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THE FAUNA OF THE SPITI SHALES.

FASCICULUS 3.

PAGES 307 TO 395 AND PLATES XLIX TO LXXVI AND XCII TO XCIIIA.

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B.—VIRGATOSPHINCTES, nov. subgenus.

The forms united under the above name are characterized by the "virgatotomous" branching of their ribs. In its simplest form this peculiar mode of ramification consists in the separation of a branch rib at half the height of the volution or somewhat lower down, followed by two shorter ones somewhat higher up. This type of ornamentation is first developed on the body-chamber or on the penultimate volution. The inner whorls only bear dichotomous ribs which may alternate with simple ones.

The gradual evolution of this ornamentation proceeds first by the occasional intercalation of trichotomous bundles, in the midst of the bifurcate ribs; as growth proceeds their relative number increases though not to the complete exclusion of the bifurcate ribs. This stage is the final one in certain species such as *Perisphinctes indistinctus* and *Perisph. contiguus;* in others the dichotomous ribs are completely replaced on the body-chamber by trichotomous or even more complex rib-bundles. The latter appear usually first on the middle part of the body-chamber. The number of ribs constituting such a rib-bundle may increase to five or six or even to ten to twelve by repeated division or by intercalation; the common stalks are of considerable thickness and widely spaced; between them the shell is strongly excavated, as for instance in *Perisph. frequens, multifasciatus, raja, minusculus exornatus* and others.

The ribs appear prominent and sharp, especially in the case of specimens with the shell preserved. They are rather strongly deflected forward and so densely crowded as to allow very little divergence of the branch-ribs. They are not interrupted or reduced across the external margin which they cross normally. The shell is usually discoidal though one never meets with extremely flattened forms no more than with strongly inflated ones. The external margin is always rounded. The umbilical wall is rounded and declivous. The flanks are sometimes slightly rounded, sometimes flattened.

In the majority of species the length of the body-chamber corresponds approximately with one volution. The only notable exceptions are *Virgatosphinctes discoides* n. sp. in which the body-chamber only occupies about two-thirds of the last volution and perhaps also *Perisphinctes rotundidoma.* The final oral aperture is known partly at least in several species from the Spiti Shales. It is somewhat expanded and accompanied by a broad and shallow constriction. The apertural edge is produced into a rounded lateral lappet with an expanded base forming a broad "ear." In the Alpine *Perisph. contiguus* the apertural edge according to Zittel,[1] forms ears which in immature specimens have an elongated stalk, while at a later stage they become broadly sessile. Nevertheless, if the shells, whether small or large, cannot develop "ears" unless full-grown, the specimens alluded to by Zittel cannot have belonged to one and the same species. Whether this form of mouth with long lateral lappets is the only one occurring in *Virgatosphinctes* or whether other forms are also developed cannot at present be decided. Constric-

[1] Aeltere Tithonbildungen, p. 229.

t ons numbering one to three per whorl are frequently noticeable. They are often more pronounced on the inner whorl than on the two last volutions. "Parabolas" have never been observed.

The suture scarcely possesses any characteristic feature, and it is of very little value especially as a specific character. The external lobe is always of about the same length as the first lateral, while the second lateral lobe is always much shorter. The auxiliary lobes, four in number, are always obliquely disposed and in some species, such as *Perisphinctes intermedius*, *Per. rotundidoma* do not extend lower than the apex of the first lateral lobe, the amount of deflection being still less in some others.

The most pronounced differences observed in the suture are principally variations in breadth of the saddles, the higher or lower level of the first lateral saddle and especially the configuration of the second lateral lobe.

In many species the second lateral lobe is so closely hemmed in by the inner lateral branch of the first lateral lobe and by the first auxiliary lobe, that its growth is very much impeded and it is reduced almost to the rank of an auxiliary lobe. In other species, however, the growth of the second lateral lobe is not interfered with by the adjacent inflections, so that it is able to develop freely. In the former case the downward deflection of the line of auxiliary lobes is relatively more pronounced, while it is less so when the second lateral lobe is freely developed.

The Spiti Shales contain numerous species belonging to the subgenus *Virgatosphinctes*, some of which are amongst the commonest fossils of that formation. In no other group is the variability so great as in the present one; every character undergoes an almost incredible degree of fluctuation. Hardly a single specimen resembles another one in every detail. Overwhelming difficulties attend the delineation of species under such circumstances. Any attempt at defining the natural limits and mutual relationships of the different species would be hopeless without much more abundant material than is at present available. The difficulties are intensified by the poor state of preservation of the specimens. As in various other Ammonite-groups one notices that the earlier volutions of closely allied species are almost or even quite identical, and the specific characters become appreciable only on the body-chamber.

In attempting to give a general outline of the subgenus we shall distinguish here two main groups: one in which the ribs are fine and crowded, and another in which they are wider-spaced, coarser, prominent and sharp. The two groups are, however, not sharply divided from each other.

The first group includes—

Perisphinctes (*Virgatosphinctes*) *denseplicatus* Waag.
,, ,, *raja* n. sp.
,, ,, *minusculus* n. sp.
,, ,, *rotundidoma* n. sp.
,, ,, *intermedius* n. sp.
,, ,, *Pompeckji* n. sp.
,, ,, *similis* n. sp.
,, ,, *serpentinus* n. sp.

Perisphinctes (*Virgatosphinctes*) *Holdhausi* n. sp.
,, ,, sp. ind. aff. *denseplicatus* Waag.

The species of the second group are—

Perisphinctes (*Virgatosphinctes*) *frequens* Oppel.
,, ,, *subfrequens* n. sp.
,, ,, *kutianus* n. sp.
,, ,, *himalayanus* n. sp.
,, ,, *Burckhardti* n. sp.
,, ,, *multifasciatus* n. sp.
,, ,, *Haydeni* n. sp.
,, ,, *Kraffti* n. sp.
,, ,, *Broilii* n. sp.
,, ,, *discoides* n. sp.
,, ,, *indistinctus* n. sp.
,, ,, n. sp. ind.
,, ,, *subquadratus* n. sp.
,, ,, *contiguus* (Cat.) Zitt.

Finally we must add here three species whose rounded whorls recall the *Torquatus* group of the subgenus *Aulacosphinctes*, but which, owing to the absence of a marginal furrow on the innermost volutions, must provisionally at least be classified with *Virgatosphinctes*. They are :—

Perisphinctes (*Virgatosphinctes*) *incertus* n. sp.
,, ,, *Lemoinei* n. sp.
,, ,, sp. aff. *euplocus* Waag.

The Indian Jurassics of Kachh also contain several species belonging to this group, namely :—

Perisphinctes (*Virgatosphinctes*) *frequens* Waagen (*non* Oppel) = *subfrequens* n. sp., Umia Stage.
,, ,, *denseplicatus* Waagen Umia Stage.
,, ,, *Pottingeri* (Sow.) Waag. Katrol Sandstone.
,, ,, *euplocus* Waagen Katrol Sandstone.
,, ,, *katrolensis* Waagen Katrol Stage.
,, ,, *pagri* Waagen Kuntkot Sandstone.

Whether the two last species really belong to this group is questionable. *Per. Pottingeri* has been reported by Futterer from East Africa, *Per. frequens* occurs in Madagascar.

As far as Europe is concerned, the subgenus *Virgatosphinctes* has a wide distribution especially in the Mediterranean province where it abounds in the zone of *Amm. acanthicus*, and especially in the Tithonian. The following European forms belong to this group :—

Perisphinctes (*Virgatosphinctes*) *contiguus* (*auctorum*).
,, ,, *exornatus* Catullo.
,, ,, *Fontanæ* ,,
,, ,, *oxypleurus* Herbich.
,, ,, *tantalus* ,,
,, ,, *polyplocus* Neumayr (*non auctorum*).

Perisphinctes (*Virgatosphinctes*) *selectus* Neumayr.[1]
,, ,, *metamorphus* Neumayr.
,, ,, *Chalmasi* Kilian.
,, ,, *Ernesti* (Lor.) Canavari.
,, ,, n. f. aff. *Ernesti* ,,
,, ,, *geron* Zittel.
,, ,, sp. ind. Uhlig.[2]
,, ,, *planulatus siliceus* Quenst.
,, ,, *ulmensis* Oppel.
,, ,, *Basilicæ* E. Favre.
,, ,, sp. ind. E. Favre.
,, ,, *suprajurensis* d'Orbigny.
,, ,, *danubiensis* Schlosser.
,, ,, *danubiensis* Loriol.
,, ,, *diceratinus* Schlosser.

To this same group probably belong *Per. Vandelli* Choffat, *Per. abadiensis* Choffat, *Per. unicomptus* Choffat (*non* Font.), *Per. pseudolictor* Choffat, and *Per. Ribeiroi* Choffat from the marls of Abadia (Portugal) and various other forms.

