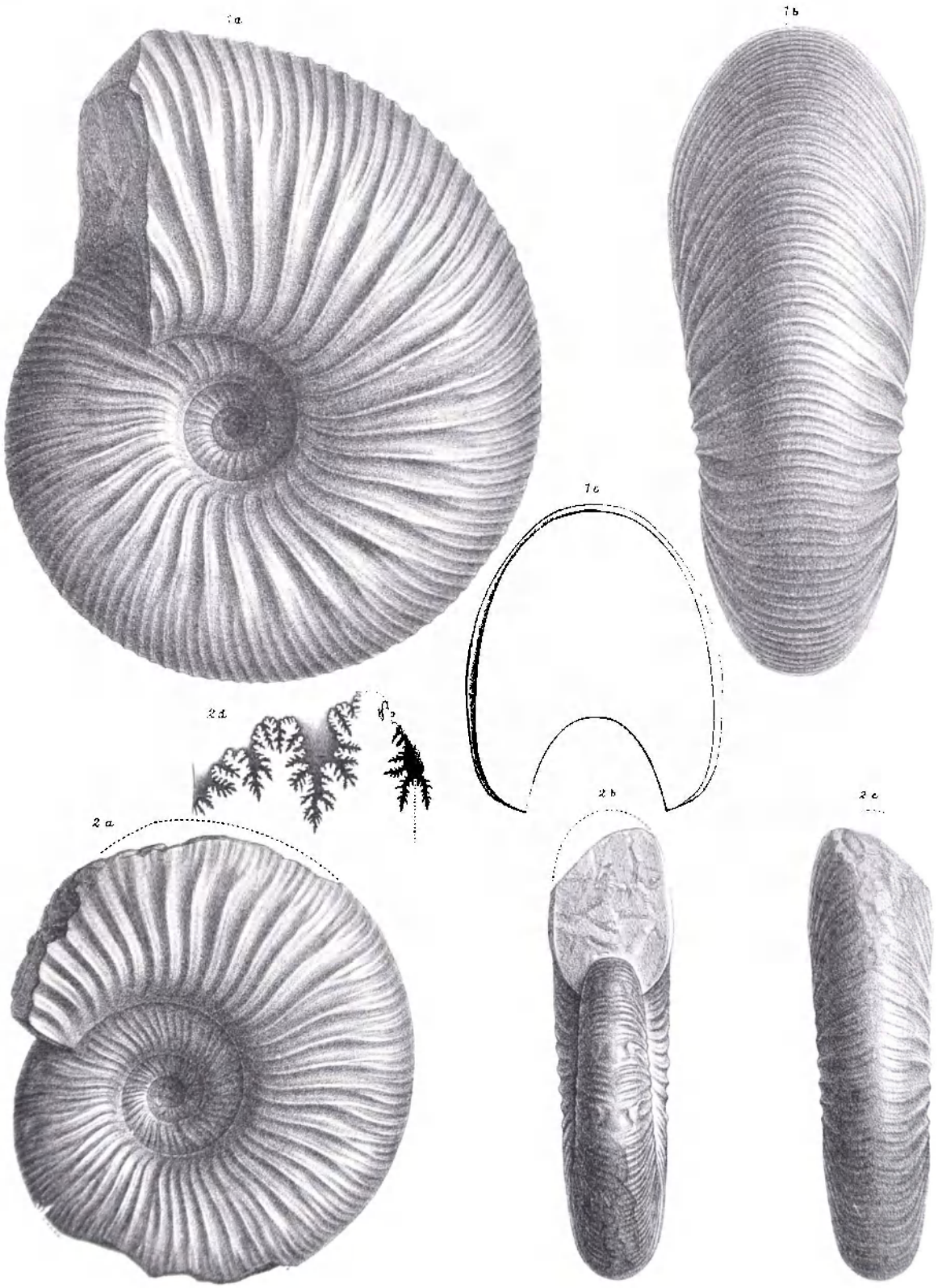
PLATE XLVA.

FIG. 1 *a*—*c*. SIMBIRSKITES NEPAULENSIS Gray sp.

Page 271. Drawn after a plaster-cast of H. F. Blanford's original specimen (Palæontology of Niti, pl. 14, fig. 1). 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. Niti.

FIG. 2 *a*—*d*. PERISPHINCTES (PARABOLICERAS) FASCICOSTATUS n. sp.

Page 304. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. Spiti Shales. Schlagintweit Collection, Munich.



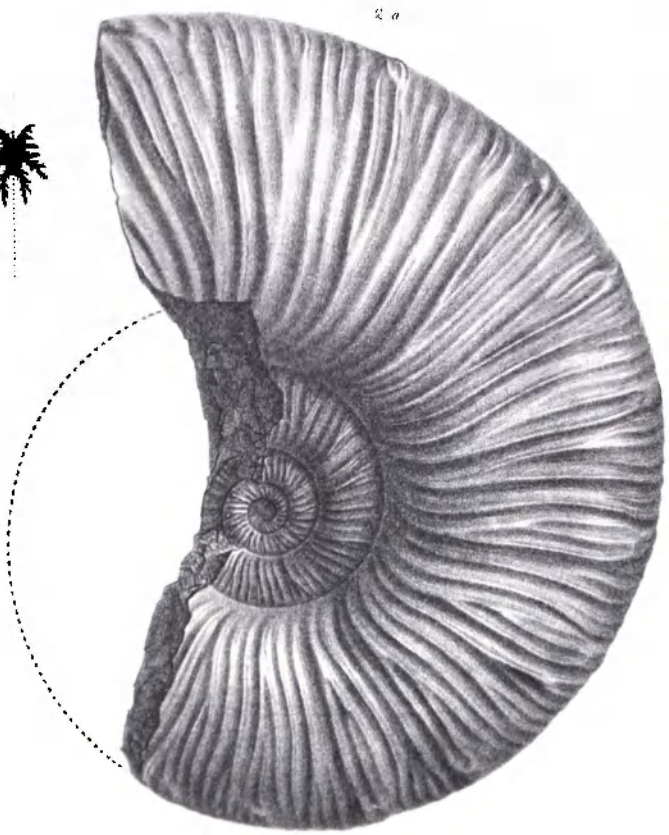
P. Mayer del et lith. Albert Berger print

PLATE XLVI.

FIG. 1 *a—d*. PERISPHINCTES (PARABOLICERAS) HIMALAYANUS n. sp.
Page 296. Internal cast, with part of the body-chamber preserved. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Jandu, Hundes.

FIG. 2 *a—c*. PERISPHINCTES (PARABOLICERAS) TIBETICUS n. sp.
Page 295. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 1*c*, Cross-section of the ultimate whorl. From Chidamu.

JURASSIC FOSSILS (HIMALAYA).



Albert Berger print

PLATE XLVII.

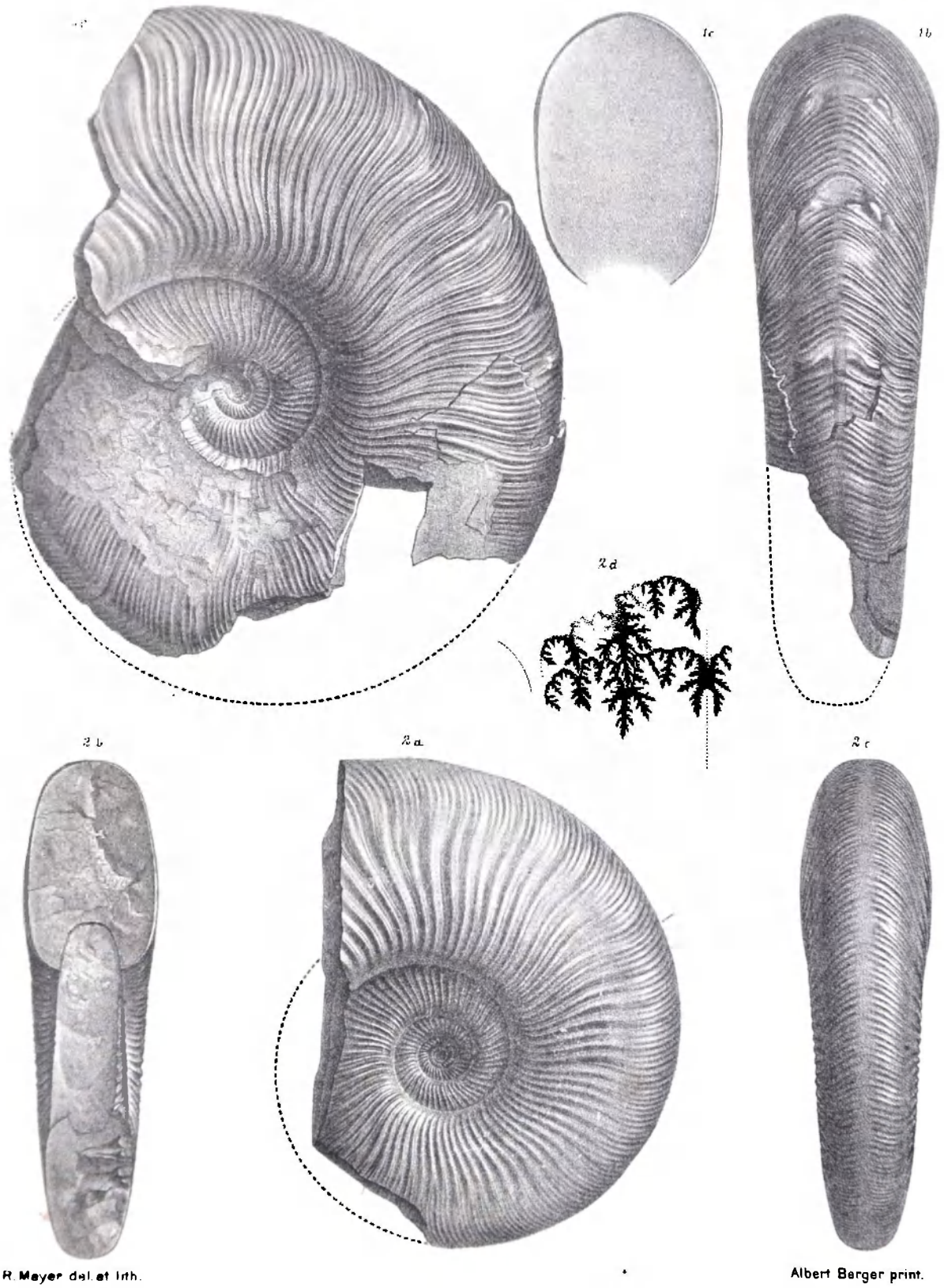
FIG. 1 *a—c.* PERISPHINCTES (PARABOLICERAS) SPITIENSIS n. sp.

Page 302. Specimen with part of the body-chamber preserved. The chambered nucleus has suffered from compression. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section of the body-chamber. From Jandu, Sherik river, Hundes.

FIG. 2 *a—d.* KOSSMATIA DESMIDOPTYCHA n. sp.

Page 277. Internal cast, with part of the body-chamber preserved. 2*a*, Lateral view. 2*b*, Cross-section. 2*c*, View of the external periphery. From Lochambelkichak, 2nd Stage.

JURASSIC FOSSILS (HIMALAYA).