Lastly, in South America, this group is represented by *Perisphinctes* aff. *pseudolictor* (Choff.) Burckhardt.

In the Indian Jurassics and more especially in the Spiti Shales the subgenus *Virgatosphinctes* constitutes a well-defined and well-circumscribed group. This is much less the case in Europe where we are acquainted with numerous forms whose characters, taken as a whole, are more or less related to *Virgatosphinctes* but whose position in this subgenus is a matter of doubt. The reason of this difference probably resides in the fact that the Oxfordian of the Spiti Shales is not rich in fossils, in consequence of which *Virgatosphinctes* makes its appearance abruptly whilst the Oxfordian and Kimeridgian of Europe contain numerous precursors of this subgenus. It naturally follows that these precursors together with the allied branches, which possibly may have developed along parallel lines, are sometimes difficult to discriminate from the genuine members of the *Virgatosphinctes* group. The difficulties of the case are moreover intensified by the deficient preservation of many of the species, and still more so by the antiquated mode of treatment that they received in the hands of most palæontologists.

A closely allied group which developed along parallel lines have long been known in Europe where they constitute the group of the *Polyploci*, corresponding with Fontanne's genus *Ataxioceras*. In this genus the fasciculated-rib ornamentation is already assumed at an early stage, parabolar tubercles are frequently developed and the form is further characterized by a greatly expanded collar-shaped oral aperture ("Kragenplanulaten" of Quenstedt) with long, stalked, spoon-shaped lateral lappets. The lobes are feebly ramified and the line of auxiliary lobes is slightly hanging, a fact to which attention has already been drawn by

[1] Whether *Per. subpunctatus* Neum. *and Per. fasciferus* Neum. should also be classified here is not quite certain although probable.

[2] From the Lower "Teschener Schiefer," *Denkschr. k. Akademie* vol. 72, p. 16,

L. v. Sutner and M. Neumayr. There is no difficulty in discriminating the typical forms of *Ataxioceras*, such as *A. Lothari* Opp., *A. hypselocyclus* Font., *A. effrenatus* Font., *A. inconditus* Font., *A. Ribeiroi* Kil. et Guebh., *A. planulatus parabolis* Quenst., *A. polyplocus breviceps, nudiceps* and *rugiceps* Quenst., *polyplocus parabolis* Quenst., *A. Balnearius* Lor., *A. Guntheri* Oppel. In other cases the correct attribution of certain forms gives rise to considerable hesitation, as in the case of *Amm. planulatus nodosus* Quenst., *Amm. triplex* Quenst., *Amm. triplicatus albus* Quenst., *Perisphinctes lictor* Font., *Per. Achilles* d'Orb., *Per. Castroi* Choff., *Per. Ernesti* Loriol, *Per. unicomptus* Font. and various others.

The inner whorls of the subgenus *Virgatosphinctes* possess, as has already been mentioned, a striking plicate sculpture. This type of ornamentation predominates in the *biplex*-group which has such a wide distribution in the Oxfordian[1] and which exhibits a suture-line similar to that of *Virgatosphinctes*. We cannot therefore be far wrong in supposing that the *biplex*-group and *Virgatosphinctes* were derived from common ancestors and belong to the same stock of the genus *Perisphinctes*. Other groups, among which is *Ataxioceras*, branched off from this same stock, and, owing to the slight extent to which they diverge, it is, of course, difficult to distinguish these branches sharply from each other. The number of these diverging branches is possibly greater than is generally admitted. Only a detailed monographic treatment of the European material will lead to a complete elucidation of this problem. We may, however, expect that in Europe also the subgenus *Virgatosphinctes* will finally prove to be a well-defined branch of the richly developed *Perisphinctes* stock.

The "virgatotomous" sculpture of the group here described recalls the fasciculated ribs of the Russo-boreal genus *Virgatites*[2] Pavl. Certain authors have been misled thereby into the belief that certain representatives of the subgenus *Virgatosphinctes* belong to the Russian genus *Virgatites*.[3] In reality the two are separated from each other by a considerable gap. According to Michalski the inner whorls of *Virgatites* are beset with densely crowded fine sharp ribs which may be either partly biplicate and bidichotomous, or partly virgatotomous and partly dichotomous, or else entirely virgatotomous; on the body-chamber or on the last volution the sculpture becomes simplified and the anterior part of the body-chamber exhibits nothing but stout bifurcate ribs or even simple ribs. *Virgatosphinctes*, on the other hand, follows exactly the opposite course of development: in this subgenus the shell first passes through a stage of dichotomous sculpture and it is only later, on the body-chamber that the virgatotomous ornamentation makes its

[1] Note the species *Per. Warta* Buk., *Per. promiscuus* Buk., *Per. biplex* (Sow.) Healey, *Per. Healeyi* Neumann (= *plicatilis Auct.*), *Per. chlorooliticus* Gumb., *Per. plicatilis* Sow., *Per. variocostatus* Sow., *Per. Kiliani* de Riaz, *Per. Helenæ* de Riaz, *Per. Delgadoi* Choff., *Per. Tiziani* Opp., *Per. Tizianiformis* Choff., *Per. pseudoplicatilis* Siem., *Per. stenocycloides* Siem., *Per. Jelskii* Siem., *Per. gyrus* Neumann, *Per. rota* Wang., *Per. subrota* Choff., *Per. Eschweyi* Choff., *Per. Martelli* Opp., *Per. orientalis* Siem., *Per. Bocconii* Neum., *Per. lucingensis* Favre, *Per. Linki* Choff., *Per. mogoscensis* Choff. and others.

[2] A. Michalski, Die Ammoniten der unteren Wolgastufe. *Mem. Com. Géol. St. Petersbourg*, Vol. VIII, No. 2. A. Pavlow et G. Lamplugh, Argiles de Speeton, *Bull. Soc. Imp. Natur. d. Moscou* 1892, p. 113.

[3] Up to the present the Alpine Province has yielded only one form whose development recalls that of *Virgatites* although not quite identical. This is *Ammonites scruposus* Zitt., which H. Vetter has made the type of his subgenus *Pseudovirgatites*.

appearance. Within the form-circle of *Perisphinctes*, in the wider sense of this term, it would be difficult to give an instance of stronger contrast than that which exists between the body-chamber of *Virgatosphinctes* with its copiously ramified rib-fascicles and that of *Virgatites* with its biplicate or even simple ribs. Although the various developmental stages of sculpture may not be so clearly pronounced in all species of *Virgatites* as they are in *V. scythicus* Vischniakow or *V. virgatus* Buch., the whole group exhibits a course of development which cannot be confounded with that of *Virgatosphinctes*.

To this we should add that on the external margin of *Virgatites* the ribs are often somewhat convex anteriorly and reduced along the median zone, that there exists a tendency towards the formation of external edges and finally that the suture has a radically different character as compared with that of *Virgatosphinctes*, being less ramified, with broader saddles, a more obliquely disposed second lateral lobe, which is never hemmed in by the neighbouring inflections; the auxiliary lobes are only feebly developed and their situation is very slightly oblique so that their disposition is scarcely appreciably retrograde. The first lateral saddle of *Virgatites* often occupies a higher situation than the external saddle and the disposition of the suture-line is partly radial, partly anteriorly deflected, whilst in the case of *Virgatosphinctes* there is a pronounced backward deflection corresponding with the disposition of the hanging umbilical lobe. The divergence as regards the totality of the characters and the ontogenetic development, between *Virgatites* on the one hand, and the *biplex*-group and *Virgatosphinctes* on the other hand, is so great, that we are compelled to assume a separate origin for the two stocks. The virgatotomy of the ribs evidently constitutes a character which is not restricted to one single offshoot of *Perisphinctes*, and the external resemblance of various derivative groups, resulting from their ornamentation, must be regarded as a case of convergence. When placing the genus *Virgatites* in the neighbourhood of *Holcostephanus*, A. Pavlow evidently had in mind the strong divergence which differentiates the species of *Perisphinctes* characterising Western and Central Europe from the Russo-Boreal *Virgatites* as well as the relationship of *Virgatites* itself to certain members of the genus *Holcostephanus* (namely *Polyptychites*).

The comparison between the typical forms of *Virgatosphinctes* and *Virgatites* is a far easier task than the elucidation of the relationships of certain forms from the Cordillera of the Argentine, allied both to *Virgatites* and *Virgatosphinctes*, which Karl Burckhardt[1] has described under the following names:

Per. aff. *pseudolictor* Choff., *Per. contiguus* Zittel, *Virgatites dorsoplanus* Vischn., *Virgatites* aff. *Quenstedti* Rouill. *Virgatites australis* Burckhardt, *Perisphinctes* cf. *Nikitini* Michalski, *Per. choisensis* Burckhardt, *Virgatites scythicus* Vischn., *Virg.* aff. *apertus* Vischn. We might distribute these forms into three groups. The first consists only of *Per.* aff. *pseudolictor* and possesses the characters of *Virgatosphinctes*. The second group includes *Virgatites* aff. *Quens-*

[1] Jura-und Kreideformation der Cordillere, *Palaeontographica*, Vol. 50.

tedti and perhaps also *Perisphinctes choicensis;* the third group includes all the remaining species. The second group is certainly the one exhibiting the closest similarity with *Virgatites* especially in the case of *Virg.* aff. *Quenstedti;* but the third group also approaches the Russian *Virgatites* in two directions: the lobes are scantily ramified, the auxiliary lobes are only indistinctly hanging, and the sculpture appears to experience the same simplification as in the Russian species.

The total habit, however, deviates somewhat from that of the Russian forms, and it is not impossible that we may have to deal here with a separate branch of *Perisphinctes* which is not identical with *Virgatites*, although strongly converging towards it. The material at present available is too scanty and isolated to decide this question. The discovery of new fossil faunas from the Central and Northern parts of the American Cordillera may lead to a final elucidation of these points. For the present the question remains an open one.

As already mentioned, the limits of the group under discussion cannot be circumscribed as sharply as might be desired. Nevertheless their separation as a subgenus will help to evolve some sort of order out of the multitude of forms belonging to the extensive genus *Perisphinctes*. A. Hyatt proposed the subgeneric name of *Lytacoceras* for one of the species which probably belongs to our subgenus. We have not adopted this name, being unaware of the limits which Hyatt intended to assign to his subgenus and of the characters upon which it is supposed to have been established.

The relation between *Virgatosphinctes* and the subgenus *Aulacosphinctes* will be discussed when dealing with the latter. Two specimens belonging to *Perisphinctes* (*Virgatosphinctes*) *frequens* and *Per. denseplicatus* (Plate LVI, fig. 1, and Pl. LXXV, fig. 1) exhibit, on certain parts of the whorls, what appear to be remnants of a thick shell consisting of two coarsely crystalline layers. The most curious feature about them is that the sutures are just as visible on this apparently shelly substance as on the internal cast. It would seem as if the septa extended right through this crystalline covering layer. Unfortunately the available material is too scanty to offer opportunities for a more exact study of so remarkable a structure; we earnestly hope for the discovery of similarly preserved fragments which it would be possible to sacrifice so as to elucidate the mode of growth of these *Perisphinctes* shells.

PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS, Waagen.

(Plate LIII, fig. 3 *a—d;* Plate LIV, fig. 1 *a—c;* Plate LV, figs. 1 *a—d*, 2 *a—d*, 3 *a—d;* Plate LVI, fig. 1 *a—c*.)

Perisphinctes denseplicatus W. Waagen, Jurassic Cephalopoda of Kutch, *Palæontologia Indica*, I, Calcutta, 18, p. 201, pl. XLVI, fig. 3; pl. LV, fig. 1.

Dimensions:—

	Plate LV, fig. 2	Plate LIV, fig. 1	Plate LVI, fig. 1	Plate LV, fig. 1.
Diameter	78·2 mm.	98 mm.	92·5 mm.	92 mm.
Width of umbilicus	31·2 ,,	39 ,,	32 ,,	39 ,,
Volution height	30 ,,	33·2 ,,	34 ,,	31 ,,
Maximum thickness (approximately)	29·2 ,,	31 ,,	30·5 ,,	30 ,,

Under the expressive title of *Perisphinctes denseplicatus* W. Waagen has described a densely ribbed species from the Umia Stage of Kachh which at the first glance is so strikingly similar to a species from the Spiti Shales that, notwithstanding certain divergences, we are unable to avoid admitting its specific identity.

The shell of the present species is rather flat, the flanks are slightly arched and somewhat sharply marked off from the steeply sloping umbilical wall. The maximum thickness corresponds with the lower part of the flanks, the cross-section being generally oval. Immature specimens have comparatively broader and lower volutions than full-grown ones (see pl. LIII, fig. 3 and pl. LV, fig. 3).

The ribs are exceedingly densely crowded and somewhat deflected anteriorly; they are nearly filiform and, on the internal cast, rounded. On the actual shell they may, however have been very sharp, as already remarked by Waagen. On the chambered nucleus simple ribs alternate with forked ones; the relative number of simple ribs decreases with increasing size. On the penultimate whorl of the chambered nucleus there are as many as 70 to 80 long ribs. Trichotomous ribs occur only on the foremost portion of the chambered nucleus and even here only at isolated intervals. It is only on the body-chamber that the ribs begin to recede somewhat further from each other and break up at their upper end into bundles of three or more branches. The anterior part of the body-chamber and the oral margin are unknown. The inner volutions carry rather numerous and deep constrictions. Behind each constriction two ribs unite with one another on the umbilical suture, splitting up into branch-ribs higher up so that a bundle of four or five ribs is thereby produced (see plate LV, fig. 3).

In Waagen's specimen the number of uncleft ribs in all stages of growth is somewhat greater than in the specimens from the Spiti Shales; moreover the shape of the cross-section is different.

These differences, however, do not possess any deep significance; for the Spiti Shales specimens themselves, although unquestionably belonging to a single species, are subject to considerable variations. The size of the umbilicus fluctuates between rather wide limits in conjunction with the ratio of thickness to height of volution. The specimen with the widest umbilicus (pl. LV, fig. 1) has the relatively lowest volutions, whilst the specimens with the smallest-sized umbilicus possesses the relatively highest whorls. The specimen represented in pl. LV, fig. 2, occupies a somewhat intermediate position since it combines a fairly narrow umbilicus with comparatively low volutions. The ornamentation of the chambered nuclei is fairly constant but there are noteworthy discrepancies in the sutures. In the form with low whorls, which, as a matter of course, offers the least amount of space for the development of the sutural inflections, the second lateral lobe is the shortest and is hemmed in by the first auxiliary lobe and the inner main lateral branch of the first lateral lobe. It is not however, in the specimens with the tallest aperture (pl. LVI, fig. 1), that the second lateral lobe exhibits its least atrophied and least deflected condition, but in a specimen which, as regards the height of volution,

occupies an intermediate position (pl. LIV, fig. 1). There is however not much difference in the relative volution-height of the two specimens. Moreover, in the specimen represented in pl. LIV, fig. 1, the lobes exhibit somewhat narrower trunks, and the first lateral lobe has shorter side-branches and a longer terminal branch than usual.

If the differences in the structure of the lobes and the form of the shell were distributed according to a definite law, it might be possible to distinguish two species; but failing this condition together with the fact that the most pronounced differences affect precisely specimens all derived from one locality (Shalshal), we are evidently justified in uniting these various forms into one species.

According to Waagen *Perisphinctes denseplicatus* is the commonest species of the Umia Stage. In the Spiti Shales *Per. denseplicatus* is also one of the commonest species. The *Acanthicus* Zone of Europe contains a very closely allied species, *Perisphinctes metamorphus* Neumayr[1]; it differs from the Indian species by its narrower umbilicus, relatively higher volutions, and somewhat coarser, more strongly curved, but less numerous ribs. A second closely allied species is probably *Perisph. Chalmasi* Kilian[2] from the Tithonian of Andalusia. In *Per. Chalmasi* the ribs are more deeply cleft, and the anterior portion of the body-chamber carries umbilical tubercles arising from the main-ribs, which are not known to occur in *Per. denseplicatus*; finally, the volutions are comparatively somewhat higher and the shell somewhat larger than in the Indian species. *Perisphinctes geron* Zittel has a narrower umbilicus, much taller and narrower volutions, while the trichotomous ribs are much fewer in number. According to Zittel the sculpture of the body-chamber is identical with that of the chambered nucleus; consequently it does not pass through the same series of developmental changes which are so characteristic of *Perisphinctes denseplicatus*. Probably also *Perisphinctes oxypleurus* Herbich[3] from the *Terebratula janitor* strata of Transylvania is closely related to *Per. denseplicatus*; since, however, only the immature stage of the Transylvanian species is known, it is not possible for the present to determine with sufficient precision its degree of relationship to *Perisphinctes denseplicatus*.