R. Meyer del. et lith.

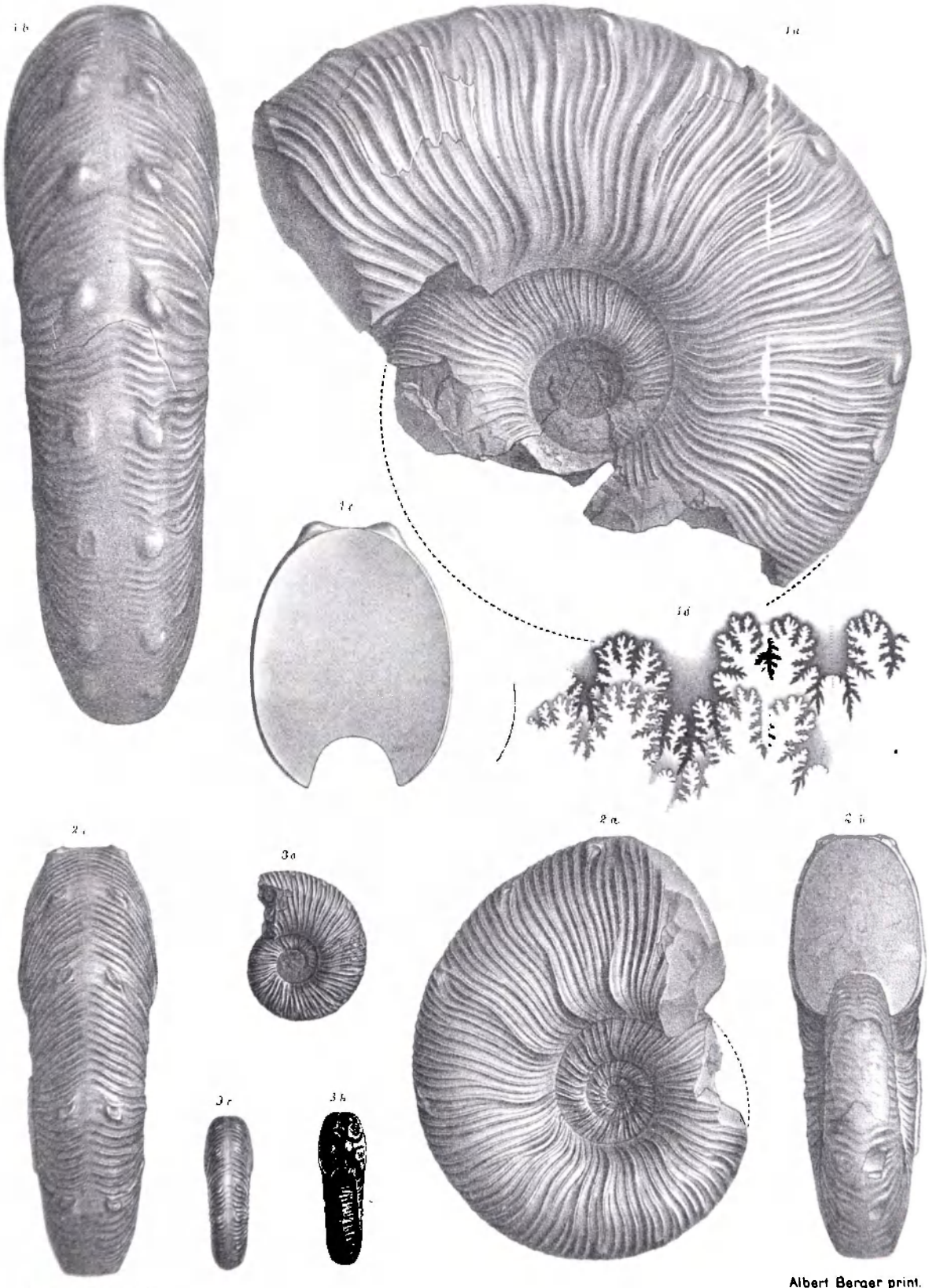
Albert Berger print.

PLATE XLVIII.

FIG. 1 *a—d*. PERISPHINCTES (PARABOLICERAS) GRIESBACHI n. sp.
Page 300. Specimen with posterior part of the body-chamber preserved. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section of the body-chamber. 1*d*, Suture. From Jandu, Hundes.

FIG. 2 *a—c*. PERISPHINCTES (PARABOLICERAS) POMPECKJI n. sp.
Page 301. Specimen with part of the body-chamber preserved, and the shell partly adhering. Natural size. 2*a*, Lateral view. 2*b*, Apertural view (the thickness is drawn too small by 2 mm.). 2*c*, View of the external periphery. From Kibber in Spiti.

FIG. 3 *a—c*. PERISPHINCTES (PARABOLICERAS) SABINEANUS Oppel sp.
Page 292. Chambered nucleus. Natural size. 3*a*, Lateral view. 3*b*, Apertural view. 3*c*, View of the external periphery. See also pl. 44, fig. 3. Chidamu.



R Mayer del. et lith.

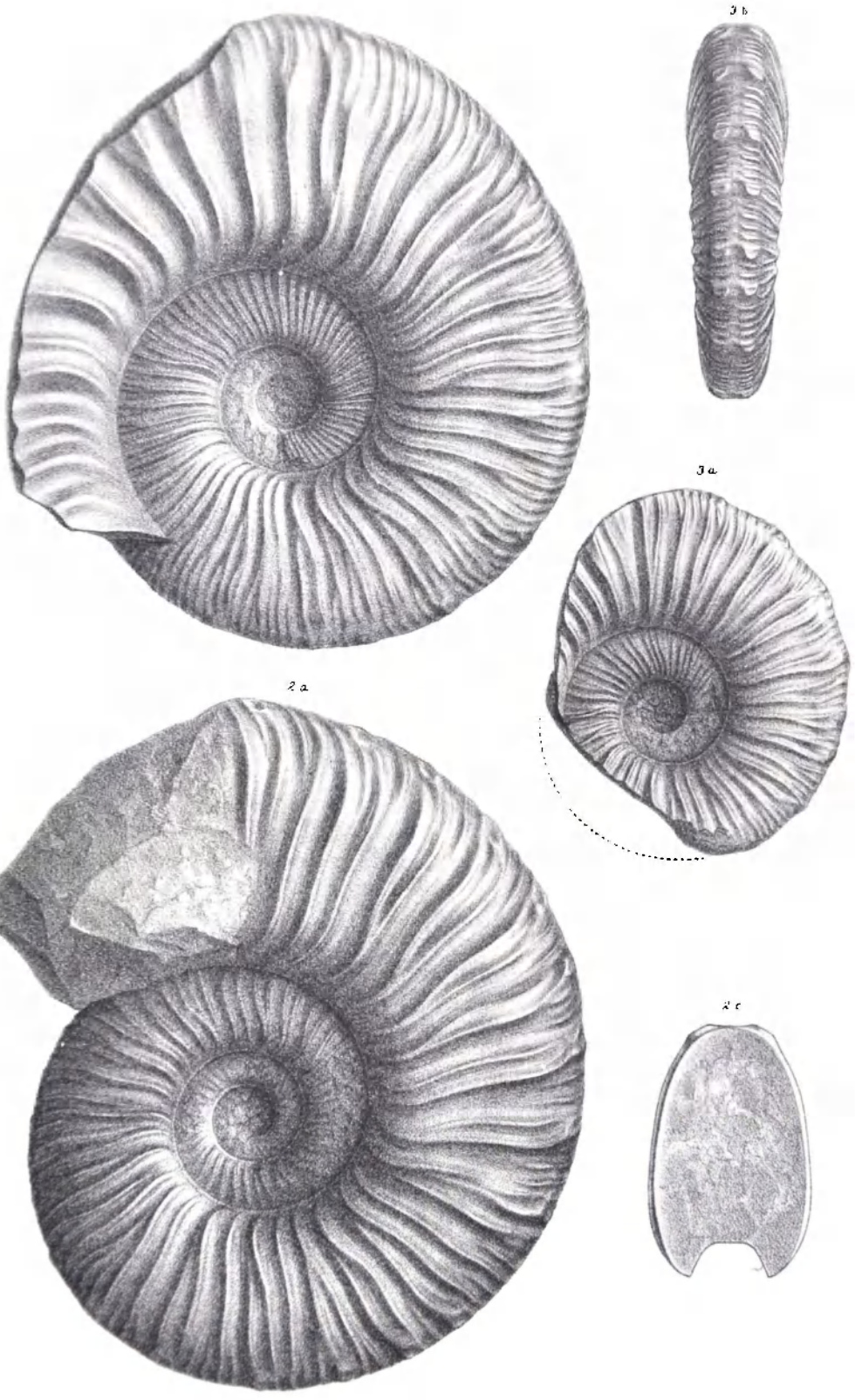
Albert Berger print.

PLATE XLVIIIA.

FIG. 1 *a*, *b*. PERISPHINCTES (PARABOLICERAS) HAUGI n. sp.
Page 297. Internal cast with the shell partly adhering. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. Spiti Shales. Coll. Schlagintweit, Munich.

FIG. 2 *a*—*c*. PERISPHINCTES (PARABOLICERAS) POLYSPHINCTUS n. sp.
Page 298. Specimen with the shell partly adhering, and a part of the body-chamber preserved. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. Spiti Shales. Coll. Schlagintweit, Munich.

FIG. 3 *a*, *b*. PERISPHINCTES (PARABOLICERAS) RECTECOSTATUS n. sp.
Page 290. Internal cast with a portion of the body-chamber preserved. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. Spiti Shales. Coll. Schlagintweit, Munich.



P. Mayer del. et lith.

PLATE LXXVII.

Fig. 1. MACROCEPHALITES WAAGENI n. sp.
Page 270. Chambered nucleus, somewhat compressed, but restored by the artist. Natural size. Lateral view. Gieumal, Spiti. (Oxfordian ?)

Fig. 2 *a*, *b*. MACROCEPHALITES WAAGENI n. sp.
Page 270. Chambered nucleus, somewhat compressed, but restored by the artist. Natural size. 2*a*, Lateral view. 2*b*, Front view. Near Gieumal, Spiti. (Oxfordian ?).

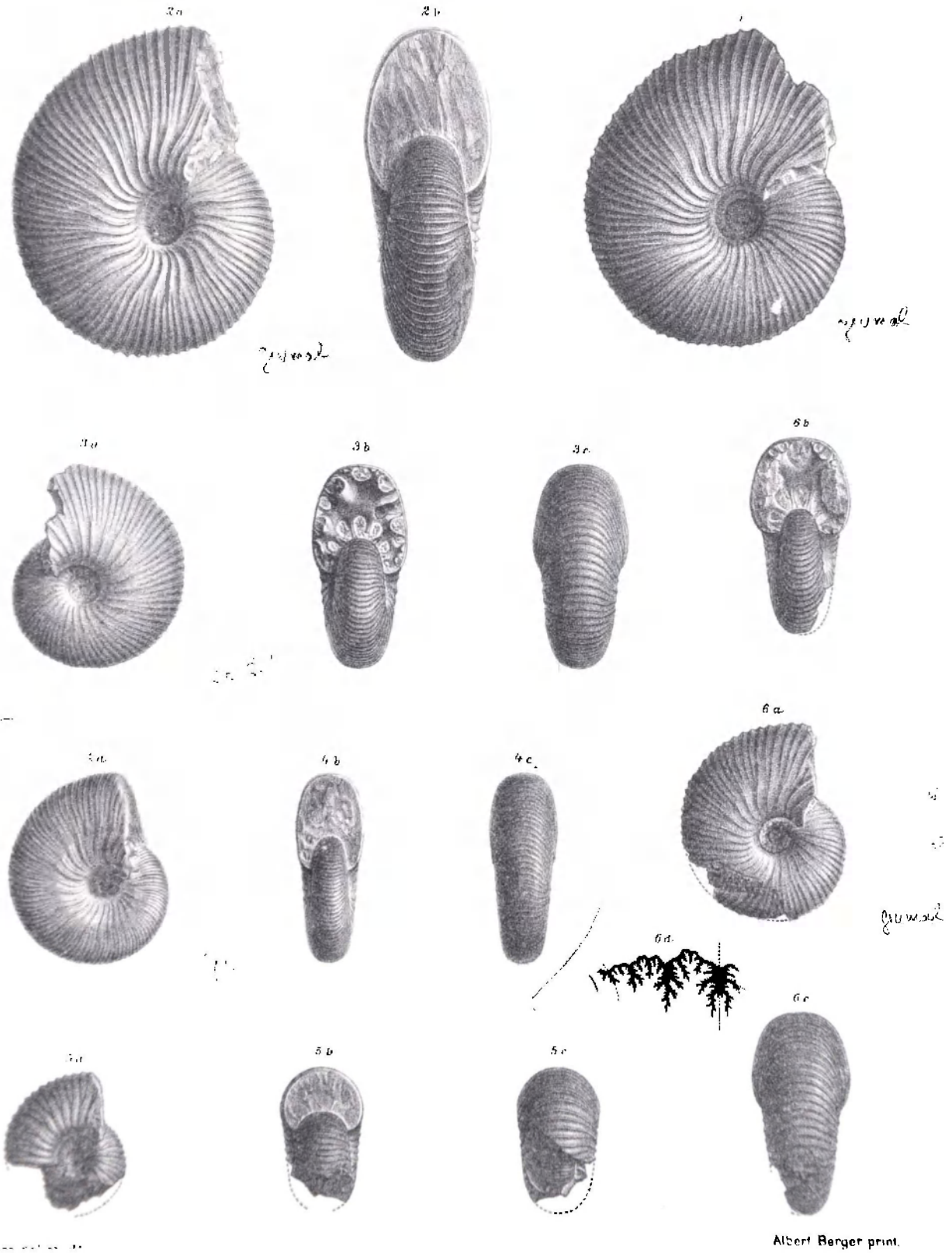
Fig. 3 *a*, *b*, *c*. MACROCEPHALITES WAAGENI n. sp.
Page 270. Internal cast of chambered nucleus. 3*a*, Lateral view. 3*b*, Front view. 3*c*, View of the external periphery. From the Spiti Valley. (Oxfordian ?).