A problem of considerable difficulty is offered by *Perisphinctes ulmensis* Oppel[4] from the Lithographic Slates and the zone of *Pteroceras Oceani* and *Exogyra virgula* of Wurtemberg. Owing to the courtesy of Prof. Dr. Rothplez I have been able to examine the two original type-specimens of this species, and a closer study of these fossils reveals the fact that they belong to two different species of which one (pl. 74, fig. 1 of Oppel's work) is ornamented with densely crowded and fine ribs, whilst the other (fig. 2 of the same plate) has fewer and coarser ribs. The former is closely related to *Perisph. denseplicatus*, but is distinguished by the stronger curvature and anterior deflection of its ribs. The specimen, however, is entirely distorted by compression and it is impossible directly to

[1] Fauna der Acanthicus-Schichten, *Abh. geol. Reichsanstalt* Wien, V, p. 176, pl. XXXIV, fig. 1 ; pl. XXXIII. fig. 7.
[2] Mission d'Andalousie, XXVIII, fig. 1, p. 652.
[3] Szeklerland, pl. IX, fig. 1, p. 164.
[4] *Palaontol. Mitteil.*, pl. 74, figs. 1, 2, p. 261.

ascertain the original shape of the cross-section. Associated with the second specimen of *Perisph. ulmensis* (pl. 74, fig. 2), is a well preserved aptychus whose outlines conclusively establish that this specimen, although now completely flattened out, must have possessed a very convex shell. The same may have been the case with the closely costate form of *Per. ulmensis*. But so long as better preserved specimens of the latter form are not available, it is impossible to express any opinion concerning its relationship to *Per. denseplicatus*.

Lastly, *Perisphinctes denseplicatus* is also related to *Perisphinctes planulatus siliceus* Quenstedt; since, however, in the latter species the trichotomous type of ornamentation is assumed at a very early stage of growth, and since the main-ribs do not become thickened on the body-chamber, the specific discrimination of the two species gives rise to no hesitation.

Locality.—Shalshal, Middle Stage (4 specimens); Sirkia, Laptal, Middle Spiti Shales; North of Ting Jung La, Spiti, Chidamu, Chojan (Middle Spiti Shales).

Perisphinctes (Virgatosphinctes) raja, n. sp.

(Plate L, fig. 1 *a*—*d*.)

Dimensions:—

Diameter	143	mm.
Width of umbilicus	58·3	,,
Height of volution	49	,,
Maximum thickness between the ribs	54	,,
Maximum thickness measured over the ribs	57	,,

In this beautiful species the volutions overlap by about half their height, their breadth is greater than their height and the maximum thickness coincides with the transition from the flanks into the rounded umbilical wall. The flanks merge gradually into the rounded external region.

The ornamentation exhibits great variations. The inner volution is ornamented with very numerous, probably dichotomous, filiform ribs. The posterior part of the body-chamber shows an alternation of trichotomous, dichotomous, and bidichotomous ribs, while trichotomous ribs predominate on the middle portion of the body-chamber. On the anterior portion of the body-chamber the main ribs recede from each other, assume the shape of slightly curved strong folds and break up into ten or eleven or even twelve secondary ribs. The splitting up into secondary ribs takes place chiefly at about half the height of the flanks or somewhat lower down; it is only at the commencement of the body-chamber that the lower branching-point of the bidichotomous ribs sometimes become shifted to the lower part of the flanks.

Constrictions exist, but they are not conspicuous. The suture line is somewhat deflected forward between the external saddle and the apex of the first lateral saddle, beond which it is strongly retrograde up to the umbilicus. The first lateral lobe has a rather broad trunk and reaches nearly as deep down as the external lobe. The second lateral lobe is considerably shorter and disposed

somewhat obliquely. The auxiliary lobes are very well developed and reach down to the same level as the terminal branch of the first lateral lobe. The external saddle is moderately broad. The suture is copiously ramified.

Although the oral margin is missing, the preserved portion of the body-whorl includes the greatest part of the last volution. Its length therefore must have been equal to one whole volution.

The present species is very easily distinguished from *Perisphinctes densepli-catus* owing to its thick volutions and the striking peculiarities of its body-chamber. From *Perisphinctes rotundidoma* it is distinguished by the shape of its cross-section and the relatively greater thickness of its whorls, its somewhat narrower umbilicus and certain rather important differences in the structure of the body-chamber. The relations to *Perisph. minusculus* are discussed under the heading of the latter species.

Perisphinctes raja is represented by a single specimen from Chidamu (Coll. Diener).

Perisphinctes (Virgatosphinctes) minusculus, n. sp.

(Plate LVI, fig. 2 *a*—*c*.)

Dimensions:—

Diameter	108	mm.
Width of umbilicus	47	,,
Height of volution	32	,,
Maximum thickness between the ribs	34·7	,,
Maximum thickness at the ribs	36	,,

The present species represents, as it were, a miniature replica of *Perisphinctes raja*. As in the latter species the anterior part of the body-chamber carries fold-like widely-spaced main-ribs showing a faint sigmoidal curvature, a decided forwarded deflection, and breaking up, on the upper part of the flanks into numerous, densely crowded secondary ribs. The number of secondary ribs produced by each main-rib is 9 or 10 in the case of *Perisphinctes minusculus*, and 10 or 11 in the case of *Perisph. raja*. Trichotomous ribs are developed on the posterior portion of the body-chamber just as in *Per. raja* their branching-points coming very close to each other. Dichotomous ribs prevail at the commencement of the body-chamber. Bidichotomous ribs seem to be entirely wanting. Both the chambered nucleus and body-chamber exhibit constrictions which are more strongly developed than on the one available *Perisphinctes raja*. The number of long ribs on the inner volutions is greater in the present species than in *Perisph. raja* and the ribs are more densely crowded. The penultimate volution bears no less than 81 long ribs, and the preceding whorl has 54, while in the case of *Perisph. raja* the penultimate whorl carries only 60 ribs.

These differences in sculpture would perhaps be insufficient for a specific separation of the two forms, were it not for the considerable difference in size and certain differences in the shape and suture. *Perisph. minusculus* has a some-

what wider umbilicus; its dimensions increase at a slower rate, and the volutions are not quite so thick.

The suture-line, which, unfortunately, is only partly known, is less copiously ramified, and the second lateral lobe is less hemmed in by the first auxiliary lobe and the inner lateral branch of the first lateral lobe than in the case of *Per. raja*.

The oral margin is missing and the exact position of the last suture cannot be ascertained, yet so much can be made out that the last volution belongs entirely to the body-chamber.

There is no escaping the fact that the differences between *Perisphinctes raja* and *Perisphinctes minusculus* are very trifling. Many palæontologists will prefer uniting both forms, while others may look upon the difference in size as a sexual difference. The question cannot be considered as definitely settled, but for my part, I look upon specific difference as the more probable explanation, and have therefore named the smaller form separately, although richer finds might ultimately lead us to alter our opinion.

Locality.—Spiti (Coll. Gerard).

Perisphinctes (Virgatosphinctes) rotundidoma, n. sp.

(Plate LII, fig. 1 *a*—*c*; Plate LIII, fig. 1.)

Dimensions:—

Diameter	121	mm.
Width of umbilicus	55·6	,,
Height of volution	36·8	,,
Maximum thickness	40	,,

The above-named species is readily distinguished from *Perisphinctes denseplicatus* owing to its uniformly rounded low volutions and its wide umbilicus. The differences in the ornamentation are much less obvious especially on the chambered nucleus. The last chambered whorl of *Perisphinctes rotundidoma* carries 78 forked ribs, the previous one 46. On the inner whorls the bifurcation of the ribs takes place above the middle of the volution, whilst on the last volution of the chambered nucleus the branching-point is shifted lower down. The inner volutions are diversified by deep constrictions.

The sculpture of the chambered nucleus is, therefore, almost identical with that of *Perisph. denseplicatus*. There are noticeable differences, however, on the body-chamber. In the case of *Perisph. denseplicatus*, the main-ribs on the body-whorl become wider-spaced and break up into rib-bundles, while in that of *Perisph. rotundidoma* they remain fairly densely crowded and continue ramifying mostly into no more than two branches, rarely into three.

Perisphinctes rotundidoma is also closely allied to *Perisph. intermedius*. The volutions of *Perisph. rotundidoma* are somewhat thicker and lower; the cross-section is somewhat less distinctly bevelled externally; the umbilicus is wider, the sculpture is finer and more crowded. The distinction from *Perisph. raja* is still

more obvious. Even when the characteristically ornamented body-chamber of *Perisph. raja* is missing, this species cannot be confounded with *P. rotundidoma*, because it is considerably thicker and more narrowly umbilicated, with a lower cross-section and somewhat coarser ribs.

The suture of *P. rotundidoma* vividly recalls the form sometimes assumed by that of *P. denseplicatus* such as figured on plate LIV, fig. 1 *c*. The position of the second lateral lobe is scarcely or not at all oblique and it is not hemmed in by the inner lateral branch of the first lateral lobe and by the first auxiliary lobe. The line of auxiliary lobes is scarcely deflected and they stand on about the same level as the inner lateral main-branch of the first lateral lobe. The first lateral lobe of *P. rotundidoma* is shorter, broader and thicker than that of *P. denseplicatus*.