Fig. 4 *a*, *b*, *c*. MACROCEPHALITES cf. MAYA Sowerby sp.
Page 269. Internal cast of chambered nucleus. This is the original specimen of Blanford's *Ammonites nepaulensis* (*Jour. Asiat. Soc.* Calcutta, 1864, XXXII, p. 128, pl. I, figs. 6, 6*a*). 4*a*, Lateral view. 4*b*, Front view. 4*c*, View of the external periphery. From the Spiti Valley. (Oxfordian ?)

Fig. 5 *a*, *b*. MACROCEPHALITES sp.
Page 269. Internal cast. Natural size. 5*a*, Lateral view. 5*b*, Front view. 5*c*, View of the external periphery. Tera Gadh, below the base of the Spiti shales (A. V. Krafft). (Kellaway ?)

Fig. 6 *a*—*d*. MACROCEPHALITES KITCHINI n. sp.
Page 271. Internal cast of chambered nucleus. Natural size. 6*a*, Lateral view. 6*b*, Front view. 6*c*, View of the external periphery. 6*d*, Suture-line. Gieumal. (Oxfordian ?).

JURASSIC FOSSILS (HIMALAYA).



Albert Berger print.

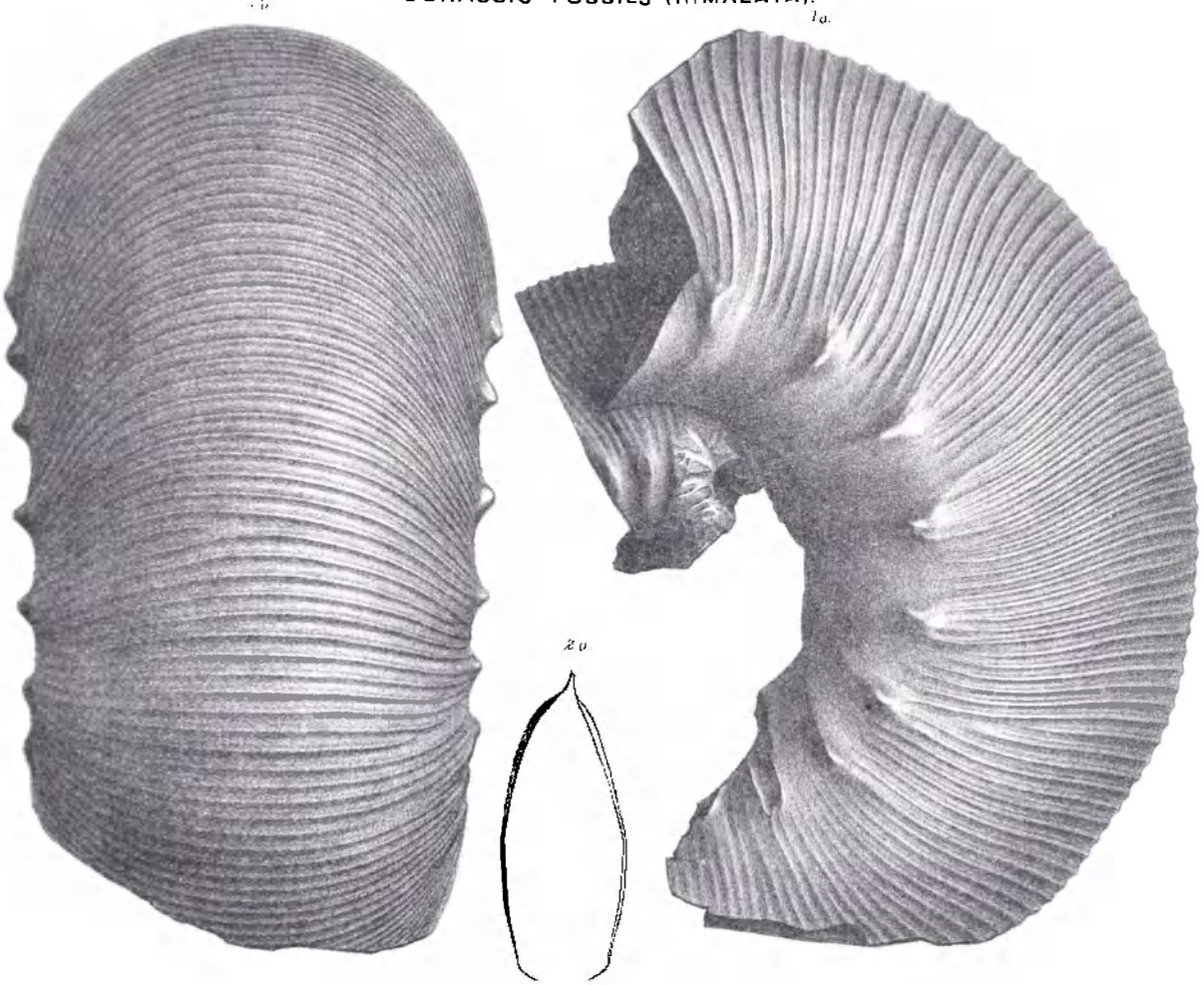
PLATE LXXVIII.

Fig. 1 *a*—*c*. HOLCOSTEPHANUS (ASTIERIA) cf. CONVOLUTA v. Koener.

Page. 395. The whole specimen belongs to the body-chamber. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section in outline. From Lochambelkichak. Neocomian.

Fig. 2 *a*, *b*. OPPELIA (STREBLITES) CRASSICOSTATA n. sp.

Page 392. Fragment of the body-chamber, preserved as an internal cast. Natural size. 2*a*, Lateral view. 2*b*, Cross-section in outline. From Hundes. (Coll. T. L. Walker.)



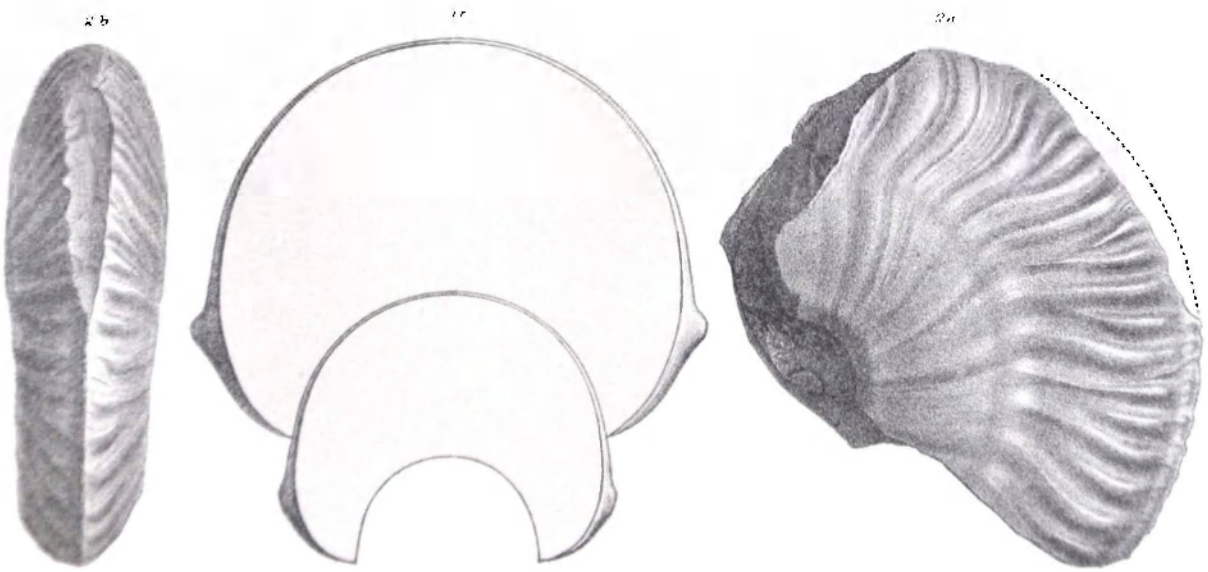


PLATE LXXIX.

Fig. 1 *a—c*. HOLCOSTEPHANUS (SPITICERAS) TOBLERI n. sp.
Page 394. Internal cast almost entirely chambered. Natural size. 1*a*, Lateral view. 1*b*, Front view. 1*c*, Suture. From Hundes. (Coll. T. L. Walker.)

Fig. 2 *a—d*. HOPLITES (SARASINELLA) aff. SUBSPINOSUS Uhlig n. sp.
Page 241. Chambered internal cast. Natural size. 2*a*, Side view. 2*b*, View of the external periphery. 2*c*, Suture. 2*d*, Cross-section. From Hundes. Valanginian.

Fig. 3 *a—f*. BOCHIANITES GERARDI Stoliczka sp.
Page 382. Fragment showing two sutures and a portion of the body-chamber. Natural size. 3*a*, View of the ventral side. 3*b*, View of the dorsal side. 3*c*, Lateral view. 3*d*, 3*e*, Cross-section. 3*f*, Suture-line. This is the original type of Stoliczka's *Anisoceras* Gerardianum. From the Spiti shales; exact locality not known.

Fig. 4 *a—d*. OPPELIA (STREBLITES) PYGMAEA Uhlig and Suess.
Page 393. Internal cast with a portion of the body-chamber preserved. Natural size. 4*a*, Lateral view. The figured suture indicates the position of the last septum. 4*b*, Apertural view. 4*c*, View of the external periphery. 4*d*, Suture. From Kuti, Byans.