In the large figured specimen of *P. rotundidoma* the body-chamber shows a slight, rounded expansion on both sides of its anterior end suggesting the broad base of a lateral lappet. Shortly behind this the sculpture shows certain irregularities and two long ribs become fused close to the external margin into a single rib.

If the anterior edge has been correctly interpreted as the margin of the oral aperture, *P. rotundidoma* must be characterized by a very short body-chamber occupying very little more than half a volution. A similar feature, though not quite so pronounced also characterises *Perisph. discoides*. Nevertheless, the state of preservation of the above-mentioned specimen of *Per. rotundidoma* is not sufficiently perfect to allow a definite conclusion to be arrived at in this matter, and, should our interpretation turn out to be incorrect, it would appear that the anterior portion of the body-chamber must have been ornamented with rather swollen ribs anteriorly convex at about half the height of the volutions.

The figured specimen of *Perisphinctes rotundidoma* is from the Middle Spiti Shales of Chidamu; there is also a smaller specimen from the Middle Spiti Shales of Shalshal.

Among the specimens which Stoliczka referred to *Ammonites Braikenridgei* d'Orb. there is a small fragment closely related to *Perisph. rotundidoma*. It has somewhat coarser ribs and thicker volutions and possibly represents a distinct species. We designate it provisionally as *Perisphinctes* aff. *rotundidoma* Uhlig. It is from Spiti.

PERISPHINCTES (VIRGATOSPHINCTES) INTERMEDIUS, n. sp.

(Plate LXVI, fig. 1 *a*—*d*.)

Dimensions:—

Diameter	115	mm.
Width of umbilicus	52	,,
Height of volution	35·5	,,
Maximum thickness	32·5	,,

The species described under the above name occupies in certain respects an intermediate position between *Perisphinctes denseplicatus* and *Perisphinctes rotundidoma*, though it cannot be specifically united with either. It differs from

both by its somewhat less crowded and rather more massive ornamentation. The number of ribs on the last volution is 74, whilst on the penultimate whorl they are much fewer. Most of the ribs bifurcate just as in the two species previously described; it is only on the portion of the last volution situated just behind the most anterior part that one notices a few trichotomous ribs.

It is chiefly the cuneate form of the cross-section and the characters of the body-chamber that entitle the present form to rank as an independent species. *P. intermedius* is not so thick as *P. rotundidoma* and its cross-section is somewhat taller and more distinctly bevelled externally. Compared with *P. denseplicatus*, the section though more distinctly bevelled externally, is at the same time somewhat lower.

The suture of *P. intermedius* agrees in its character with some of the forms assumed by that of *P. denseplicatus* such as that depicted in plate LVI, fig. 1. The first lateral lobe is nearly as long as the external lobe;[1] the first lateral saddle rises somewhat higher than the external saddle: the second lateral lobe is rather hemmed in and is disposed obliquely.

The ornamentation of the posterior portion of the body-chamber is not essentially different from that of the chambered nucleus. But on the anterior portion of the body-chamber the ribs abruptly recede from each other, they are strongly deflected forward and separated from each other by deep constrictions. A short distance behind the place where this change occurs, one notices a fusion of two ribs on the external margin resulting from an irregularity in the development of the rib-system. The sudden increase in the distance between the ribs on the front portion of the body-chamber indicates for that systematically important part of the shell a developmental phase which cannot be brought into harmony with the characters of the body-chamber of either *P. denseplicatus* or *P. rotundidoma*. Had the body-chamber of these various species been completely preserved, it is probable that the differences observed, would have been far greater than is observable under the present circumstances. These reasons speak strongly in favour of the correctness of our conclusions with regard to the separation of the present species. Another specimen of the same species preserved in the Schlagintweit collection has the ribs somewhat stronger and less numerous than in the figured form.

Localities.—Chidamu, Sirkia, South Hundes, Shangra and Laptal in Ngari Khorsum, Tibet.

Perisphinctes (Virgatosphinctes) Pompeckji, n. sp.

(Plate LXV, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	123	mm.
Width of umbilicus	50	,,
Height of volution	42	,,
Maximum thickness	36·5	,,

[1] The artist has drawn the first lateral lobe much too short.

Perisphinctes Pompeckji is a species perhaps entirely devoid of trichotomous ribs. No trichotomous ribs can be seen in the figured specimen although the anterior portion of the last volution of the rather large shell already belongs to the body-chamber. Consequently, it is only on the foremost missing portion of the body-chamber that trichotomous ribs could have been developed. In any case they cannot but have played a very subordinate part. Nevertheless the present species cannot be disconnected from the group of *Perisphinctes denseplicatus*, *rotundidoma*, and *intermedius*, for it closely resembles the members of this group.

The last volution carries 81 ribs, the penultimate one 71; they are forked and slightly deflected forward. They bifurcate above the middle of the volutions on the inner whorls, whilst on the last whorl the apex of the fork is shifted downwards to about the middle of the volution-height.

The flanks are greatly flattened and clearly marked off both from the flatly arched external region and from the steeply sloping rounded umbilical wall. The maximum thickness occurs at the junction of the flanks and umbilical wall. As the flanks converge only very slightly upwards, the thickness of the volutions measured in their upper part is very little less than lower down, and the cross-section has consequently an oblong form with rounded corners. The height of the whorls is considerably greater than their thickness and they overlap by two-fifths of their height.

The first lateral lobe has a rather broad trunk and is somewhat shorter than the external lobe.[1] The second lateral lobe is moderately developed; its apex comes closer to the inner lateral branch of the first lateral lobe than to the first auxiliary lobe. The auxiliary lobes stand at about the same level as the apex of the first lateral lobe. The first lateral saddle is somewhat higher than the external saddle.

Perisphinctes Pompeckji is distinguished from the allied species by the absence of trichotomous ribs. Even if it should be found that trichotomous ribs do occur on the foremost portion of the body-chamber, their scarcity combined with the decided flattening of the flanks and the remarkable shape of the cross-section would still afford ample means for discrimination. In *P. intermedius* the volutions are lower and more wedge-shaped externally; *P. denseplicatus* has a more convex external face, and less complanate flanks which are not so clearly marked off from the external margin as in *P. Pompeckji*. In the case of *P. rotundidoma* the cross-section is relatively much lower and has more rounded outlines; the external margin and umbilical wall are more strongly convex and much less distinctly marked off from the flanks than in the case of *P. Pompeckji*.

Locality.—North of Jandu, Sherik river, Hundes.

1 On plate LXV, fig. 1c, the first lateral lobe has however been drawn too short.

Perisphinctes (Virgatosphinctes) similis, n. sp.

(Plate LIV, fig. 2 *a*—*d*.)

Dimensions:—

Diameter	69·3 mm.
Width of umbilicus	26·7 ,,
Height of volution	26 ,,
Maximum thickness of last volution	28 ,,

The present species is very closely related to *Perisphinctes rotundidoma*. Both forms have a subcircular cross-section the thickness of which slightly exceeds the height, the only difference in this respect being that *P. similis* has the flanks more convex. Both forms are similarly ornamented. In both instances the ribs are relatively widespaced and very sharp on the inner whorls, while they become fine and densely crowded on the outermost volution. The ribs of the inner whorls are however somewhat fewer, more prominent, and thicker in *P. similis* than in *P. rotundidoma*. The fact that in *P. similis* the ribs are almost exclusively dichotomous whilst in *P. rotundidoma* trichotomous ribs often make their appearance on the anterior portion of the shell can hardly be regarded as a distinctive character, as it is connected with the small size of the figured specimen of *P. similis*. *P. similis* increases in size at a much more rapid rate and has a much narrower umbilicus than *P. rotundidoma*.

The suture of *P. similis* has narrower saddles and is more finely and more deeply ramified than that of *P. rotundidoma*. Although the figured suture of *P. similis* corresponds to a diameter of only 67 mm., while that of *P. rotundidoma* corresponds to a diameter of about 84 mm., yet the external and first lateral lobes of *P. similis* are much longer than those of *P. rotundidoma*. Moreover, the line of auxiliary lobes of *P. similis* is much more retrograde and the first auxiliary lobe projects obliquely to such an extent towards the first lateral lobe that the second lateral lobe is almost crowded out, while in *P. rotundidoma* the first auxiliary and first lateral lobe are widely separated from each other and do not interfere with the free development of the second lateral lobe. The differences in the details of the suture and in the width of the umbilicus seem sufficiently considerable to justify the separation of *P. similis* and *P. rotundidoma*. *P. similis* differs from *P. intermedius* owing to its greater umbilical width, its greater thickness, its more rounded flanks and the finer costation of the outer volution.

P. similis is represented by a single specimen from Spiti (Coll. Gerard). The specimen is labelled with the same number (H. 47/448) as *Perisphinctes minusculus*.

Perisphinctes (Virgatosphinctes) serpentinus, n. sp.