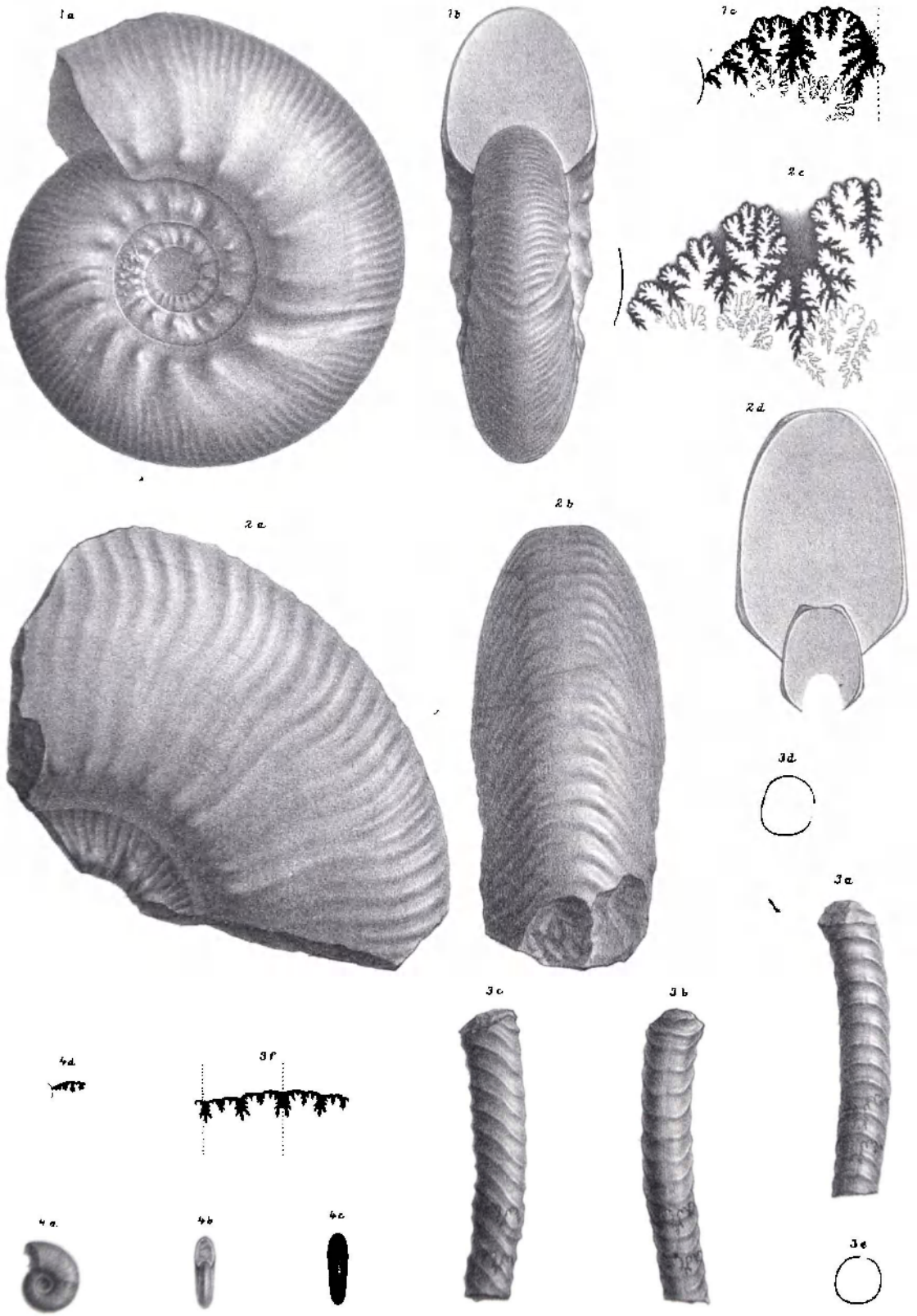

1a
1b
1c
2c
2d
2a
2b
3d
3a
3c
3b
4d
3f
4a
4b
4c
3e

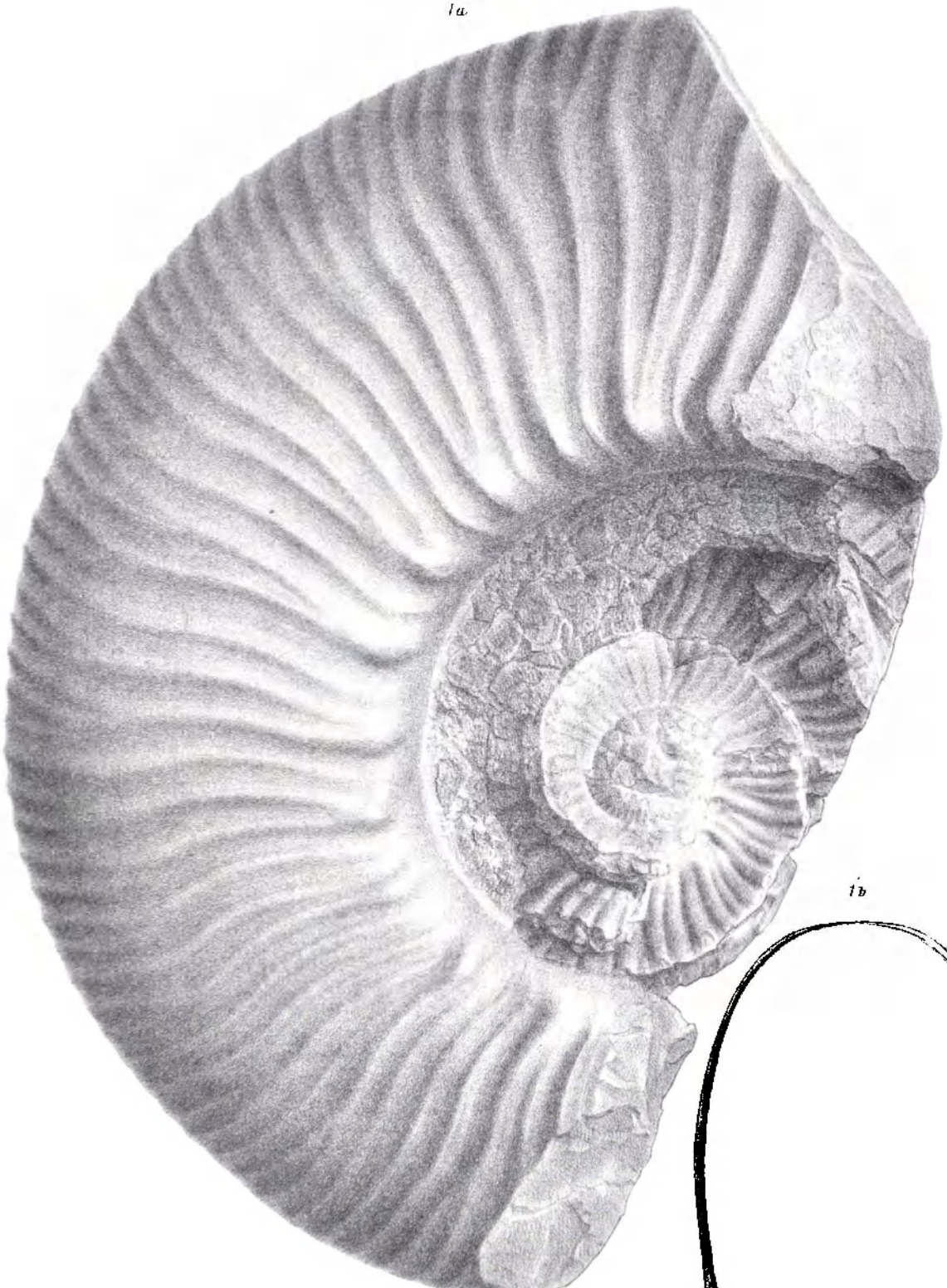
PLATE LXXX.

Fig. 1 *a*, *b*. **Hoplites (Thurmannia) Boissieri** Pictet sp.

Page 233. Internal cast. Natural size. 1*a*, Lateral view. The last whorl belongs to the body-chamber. 1*b*, Cross-section in outline. From Lochambelkichak, Lochambel-beds.

JURASSIC FOSSILS (HIMALAYA).

1a



1b

R Mayer del. et lith.

Albert Berger print.

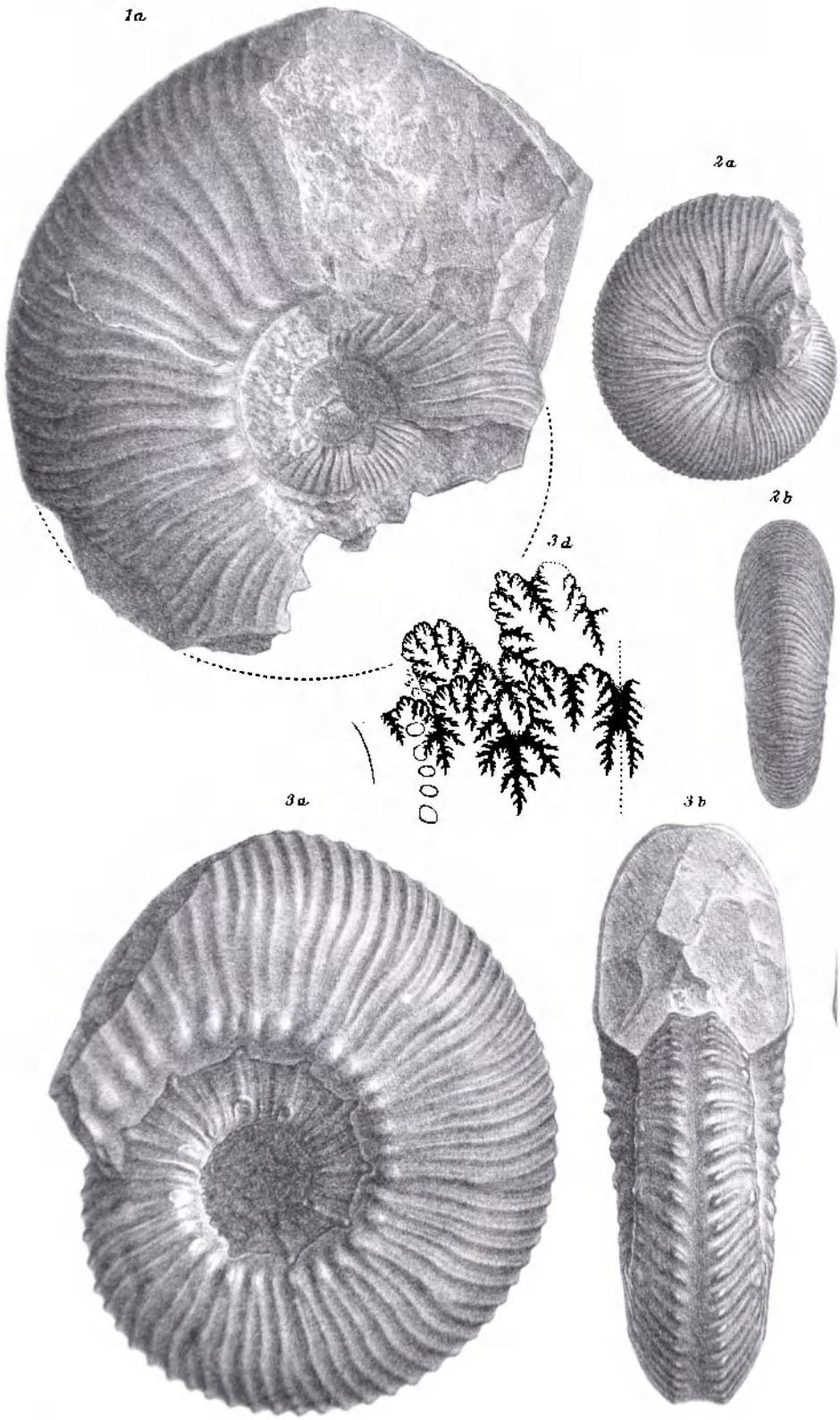
PLATE LXXXI.

Fig. 1 *a*, *b*. HOPLITES (THURMANNIA) n. sp. ind., aff. BOISSIERI Pictet sp.
Page 234. Specimen with the shell partly adhering. Natural size. 1*a*, Lateral view, much restored by the artist. The anterior part of the last whorl belongs to the body-chamber. 1*b*, View of the external periphery. From Lochambelkichak, Lochambel-beds.

Fig. 2 *a*, *b*. SIMBIRSKITES n. sp. ind.
Page 275. Internal cast of chambered nucleus. 2*a*, Lateral view. 2*b*, View of the external periphery. Kiangur Pass.

Fig. 3 *a*—*d*. HOPLITES (SARASINELLA) VARIANS n. sp.
Page 238. Internal cast of chambered nucleus. Natural size. 3*a*, Lateral view. 3*b*, Front view. 3*c*, View of the external periphery. 3*d*, Suture. Lochambelkichak. (Neocomian.)

JURASSIC FOSSILS (HIMALAYA).



H. Mayer del. et lith.

PLATE LXXXII.

Fig. 1 *a*—*c*. OPPELIA (STREBLITES) SPHENODOMA Uhlig and F. Suess.
Page 394. Specimen with part of the body-chamber preserved and the shell partly adhering. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. See also pl. VI, fig. 3.

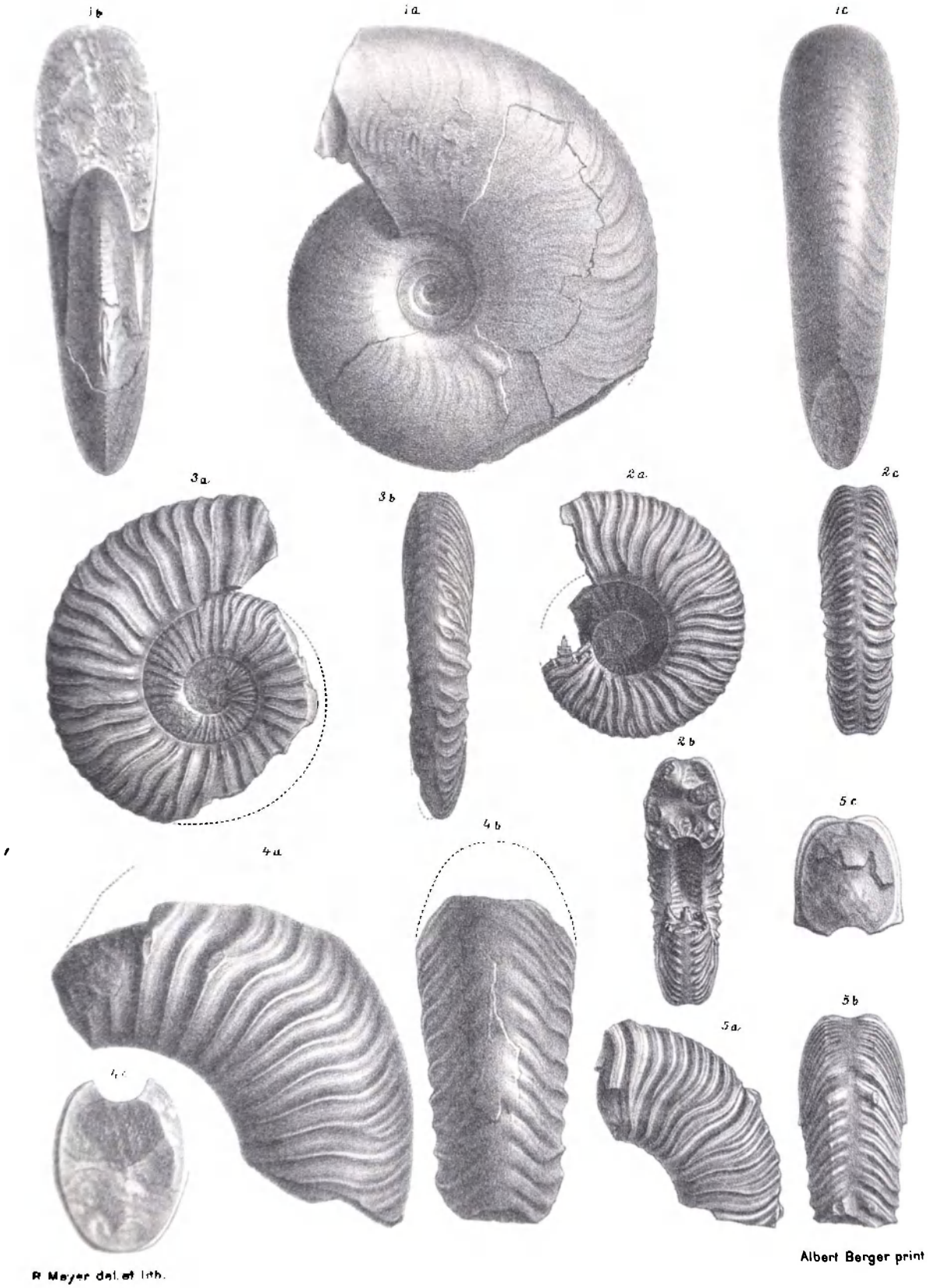
Fig. 2 *a*—*c*. HOPLITES (KILIANELLA) PEXIPTYCHUS Uhlig.
Page 229. Internal cast of chambered nucleus. Natural size. 2*a*, Lateral view. 2*b*, Front view. 2*c*, View of the external periphery. Form Lochambelkichak. (Valanginian.)

Fig. 3 *a*, *b*. HOPLITES (KILIANELLA) LEPTOSOMA n. sp.
Page 232. Specimen with the shell partly adhering. Natural size. 3*a*, Lateral view. The anterior part of the last whorl belongs probably to the body-chamber. 3*b*, View of the external periphery. From Lochambelkichak. (Valanginian.)

Fig. 4 *a*—*c*. HOPLITES (KILIANELLA) n. sp. ind.
Page 232. Fragment of body-chamber, without the shell. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Cross-section. Lochambelkichak. (Valanginian.)

Fig. 5 *a*—*c*. HOPLITES (KILIANELLA) CONSTRICTUS n. sp.
Page 230. Fragment of body-chamber, without the shell. Natural size. 5*a*, Lateral view. 5*b*, View of the external periphery. 5*c*, Cross-section. From Lochambelkichak. (Valanginian.)

JURASSIC FOSSILS (HIMALAYA).



R. Meyer del. et lith.

Albert Berger print

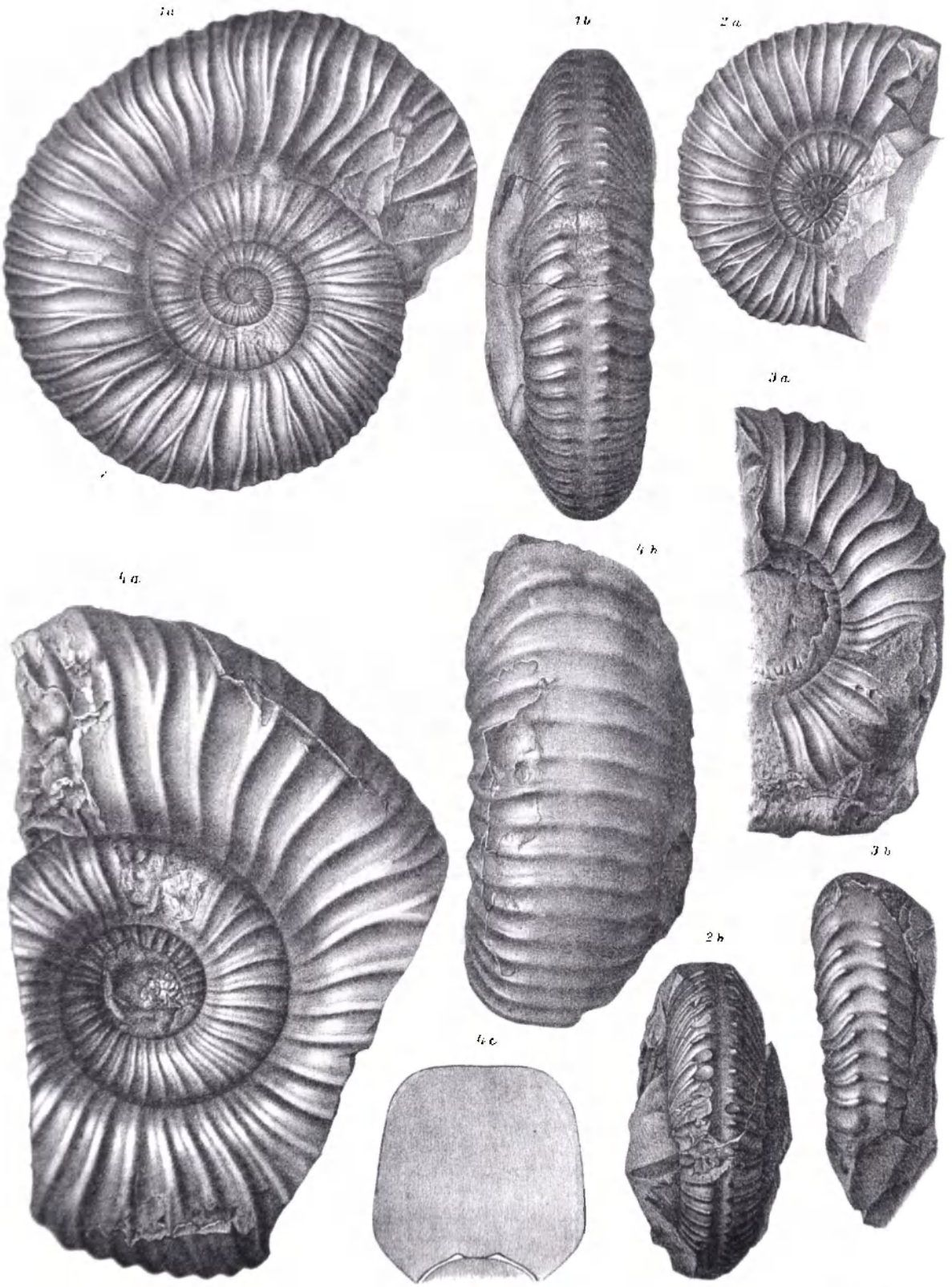
PLATE LXXXIII.

Fig. 1 *a*, *b*. HOPLITES (BLANFORDIA) ROTUNDIDOMA n. sp.
Page 189. 1*a*, Lateral view. The anterior part of the last whorl seems to belong to the body-chamber. 1*b*, View of the external periphery. From Lingti river, Spiti.

Fig. 2 *a*, *b*. HOPLITES (BLANFORDIA) ROTUNDIDOMA n. sp.
Page 189. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery.

Fig. 3 *a*, *b*. HOPLITES (BLANFORDIA) n. sp. aff. ROTUNDIDOMA n. sp.
Page 190. Internal cast. Natural size. 3*a*, Lateral view. The anterior part of the last whorl seems to belong to the body-chamber. 3*b*, View of the external periphery. From Ladakh, Kashmir. (Coll. Prochnow, Museum für Naturkunde, Berlin.)

Fig. 4 *a*—*c*. HOPLITES (BLANFORDIA) SUBQUADRATUS n. sp.
Page 194. Chambered nucleus. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Cross-section. Compare with pl. LXXXIV, fig. 1. From Kuti (Upper and Middle Spiti shales. A. v. Krafft).



Albert Berger print.

PLATE LXXXIV.

Fig. 1 *a*, *b*. HOPLITES (BLANFORDIA) cf. SUBQUADRATUS n. sp.
Page 194. Fragment of body-chamber. Natural size. 1*a*, Lateral view. 1*b*, Cross-section. Compare with pl. LXXXIII, fig. 4. From Gieumal.

Fig. 2 *a*—*d*. HOPLITES (SARASINELLA ?) CAUTLEYI, Oppel sp.
Page 242. Fragmentary specimen, with body-chamber and apertural margin preserved. Natural size. This is one of Oppel's type-specimens of *Ammonites Cautleyi* (Paläontolog. Mitteilungen, II, pl. 78, fig. 2 (*non* fig. 3 = *Spiticeras Cautleyi*). 2*a*, Lateral view. 2*b*, View of the external periphery of the body-chamber. 2*c*, Lateral view of the penultimate whorl. 2*d*, View of the external periphery of the penultimate whorl. Shangra. (Neocomian.)

Fig. 3 *a*, *b*. HOPLITES (BLANFORDIA) n. sp. ind.
Page 191. Fragment of body-chamber. Internal cast. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. From the Spiti shales, Hundes.

Fig. 4 *a*, *b*. HOPLITES (BERRIASELLA) aff. RAREFURCATUS Pictet sp.
Page 237. Internal cast. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. Lochambelkichak, 3rd Stage.