(Plate LII, fig. 2 *a*—*d*.)

Dimensions:—

Diameter	76 mm.
Width of umbilicus	31·8 ,,
Height of volution	26·2 ,,
Maximum thickness	30 ,,

The present species has subcylindrical volutions overlapping by about one half. The thickness of the whorls is only very slightly greater than their height.

The ribs are densely crowded, only slightly inclined forward and nearly straight. On the last volution they number 68. Their point of bifurcation is situated at half the height of the volutions or even a little lower. They are almost exclusively dichotomous; even on the body-chamber trichotomous ribs are only occasionally developed, and then only in conjunction with shallow constrictions. A few ribs remain undivided. There are three constrictions on the last whorl.

The remarkably high position of the first lateral saddle constitutes a characteristic feature of the suture. The trunk of the first lateral lobe is rather narrow; the first auxiliary lobe converges strongly towards the first lateral one. The apex of the first lateral lobe reaches down to a somewhat lower level than the auxiliary lobes.

Perisphinctes serpentinus is closely allied to *Perisphinctes similis* and *Perisphinctes rotundidoma*. From *P. similis* it differs by the much greater number, denser crowding, and finer construction of the ribs on the inner volutions, its somewhat more rounded flanks and a slower rate of increase. The body-chamber of *P. similis* is unfortunately not known so that a comparison in this respect is impossible. The crowding of the ribs on the inner whorls is a character common both to *P. serpentinus* and *P. rotundidoma*; but on the body-chamber of *Per. serpentinus* the ribs are sharper and less numerous. Moreover *P. serpentinus* increases more rapidly in breadth and thickness, its cross-section is more nearly circular and it shows considerable deviations in the disposition of the suture.

Perisphinctes serpentinus is represented by four specimens all of which still preserve portions of the body-chamber. In every case the body-chamber is of the same size as the figured specimen and exhibits the same primitive type of sculpture. We may therefore assume that the latter represents the final fullgrown stage.

The figured specimen was designated *Amm. biplex* by H. F. Blanford (Journal Asiatic Soc., XXXII, p. 129), and *Ammonites annulatus* by Sowerby.

Localities.—Spiti valley, Shangra, Laptal.

Perisphinctes (Virgatosphinctes) Holdhausi, n. sp.

(Plate LXIV, fig. 2 *a*—*c*.)

The only available specimen of this species is incomplete. The maximum thickness at the anterior end is 36·6 mm., to a volution height of 30·5 mm. The flanks are slightly flattened and strongly convergent externally. The umbilical wall is rather high, very steep and clearly marked off from the flanks. The external margin is narrow and convex. The maximum thickness coincides with the junction of the flanks and umbilical wall; the cross-section is broadly ovate

with a rounded-truncate base. The volutions appear to overlap by more than one half, in consequence of which the umbilicus is comparatively narrow.

The ornamentation consists of crowded, sharp and deeply cleft ribs which are deflected backwards on the umbilical wall and lower part of the flanks, whilst on the outer part of the flanks they are rather strongly deflected forward. Although the greater portion of the last volution belongs to the body-chamber, there is a total absence of trichotomous ribs.

The suture is not preserved.

Perisphinctes Holdhausi is connected with the group of *P. denseplicatus* on account of its densely crowded costation, but is clearly distinguished from all the other species of the same group on account of its remarkable rounded-triangular cross-section and its deeply cleft, slightly curved ribs. The form of the cross-section and the course of the ribs forcibly recall *Perisphinctes Lemoinei*. But this form has a wider umbilicus, and much coarser and frequently trichotomous ribs, so that it cannot be confounded with *Perisphinctes Holdhausi*.

The species is represented by a single specimen from Laptal, Hundes (Coll. Griesbach).

PERISPHINCTES (VIRGATOSPHINCTES), sp. ind., aff. DENSEPLICATUS Waagen.

(Plate LXV, fig. 2 *a*—*d*.)

Ammonites biplex H. F. Blanford, On Gerard's Collection of Spiti fossils. *Journ. Asiat. Society*, Calcutta, 1863, vol. 32, p. 129, pl. III, figs. 4 *a*—*c*, 5.

The specimen here alluded to, which has already been figured by H. F. Blanford, is distinguished from the closely allied *Perisphinctes denseplicatus* by its considerably narrower umbilicus and the somewhat taller and externally less rounded volutions. The cross-section recalls that of *Perisphinctes Pompeckji* n. sp.

This form probably differs specifically both from *Perisphinctes denseplicatus* and *P. Pompeckji*, but as the body-chamber is not preserved, the species cannot be completely characterized. All we can do therefore is to draw attention to the existence of this narrow-umbilicated form and trust to future discoveries for defining it more precisely.

The present form deserves special attention, because amongst all the Indian species it is the one closest related to the two European fossils *Perisphinctes metamorphus* Neumayr and *Perisphinctes ardescicus* Fontannes. In the case of *P. metamorphus*, however, the umbilicus is still narrower, the volutions are comparatively taller, and considerably narrower and the ribs are less curved. *P. ardescicus* differs by its remarkably straight ribs.

This species is represented by three specimens. The figured specimen is from Spiti, the other two from Jandu and Chidamu.

Perisphinctes (Virgatosphinctes) frequens, Oppel sp.

(Plate LXIII, figs. 1 *a*—*c*, 2, 3 *a*—*c*; Plate LXXV, fig. 1 *a*—*c*; Plate LXXV A, fig. 1 *a*—*c*.)

Ammonites frequens Oppel, 1865. *Paläontolog. Mitteil.*, Pl. 87, p. 295.
Perisphinctes frequens Siemiradzki, Monographie der Gattung Perisphinctes, *Palaeontographica*, 1898, Vol. 45, p. 237.

	Plate LXXV A.	Plate LXXV.	Plate LXIII, fig. 2.	Oppel's Specimen.	Plate LXIII, fig. 3.
Diameter	179 mm.	161 mm.	122 mm.	99 mm.	79·5 mm.
Width of umbilicus . .	69 ,,	64 ,,	49 ,,	37·5 ,,	26 ,,
Height of volution . .	62 ,,	56·5 ,,	43·3 ,,	35·5 ,,	31 ,,
Maximum thickness . .	56·3 ,,	59 ,,	44 ,,	34 ,,	29 ,,

On the inner whorls the ornamentation of *Perisphinctes frequens* consists of fine, and at the same time sharp, dichotomous ribs which are anteriorly deflected, and the branches of which diverge only very little owing to the dense crowding of the costation. When the diameter is between 55 and 80 mm., there occur isolated trichotomous ribs in which the anterior branch-rib originates below the middle of the height of the volutions, whilst the next one branches off at about half the height of the whorl. At a later stage of development, these trichotomous ribs become somewhat wider-spaced, their lower portions becoming more massive. Somewhere near the commencement of the body-chamber, when the diameter has increased to between 110 and 150 mm., the ribs split up into four to five branches; moreover short intercalary ribs become inserted in the external region in consequence of which there are as many as eight or nine short ribs to every long rib on the anterior part of the body-chamber. At the same time the longer ribs recede still further from one another, and become considerably thickened in their lower part. The ribs traverse the external margin without being interrupted or reduced; they are slightly deflected backward on the umbilical wall, slightly deflected forward near the middle of the flanks, and more radially disposed on the upper part of the flanks. Certain specimens exhibit distinct though shallow constrictions, the number of which is two or three per whorl even at the full-grown stage; in other specimens the constrictions are entirely absent from the middle and subsequent stages of growth, or else they are few in number and indistinct.

The whorls overlap one another by about one half or somewhat more, and their cross-section is oval or roundish-trapezodial. The umbilical wall is rounded and has a moderate, or rarely a steep slope towards the umbilicus. The maximum thickness is at the umbilical wall. The feebly arched flanks converge towards the comparatively narrow and strongly convex external margin.

The first lateral lobe of the copiously ramified suture reaches as far downwards as the external lobe; it consists of a long, narrow trunk and subsymmetrically disposed lateral branches. The second lateral lobe is much shorter, rather oblique and restricted to the space that remains free between the closely approaching apices of the first auxiliary lobe and of the inner lateral main-branch of the first lateral lobe. The auxiliary lobes are obliquely disposed and the point

of the last one nearly reaches down to the level of the apex of the first lateral lobe. In well preserved specimens one observes as many as five auxiliary lobes.

The body-chamber is probably one whole volution in length. In the largest specimen (pl. LXXV A) four-fifths of the last volution belong to the body-chamber. The oral margin is not preserved.

Perisphinctes frequens is very variable. Of the ten available specimens scarcely one completely agrees with any of the others. The number of ribs as well as the shape of the cross-section, the size, and the umbilical width are all liable to vary.