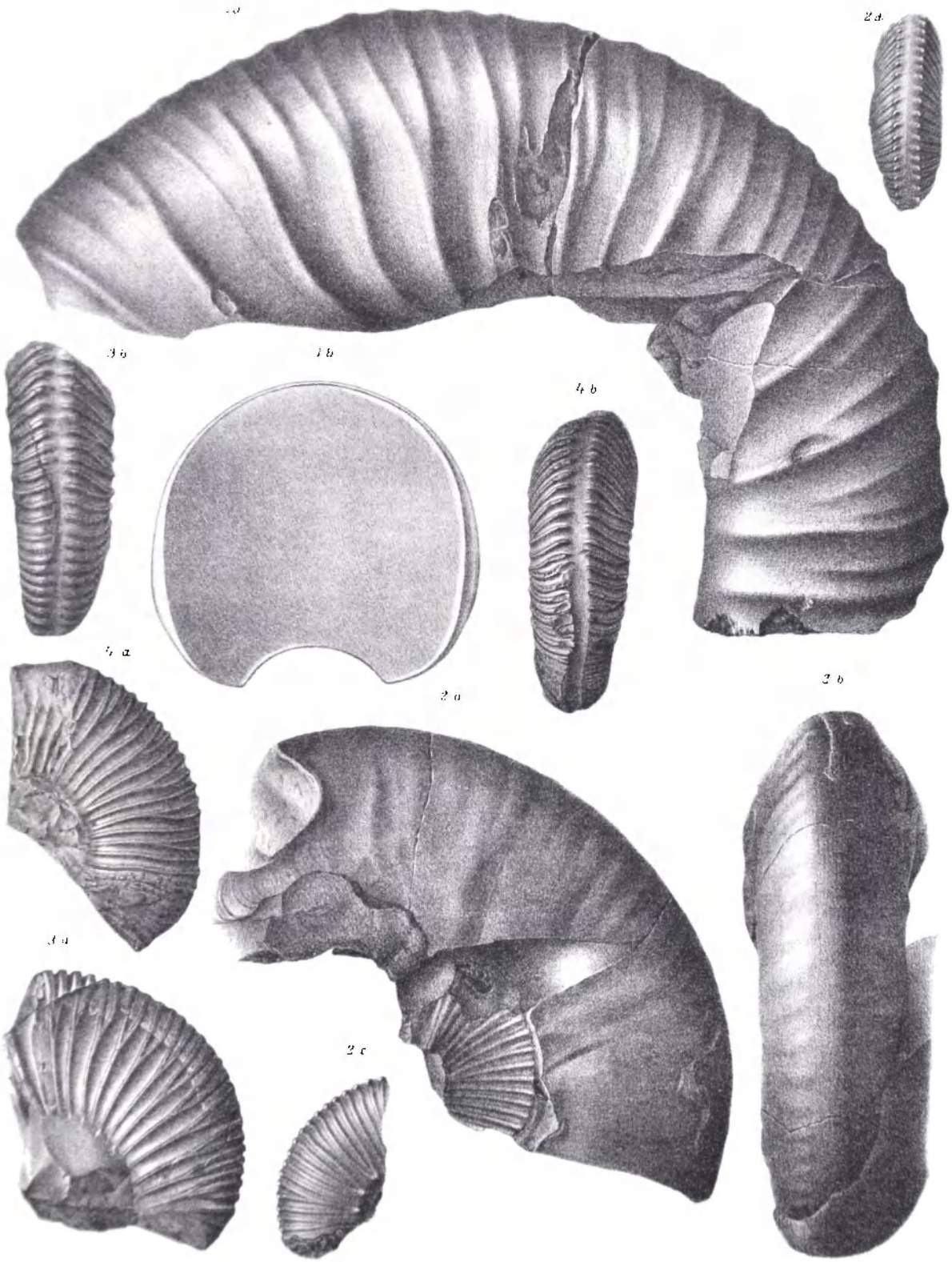

3 b
1 b
4 b
2 a
2 b
4 a
2 c

PLATE LXXXV.

Fig. 1 *a*—*c*. HOPLITES (NEOCOMITES) ODONTODISCUS n. sp.
Page 256. Internal cast with part of the body-chamber preserved. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section. From Lochambelkichak. (Valanginian.)

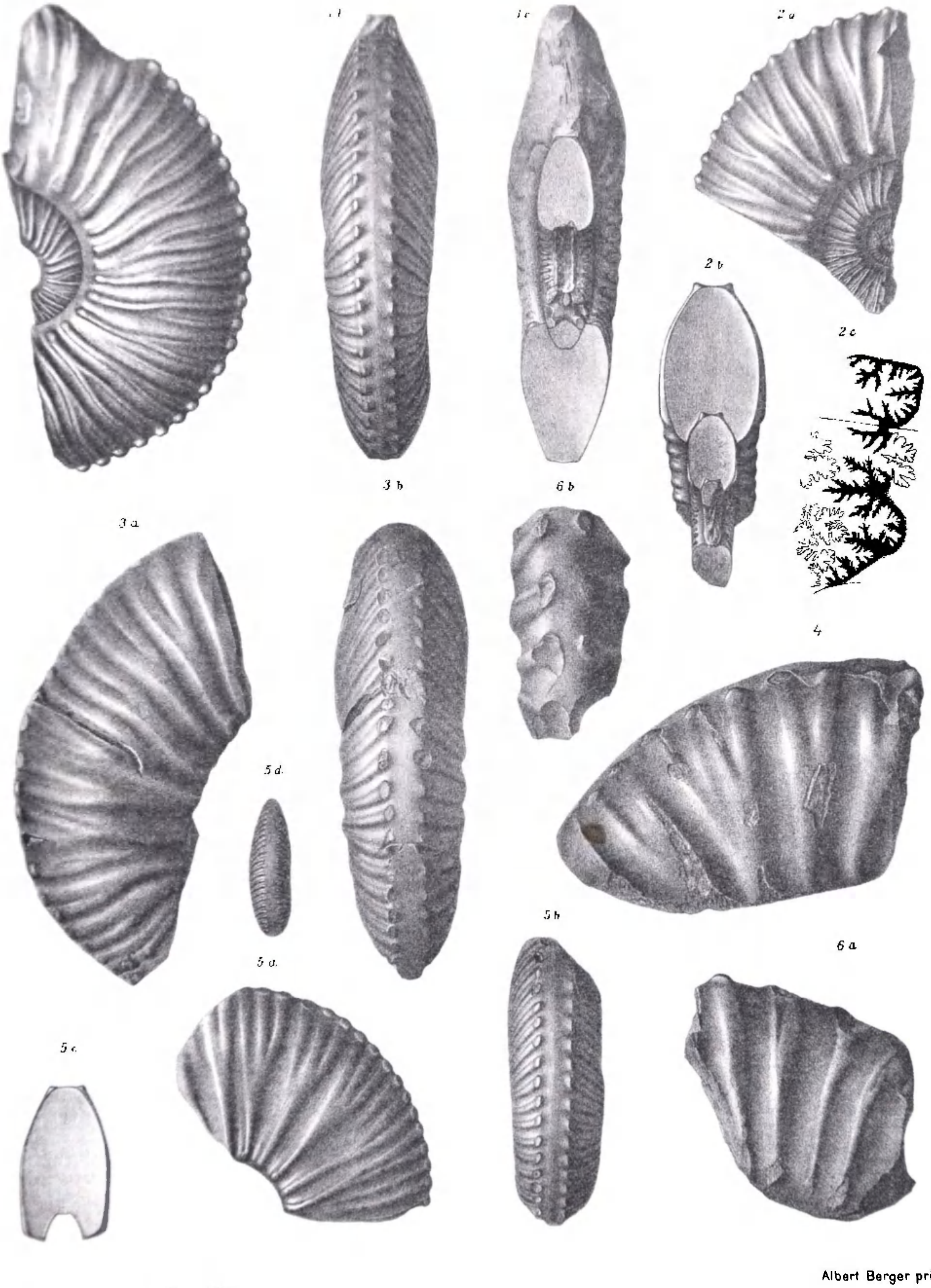
Fig. 2 *a*—*c*. HOPLITES (NEOCOMITES) ODONTODISCUS n. sp.
Page 256. Internal cast almost entirely chambered. Natural size. 2*a*, Lateral view. 2*b*, Cross-section. 2*c*, Section. South of Ting Jung La, Hundes. (Valanginian.)

Fig. 3 *a*, *b*. HOPLITES (NEOCOMITES) ODONTODISCUS n. sp.
Page 256. Fragment of body-chamber. The posterior end exhibits traces of the last septa. Internal cast. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. From Lochambelkichak. (Valanginian.)

Fig. 4. HOPLITES (NEOCOMITES) n. sp. ind. aff. ODONTODISCUS n. sp.
Page 259. Fragment of body-chamber. Internal cast. Natural size. Lateral view. From Lochambelkichak. (Valanginian.)

Fig. 5 *a*—*d*. HOPLITES (NEOCOMITES) n. sp. ind. aff. ODONTODISCUS n. sp.
Page 258. Fragment of body-chamber. Internal cast. Natural size. 5*a*, Lateral view. 5*b*, View of the external periphery. 5*c*, Cross-section in outline. 5*d*, View of the external periphery of the penultimate whorl. Drawn from plaster cast of the inner margin of the specimen. From Lochambelkichak. (Valanginian.)

Fig. 6 *a*, *b*. HOPLITES (NEOCOMITES) n. sp. ind.
Page 259. Fragment of body-chamber. Internal cast. Natural size. 6*a*, Lateral view. 6*b*, View of the external periphery. From Lochambelkichak. (Valanginian.)



Albert Berger print.

J. Fleischmann n. d. Nat. a. Stein gez.

PLATE LXXXVI.

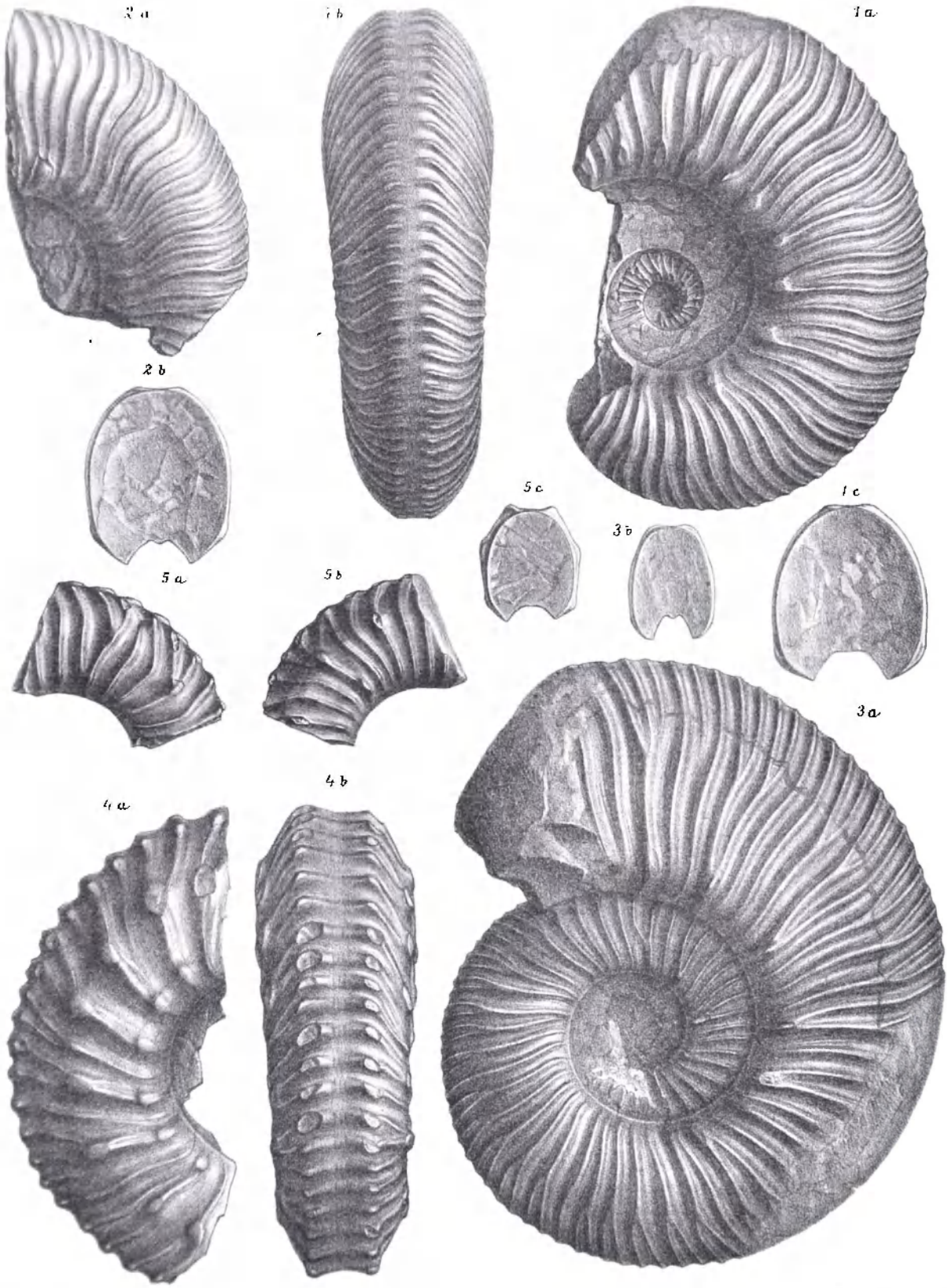
Fig. 1 *a—c*. HOPLITES (NEOCOMITES) WALKERI n. sp.
Page 253. Internal cast. Natural size. 1*a*, Lateral view. The last whorl belongs to the body-chamber. 1*b*, View of the external periphery. 1*c*, Cross-section. Compare with pl. LXXXVII, fig. 3 *a*, *b*. From Lochambelkichak (Valanginian).