In Oppel's original type,[1] the last volution which belongs to the middle stages of growth, carries no less than 75 ribs on the lower portion of the flanks, whilst in other specimens the number of ribs at this same stage is about 67. The specimen represented on pl. LXXV closely resembles the original type. In this specimen, the number of long ribs on the last volution is 59, and on the penultimate whorl 72. The cross-section differs owing to the more pronounced curvature of the flanks and umbilical wall. The specimen illustrated in fig. 2, pl. LXIII, is of considerable thickness. In the case of the specimen shown in fig. 1 of the same plate the ribs are less numerous and begin receding from each other at an earlier stage. In the case of the specimen illustrated in fig. 3, pl. LXIII, the number of ribs is only 63 on the last whorl, the external margin of the shell is somewhat thicker, the umbilicus much narrower, and the second lateral lobe somewhat shorter than in all the other specimens. This narrow-umbilicated type, which might perhaps be raised to the rank of an independent species, may be designated as *variatio angustumbilicata*.

The large-sized specimen figured on pl. LXXV A belongs to the densely costate types. On the last volution, the greater part of which belongs to the body-chamber, there are 46 long ribs, while on the penultimate whorl their number amounts to 88. The process of "virgatotomy" is particularly beautifully illustrated by this specimen. The umbilical wall is steeper and the volution-height greater than in the remaining forms so that the question arises as to whether it would not be preferable to make this specimen the type of a distinct species. But, as far at least as the nature of the umbilical wall is concerned, a large specimen from Chidamu constitutes an intermediate link between this specimen and the remainder, and I have therefore, after some hesitation, decided to unite the present specimen also with *Perisphinctes frequens*.

The above statements illustrate the wide limits within which *Per. frequens* varies. It is impossible to circumscribe species more narrowly, unless we make up our mind to apply separate names to forms which pass into each other by

1 Oppel's original illustration shows only 62 ribs on the last volution where the diameter measures 99 mm., while in reality there are 75. *P. frequens* is therefore much more densely ribbed than would appear from the original illustration. It was probably by reason of this inaccuracy in the original figure that W. Waagen was led to identify with *P. frequens* Oppel a form from Kachh whose ribs are less crowded and which we have referred to here (page 327) as *Perisphinctes subfrequens nobis*. Moreover, Oppel's illustration indicates for the type specimen a diameter of 117 mm., whilst in reality the diameter is only 99 mm. Either the anterior portion of the last volution has been broken off and mislaid since the publication of the drawing or else the figure has been restored.

termediate gradations. Moreover, there are certain characters common to all e specimens of this species, however much they may vary in other respects, amely: the comparatively rapid increase in the dimensions of the whorls, the :ceedingly close crowding and large number of the ribs, and the fact that the anch-ribs reach down to the middle of the flanks or even lower.

The present species has however been restricted within narrower limits than as done by Oppel who referred no less than 36 specimens of the Schlagintweit ollection to *Perisphinctes frequens*. Siemiradzki has already pointed out that a reat many of these specimens do not belong to *P. frequens*.

The characters differentiating *P. frequens* from other allied species are iscussed when dealing with these other forms.

The ten specimens which I have referred to *P. frequens* are from the following ocalities: Chidamu, Spiti valley, between Ting Jung La and Chhota Hoti, Laptal, hangra, Kuling.

PERISPHINCTES (VIRGATOSPHINCTES) SUBFREQUENS, n. sp.

(Plate XLIX, fig. 1 *a—d*; Plate LXI, fig. 1 *a—d*.)

Perisphinctes frequens W. Waagen (*non* Oppel), Jurassic Cephalopoda from Kutch, *Palæontologia Indica*, ser. IX, vol. I, pl. XLIV, figs. 2, 3, p. 200, Calcutta, 1873.

Dimensions:—

Diameter	116 mm.	95·5 mm.
Width of umbilicus	43 ,,	41 ,,
Height of volution	40·8 ,,	32 ,,
Maximum thickness	37 ,,	29·7 ,,

In this species the flanks are slightly arched and merge gradually into the trongly convex external region. The umbilical wall is rounded and slopes bliquely. The maximum thickness occurs at the junction of the flanks and mbilical wall. The cross-section is rounded-trapezoidal to oval.

In the figured specimens the last volution carries 63 to 64 long ribs breaking up externally into 3 to 4 secondary ribs. In the case of the smaller specimen, pl. LXI, fig. 1, there are still a few bifurcate ribs occurring here and there on the last volution which is chambered up to its anterior extremity, while on the last whorl of the larger specimen which belongs to the body-chamber, all the ribs ramify into three or four branches.

The "virgatotomous" type of branching is beautifully illustrated in this species; amongst the secondary ribs, the one originating lowest is usually the anterior one, more rarely the posterior one. There occur constrictions which, although not very sharply defined, are nevertheless quite recognisable; in one specimen the last volution exhibits three of these constrictions; they are less numerous in another specimen. The body-chamber subsists in one of the specimens (pl. XLIX, fig. 1) where it occupies a complete volution. The change in the sculpture even on the

anterior portion of the body-chamber is not very pronounced, and consists only in a slight obscuring of the virgatotomy and in the occurrence of a broad shallow constriction.

The oral margin is unfortunately not preserved. The body-chamber specimen exhibits a somewhat asymmetrical build probably due to a slight injury to the umbilical wall of the left half of the shell at the commencement of the body-chamber.

The configuration of the suture is similar to that of *Perisphinctes frequens.*

We may readily assume that *Perisphinctes subfrequens* is specifically identical with a species from the Umia group of Kachh which Waagen described under the name of *Perisphinctes frequens* Oppel. As has already been remarked by Siemiradzki, the ribs are much fewer in Waagen's species than in Oppel's type. In the illustration of the Kachh species the cross-section seems thicker at the umbilical wall than in the Himalayan specimens, but it has been already stated by Waagen that this particular feature has not been represented with strict accuracy. In the case of the specimen represented in pl. XLIX, fig. 1, the umbilicus is somewhat narrower than in Waagen's specimen, while in the other specimen (pl. LXI, fig. 1*c*) it is perhaps a little wider; but small differences of this kind cannot be of much importance, considering the great variability of the *Perisphinctes* forms of the *Perisphinctes frequens* group.

Perisphinctes subfrequens is closely related to *Perisphinctes frequens* Oppel from which it differs owing to its somewhat wider umbilicus, its slower rate of increase, and especially its much more numerous main-ribs and the character of the body-chamber. Even at its anterior end the body-chamber of *Perisph. subfrequens* has densely crowded main-ribs, not greatly thickened, each corresponding with three or at most four secondary ribs; the body-chamber of *Perisphinctes frequens*, on the other hand, is characterised by its greatly thickened and wider-spaced main-ribs and very numerous branch-ribs.

Perisphinctes subfrequens differs from *Perisphinctes discoides* n. sp. especially in the shape of its cross-section and the greater length of its body-chamber; from *P. Kraffti* it is distinguished by its much larger size, the later appearance of trichotomous ribs, proportionately taller volutions, and the shape of the cross-section.

Allied European forms are frequently mentioned under the collective name of *Perisphinctes contiguus* Catullo. Of this species there exist eleven illustrations, of which Catullo, Pavlow, Toucas, Roman, Söhle, E. Favre and Vetters have respectively published one each, while Zittel and Burckhardt are each responsible for two; they probably refer to five or even six distinct species. The one that comes nearest to the above-described Indian species is one of the two forms figured by Zittel (Aelteres Tithon, pl. 35, fig. 2, *non* fig. 1), but the Indian fossil is distinguished by the greater number of ribs and the less frequent occurrence of bifurcate ribs. We have however reserved the name of *Perisphinctes contiguus* for another Indian fossil still more closely related to the form illus-

trated by Zittel, and established a new name for the one just described. Considering the state of confusion that prevails with regard to the synonymy of *Perisphinctes contiguus*, and which calls for a complete revision, the procedure here adopted appears to us to afford the easiest way out of our difficulties.

Localities.—Sirkia (South Hundes), Chidamu.

PERISPHINCTES (VIRGATOSPHINCTES) KUTIANUS, n. sp.

(Plate LX, fig. 2 *a*—*d*; Plate LXXVI, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	172	mm.
Width of umbilicus	50	,,
Height of volution	44	,,
Maximum thickness	40	,,

The volutions overlap by about half their height. The section is wedge-shaped. The maximum thickness occurs at the junction of the complanate flanks with the rounded, obliquely sloping, comparatively tall umbilical wall. The flanks merge fairly gradually into the rounded external margin.

On the umbilical wall the ribs are rather decidedly deflected backwards, on the lower portion of the flanks they are strongly inclined forward, while on the outer part of the flanks they are radially disposed or even slightly deflected backwards. In the larger of the two figured specimens, the last volution, three-fourths of which belong to the body-chamber, carries 47 stout main-ribs, the number on the penultimate whorl being about 62.