Fig. 2 *a*, *b*. HOPLITES (NEOCOMITES) WALKERI n. sp.
Page 253. Fragment of body-chamber. Traces of the last suture are to be seen at the posterior end. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, Cross-section. From Lochambelkichak (Valanginian).

Fig. 3 *a*, *b*. HOPLITES (THURMANNIA) KINGI n. sp.
Page 235. Specimen with shell partly adhering and part of body-chamber preserved. Natural size. 3*a*, Lateral view. 3*b*, Cross-section at the beginning of the last whorl. From Lochambelkichak (Valanginian).

Fig. 4 *a*, *b*. HOPLITES (ACANTHODISCUS) SÖMMERINGI Oppel sp.
Page 213. Fragment of body-chamber. Internal cast. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. From Kuti (Valanginian ?)

Fig. 5 *a—c*. HOPLITES (KILIANELLA) aff. EPIMELOIDES (Meneghini) Parona.
Page 231. Fragment of body-chamber. Internal cast. Natural size. 5*a*, Lateral view, left-hand side. 5*b*, Lateral view, right-hand side. 5*c*, Whorl section. From Hundes (Valanginian).



Albert Berger print

PLATE LXXXVII.

Fig. 1 *a*—*c*. HOPLITES (NEOCOMITES) PYCNOPTYCHUS n. sp.
Page 252. Internal cast, with part of the body-chamber preserved. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. From Lochambelkichak (Valanginian).

Fig. 2 *a*—*c*. HOPLITES (NEOCOMITES) CALLIPTYCHUS n. sp.
Page 251. Internal cast, with part of the body-chamber preserved. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. From Lochambelkichak (Valanginian).

Fig. 3 *a*, *b*. HOPLITES (NEOCOMITES) WALKERI n. sp.
Page 253. Specimen partly retaining the shell and exhibiting part of the body-chamber. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. Compare with pl. LXXXVI, fig. 1 *a*—*c*, fig. 2 *a*, *b*. From Lochambelkichak (Valanginian).

Fig. 4 *a*—*d*. HOPLITES (NEOCOMITES) aff. WALKERI n. sp.
Page 254. Chambered internal cast. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Cross-section, 4*d*, Suture. From Hundes (Valanginian).

JURASSIC FOSSILS (HIMALAYA).

1a

1b

1c

2a

3a

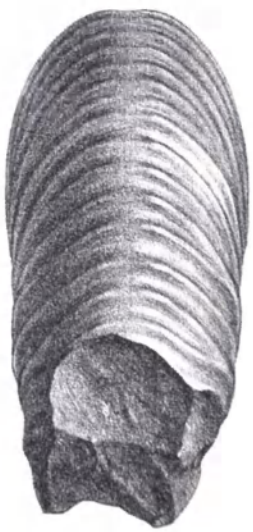
3b

2b

2c

4c

4a



4b

4d

R. Mayer del. et lith.

Albert Berger print.

PLATE LXXXVIII.

Fig. 1 *a*—*c*. HOPLITES (NEOCOMITES) NIVALIS n. sp.
Page 247. Fragment of body-chamber. Internal cast. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Cross-section in outline. From Lochambelkichak (Valanginian).

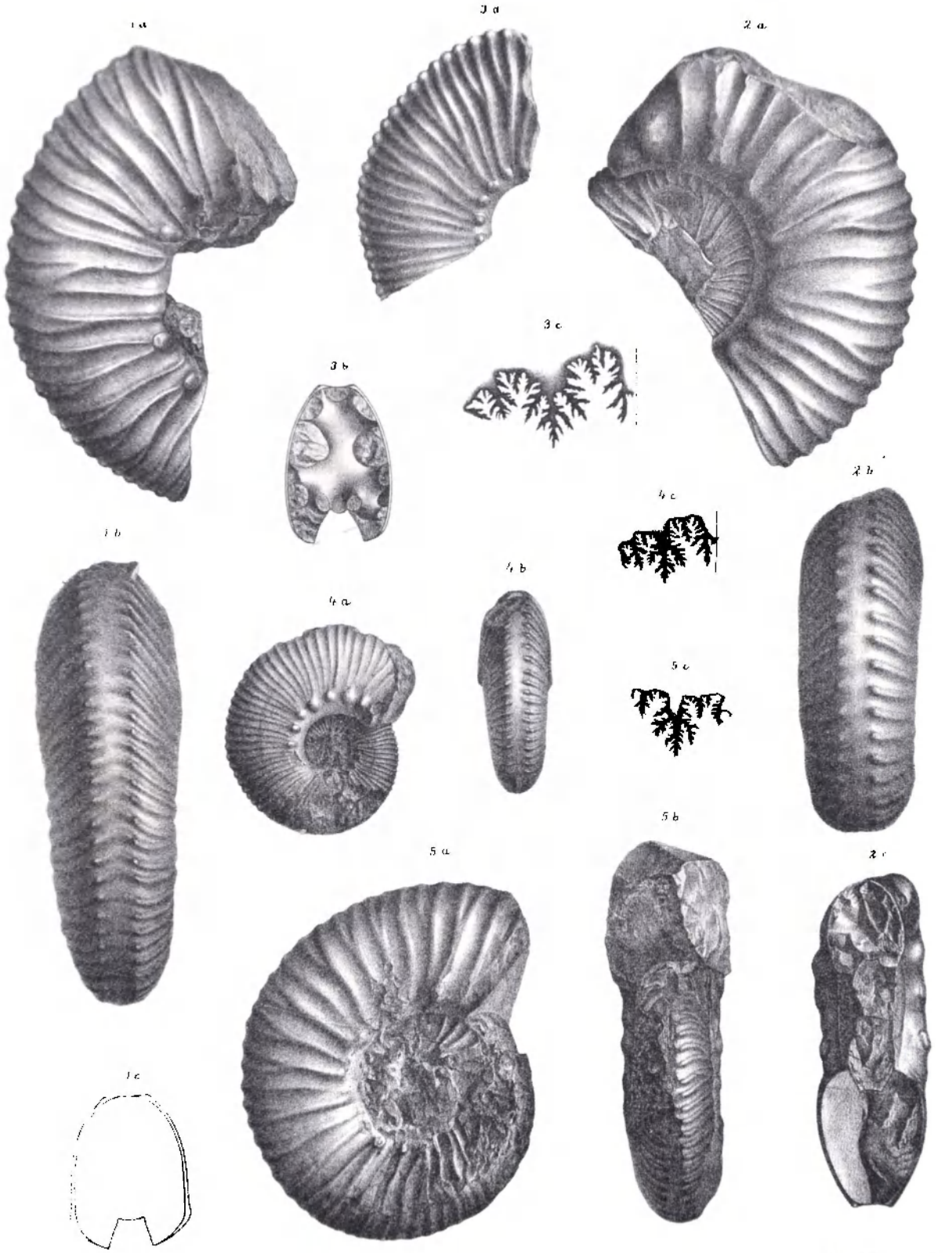
Fig. 2 *a*—*c*. HOPLITES (NEOCOMITES) NIVALIS n. sp.
Page 247. Internal cast. Natural size. 2*a*, Lateral view. The last whorl so far as preserved, belongs to the body-chamber. 2*b*, View of the external periphery. 2*c*, Cross-section. From Lochambelkichak (Valanginian).

Fig. 3 *a*—*c*. HOPLITES (NEOCOMITES) aff. NEOCOMIENSIS d'Orbigny sp.
Page 246. Chambered fragment. Natural size. 3*a*, Lateral view. 3*b*, Cross-section. 3*c*, Suture. From Hundes (Valanginian).

Fig. 4 *a*—*c*. HOPLITES (SARASINELLA?) CAUTLEYI Oppel sp.
Page 242. Internal cast of chambered nucleus. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Suture. This is the original specimen of Stoliczka's *Ammonites Theodorii* (*Mem. Geol. Surv. India*, V, pl. IX, fig. 5). Compare with pl. LXXXIV, fig. 2. From Spiti (Valanginian).

Fig. 5 *a*—*c*. HOPLITES (NEOCOMITES) NIVALIS n. sp.
Page 247. Internal cast of chambered nucleus. Natural size. 5*a*, Lateral view. 5*b*, Front view. 5*c*, Suture-line. From Lochambelkichak (Valanginian).

JURASSIC FOSSILS (HIMALAYA)



J. Fleischmann n. d. Nat. a. Stein gez.

Albert Berger print

PLATE LXXXIX.

Fig. 1 *a*—*d*. HOPLITES (NEOCOMITES) THEODORI Oppel sp.
Page 260. This is Oppel's type specimen (Paläontologische Mitteilungen, II, pl. 78, fig. 3 and pl. 83, fig. 2). 1*a*, Side view of the body-chamber. 1*b*, Side view of the inner whorls drawn after a plaster cast. 1*c*, Whorl section. 1*d*, View of the external periphery. From Laptal, Ngari Khorsum (Valanginian). Schlagintweit Collection, Munich.

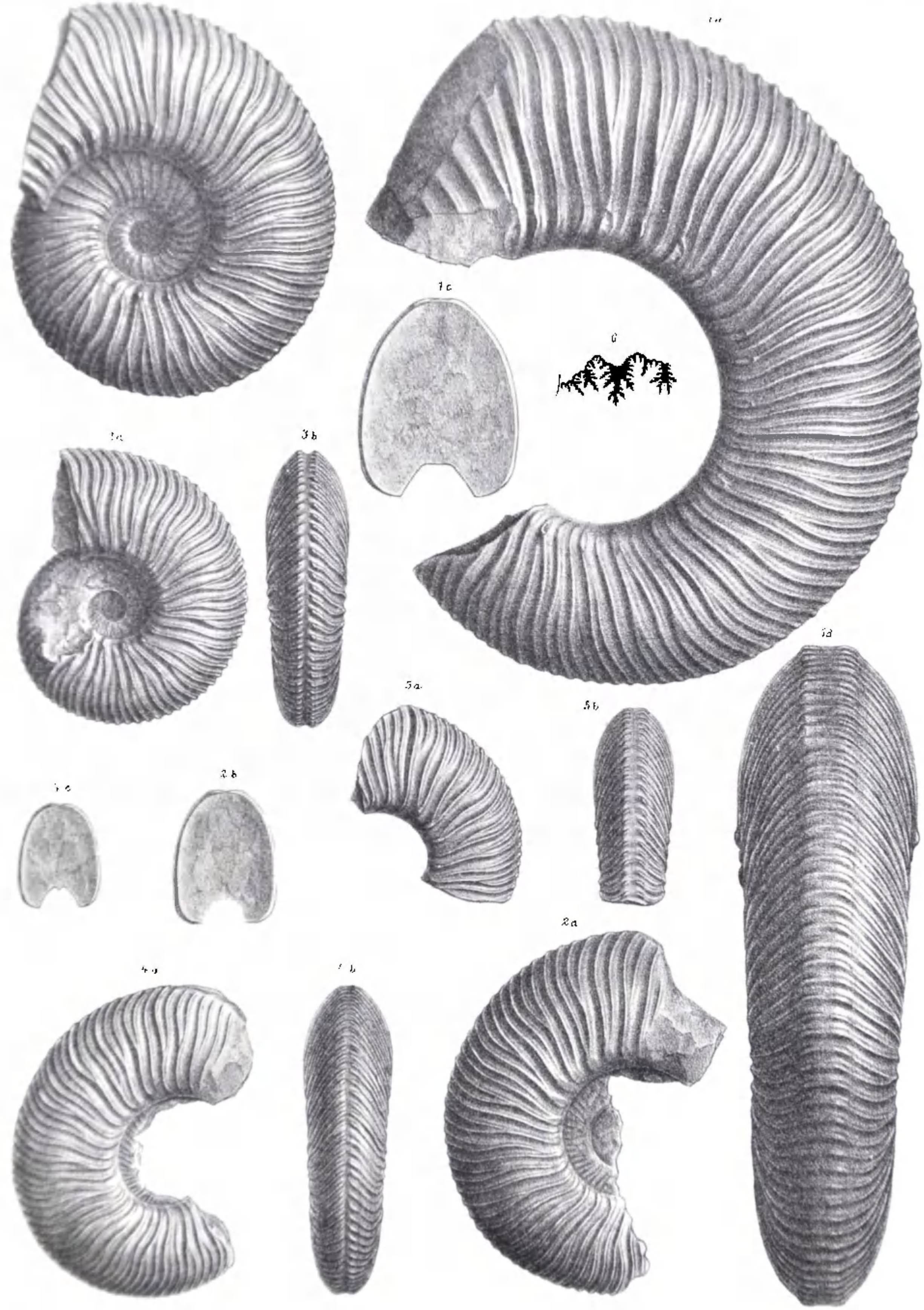
Fig. 2 *a*, *b*. HOPLITES (NEOCOMITES) THEODORI Oppel sp.
Page 260. Internal cast. Natural size. 2*a*, Lateral view. The last whorl so far as preserved belongs to the body-chamber. 2*b*, Cross-section. From Lochambelkichak (Valanginian).

Fig. 3 *a*, *b*. HOPLITES (NEOCOMITES) INDICUS n. sp.
Page 262. Internal cast, with part of the body-chamber preserved. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. From Lochambelkichak (Valanginian).

Fig. 4 *a*—*c*. HOPLITES (NEOCOMITES) INDICUS n. sp.
Page 262. Internal cast. Natural size. 4*a*, Lateral view. The last whorl so far as preserved belongs to the body-chamber. 4*b*, View of the external periphery. 4*c*, Cross-section. From Lochambelkichak. (Valanginian).

Fig. 5 *a*, *b*. HOPLITES (NEOCOMITES) INDICUS n. sp.
Page 262. Fragment of body-chamber. Internal cast. Natural size. 5*a*, Lateral view. 5*b*, View of the external periphery. From Hundes (Valanginian).

Fig. 6. HOPLITES (NEOCOMITES) INDICUS n. sp.
Page 262. Suture. From Hundes (Valanginian).



D. Mayer del et lith. Albert Berger print.

PLATE XC.

Fig. 1 *a*—*e*. HOPLITES (NEOCOMITES) MONTANUS n. sp.
Page 249. Internal cast. Natural size. 1*a*, Lateral view. Three-quarters of the last whorl belong to the body-chamber. 1*b*, View of the external periphery. 1*c*, 1*d*, Cross-sections. 1*e*, Suture-line. From Lochambelkichak. (Valanginian.)

Fig. 2 *a*—*d*. HOPLITES (BERRIASELLA) n. sp. ind. aff. PRIVASENSIS Pictet sp.
Page 184. Internal cast, exhibiting a portion of the body-chamber. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. 2*d*, Sutures. From Lochambelkichak 3rd Stage.

Fig. 3 *a*, *b*. HOPLITES (NEOCOMITES) INDOMONTANUS n. sp.
Page 250. Internal cast with part of the body-chamber preserved. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. From Lochambelkichak (Valanginian.)

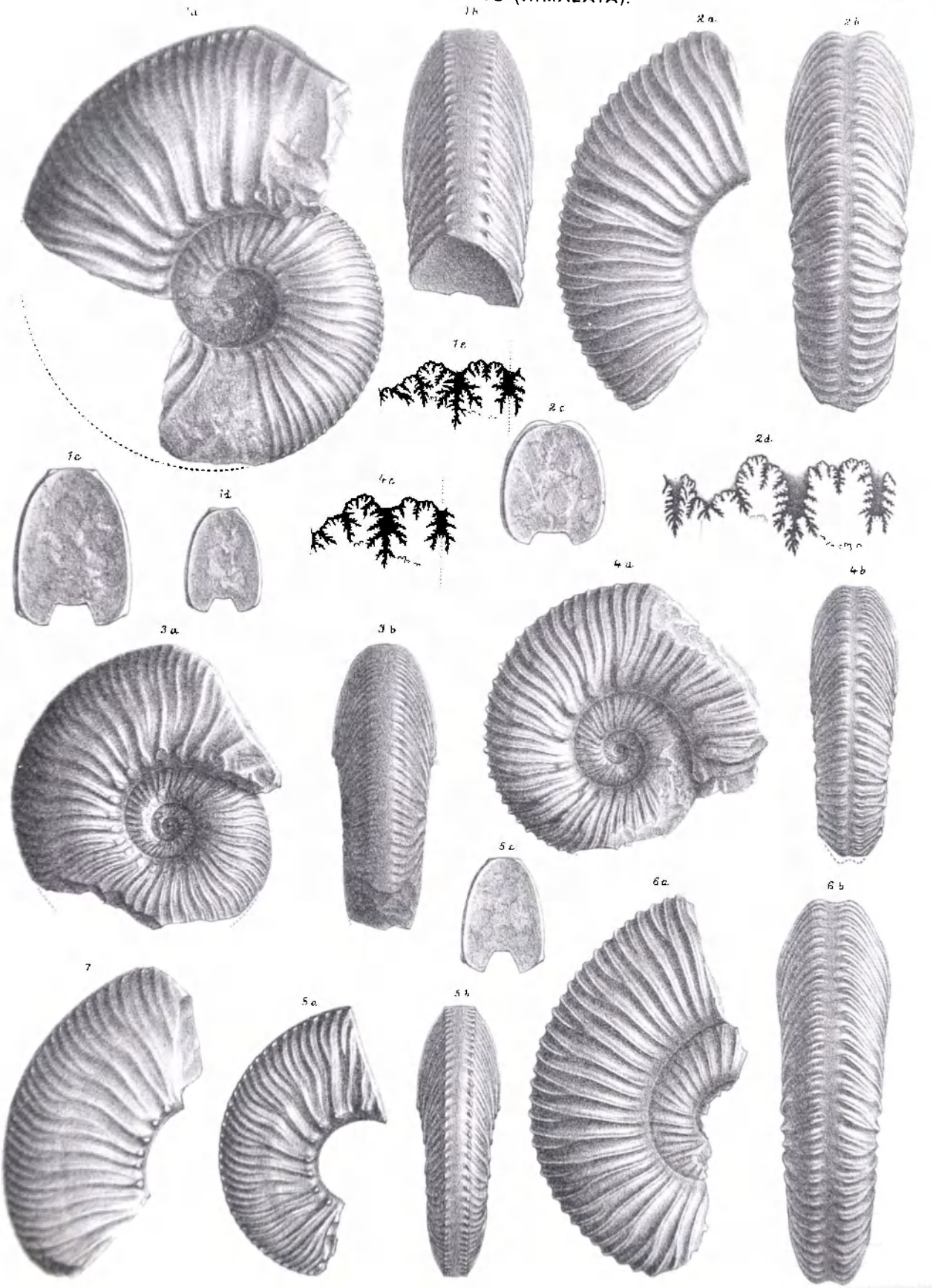
Fig. 4 *a*—*c*. HOPLITES (SARASINELLA) SUBSPINOSUS n. sp.
Page 239. Internal cast, chambered almost to the end. Natural size. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Suture-line. From Lochambelkichak (Valanginian.)

Fig. 5 *a*—*c*. HOPLITES (NEOCOMITES) MONTANUS n. sp.
Page 249. Fragment of body-chamber. Internal cast. 5*a*, Lateral view. 5*b*, View of the external periphery. 5*c*, Cross-section. From Lochambelkichak (Valanginian.)

Fig. 6 *a*, *b*. HOPLITES (BERRIASELLA) cf. PRIVASENSIS Pictet sp.
Page 183. Internal cast. Natural size. 6*a*, Lateral view. The last whorl so far as preserved belongs to the body-chamber. 6*b*, View of the external periphery. From Lochambelkichak, 3rd Stage.

Fig. 7. HOPLITES (NEOCOMITES) INDOMONTANUS n. sp.
Page 250. Lateral view of a fragment of body-chamber. Natural size. From Lochambelkichak. (Valanginian.)

JURASSIC FOSSILS (HIMALAYA).



P. Major del et lith

Albert Berger print

PLATE XCI.

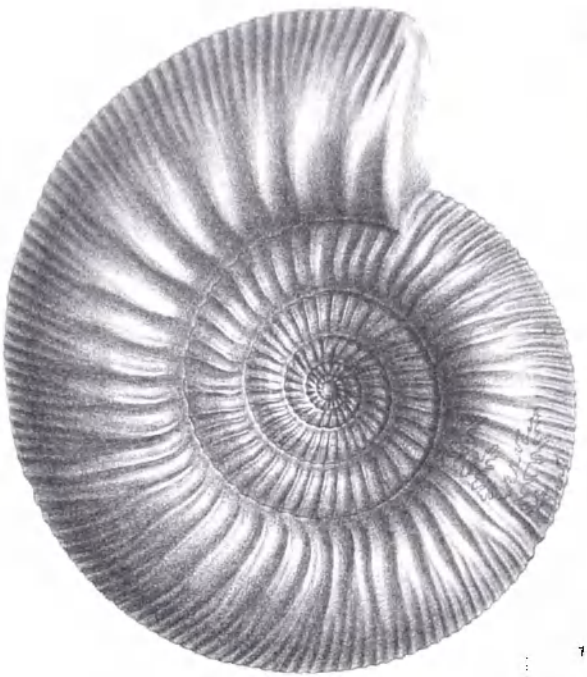
Fig. 1 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) BROILII n. sp.
Page 337. Internal cast. Natural size. 1*a*, Lateral view. Three-quarters of the last whorl belong to the body-chamber. The suture represented is the last one. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Shangra, Ngari Khorsum. Coll. Schlagintweit. Munich.

Fig. 2 *a*—*c*. KOSSMATIA n. sp. ind.
Page 276. Specimen with part of the body-chamber preserved. 2*a*, Side view. The internal volution is only preserved as an outer cast of its external form. 2*b*, Side view of the internal volution, drawn after a plaster cast. 2*c*, External periphery. From the Spiti shales. Exact locality unknown.

Fig. 3 *a*, *b*. KOSSMATIA TENUISTRIATA Gray sp.
Page 275. Plaster-cast of Gray's type specimen. (Depicted by Blanford, Palæontology of Niti, pl. XV, fig. 2*a*—*c*, and by v. Siemiradzki, *Palaeontographica* 45, pl. XXI, fig. 30). 3*a*, Side view. 3*b*, View of the external periphery. From the Sipti shales. Exact locality not known.

Fig. 4. KOSSMATIA DESMIDOPTYCHA n. sp.
Page 277. Lateral view of a fragment of the body-chamber. Internal cast. Natural size. From Kuti (Upper and Middle Spiti shales. A. v. Krafft.)

JURASSIC FOSSILS (HIMALAYA).



R. Meyer del. et. lith.

Albert Berger print.