On the innermost volutions, the ribs are also very densely crowded, contrasting strongly by their delicacy, with the coarse costation of the body-chamber. The ribs of the inner volutions are dichotomous; trichotomous ribs first set in at the commencement of the body-chamber, an intercalary rib being added a little further on. The points of bifurcation are situated higher than the middle of the volutions.

The suture exhibits characteristic peculiarities. The external saddle is broad, but the trunk of the first lateral lobe is very narrow and rather short. The second lateral lobe is comparatively long and not disposed obliquely, while the line of auxiliary lobes seems rather decidedly retrograde. The body-chamber probably occupies a whole volution. The oral margin, which subsists in the smaller of the two figured specimens, bears short rounded lateral lappets with a broad base. The last rib-bundle, situated behind the oral margin, is very much blurred, and is separated from the preceding by a broad shallow constriction.

This species is represented by six specimens which exhibit the usual range of variation. In the small figured fragment of a body-chamber the convexity of the flanks is so reduced that they are almost flat. In another specimen, the ornamentation of which agrees remarkably with that of the figured forms, the wedge-shape of the cross-section is particularly evident, the umbilical wall being very

tall and the external margin narrow. In a third specimen the main ribs are more densely crowded but the branch-ribs less numerous. Finally there is a fairly complete, but unfortunately greatly weathered specimen in which the flanks are more strongly convex and the ribs more deeply divided.

Perisphinctes kutianus is distinguished from *Perisph. frequens* owing to the smaller number of secondary ribs on the body-chamber, the higher position of the points of ramification and the aberrant suture-line. In *P. frequens* the long ribs of the body-chamber are slightly thickened on the lower region of the flanks; at the middle of the flanks they become reduced, while in *P. kutianus* they are uniformly strengthened. In *Perisphinctes subfrequens* the main-ribs are somewhat closer set on the body-chamber, and they are somewhat weaker and less strongly deflected forward; the constrictions are more frequent and deeper, the volutions proportionately lower. There are also differences in the suture-line. In *Perisphinctes multifasciatus* the ribs of the body-chamber are wider spaced and break up into more numerous secondary ribs than in the case of *P. kutianus*. Moreover the cross-section of the body-chamber is more oval, and trichotomous ribs are restricted to the body-chamber, while in *P. kutianus* the trichotomous branching commences at an earlier stage.

Localities.—Kuti, Byans, Upper and Middle Spiti Shales (Coll. F. H. Smith and Krafft); Laptal (Coll. Griesbach); Shalshal, Middle Stage.

PERISPHINCTES (VIRGATOSPHINCTES) HIMALAYANUS, n. sp.

(Plate LXI, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	134 mm.	128 mm.
Width of umbilicus	58 ,,	55·5 ,,
Height of volution	43 ,,	39 ,,
Maximum thickness	51 ,,	

The present species is closely related to *Perisphinctes chidamensis*, *Perisphinctes Kraffti* and *Perisphinctes Burckhardti*, and is distinguished by its comparatively strongly inflated volutions the maximum thickness of which is situated at the lower part of the flanks near the umbilical wall. The thickness of the volutions considerably exceeds their height. The flanks, external margin and umbilical wall are all rounded. The flanks slope more steeply towards the umbilicus than towards the external margin.

The inner volutions carry crowded dichotomous ribs numbering about 65, on the lower part of the penultimate whorl. At the beginning of the last volution more than three-fourths of which belong to the body-chamber the dichotomous ribs are accompanied by trichotomous ones, while further on trichotomous ribs predominate. At the anterior part of the last volution a short intercalary rib is inserted between successive trichotomous rib-bundles, so that, on the upper part of the flanks, there are four short ribs to every long one. The type of ramification is

distinctly virgatotomous, though the several branches originate very close to one another. The level at which the ribs commence branching is situated higher than the middle of the flanks. The rib-stems are rather wide-spaced and strongly developed on the body-chamber. Their number on the last volution is about 50. On the anterior portion of the body-chamber there exists a constriction bordered posteriorly by an undivided rib, and anteriorly by a very prominent rib, which unfortunately is not completely preserved.

The first lateral lobe is considerably shorter than the external lobe; its stem is comparatively broad; the saddles are also broad. The second lateral lobe is a little shorter than the first and only slightly oblique. There are only three distinct auxiliary lobes the last of which stands at about the same level as the apex of the first lateral lobe. The points of the first auxiliary lobe and of the inner lateral main-branch of the first lateral lobe are far apart.

The body-chamber is not entirely preserved. It probably included about one volution. In the vicinity of the last suture and of the penultimate one the right flank shows traces of some injury to the shell.

Perisphinctes himalayanus is distinguished from *Perisph. Burckhardti* by its much greater thickness, its more rounded cross-section, the more numerous branch-ribs on the anterior part of the body-chamber and the higher position of their points of ramification. From *P. chidamensis* it differs by its larger size, greater thickness, stronger development of the main-ribs and greater number of secondary ribs, the much denser costation of the inner volutions and more strongly developed auxiliary lobes.

Perisphinctes Fontanæ Catullo sp.[1] from the Upper Jurassics of Europe is an allied species which, however, is so thick and so narrowly umbilicated that it cannot be identified with *P. himalayanus*. We have, further, to mention here a form from the Malm of the Katzenberg near Unterammergau, which has been figured by U. Söhle[2] under the name of *Perisphinctes contiguus* Cat., but which, however, corresponds neither with the original *Perisphinctes contiguus* of Catullo, nor with any of the other forms to which the name of *Perisphinctes contiguus* has been applied, though it probably does belong to the group of *Perisphinctes contiguus* taken in its wider sense. It is distinguished from *P. himalayanus* owing to the less strongly pronounced virgatotomy of its ribs, a somewhat wider umbilicus and apparently also a greater flatness of its volutions. We are unfortunately unable to form any definite opinion on the subject, as the fossil in question has not yet been figured or described in sufficient detail.

P. himalayanus is represented by two specimens from Chidamu. In the unfigured specimen the ribs are somewhat more strongly curved on the lower part of the volutions. A small fragment of a body-chamber possibly belongs to the same species.

1 Intorno ad una nuova classificatione delle calcarie rosse. *Mem. Instituto Veneto*, vol. V, pl. II, fig. 1*a*, *b*, p. 205.
2 U. Söhle, Das Ammergebirge, *Geognost. Jahreshefte*, München, XI, 1898, pl. XII, p. 16.

PERISPHINCTES (VIRGATOSPHINCTES) BURCKHARDTI, n. sp.

(Plate LXII, fig. 3 *a*—*c*.)

Dimensions:—

Diameter	124 mm.
Width of umbilicus	56 ,,
Height of volution	37 ,,

With a diameter of 113 mm., the width of the umbilicus is 52 mm., the volution height 36 mm., the maximum thickness 35·5 mm.

In this species the thickness of the volutions is almost as great as their height. The cross-section is rounded with the maximum breadth situated close to the rounded and rather steeply sloping umbilical wall. The umbilicus is wide but not very deep. The volutions overlap by somewhat more than one-third.

The inner volutions are ornamented with densely crowded dichotomous ribs the exact number of which cannot be ascertained. In the figured specimen there are 44 dichotomous ribs on the anterior part of the penultimate volution. Trichotomous ribs only make their appearance when the diameter has reached 88 mm. On the front portion of the last volution a short, fourth intercalary rib is added to the trichotomous ribs. There is one distinct constriction on the last volution.

Portions of the body-chamber subsist in all the specimens. Owing to its fragmentary condition, it is not possible to decide whether the specimen with preserved oral margin from Niti, which H. F. Blanford has described as *Amm. triplicatus* (Palæontology of Niti, pl. XIII, fig. 1*c* (*non* 1 *a*,*b*) should be classified with the same species.

The present species approaches *Perisph. Kraffti* on account of its rounded volutions, but it is distinguished by the late appearance of the trichotomous ribs which replace the dichotomous ones at a very early age in *Per. Kraffti*. From *Perisphinctes kutianus* the present species is distinguished by its wider umbilicus, its lower, more strongly rounded volutions, more deeply cleft and much more crowded ribs and the later appearance of the trichotomous ribs. The distinguishing features of *P. himalayanus* and *P. chidamensis* are stated under their respective headings.

Under the name of *Perisphinctes danubiensis* Schlosser, P. de Loriol[1] has described a closely allied species from the coral reef of Valfin. This form, which, however, does not seem to be specifically quite identical with the original Kelheim type of *Perisphinctes danubiensis*, differs from *Perisphinctes Burckhardti* owing to the higher position of the points of origin of the rib-bundles and a somewhat greater thickness. The type specimen of *Perisphinctes danubiensis* Schlosser[2] is much thinner and has a taller, oval aperture.

1 *Mém. Soc. paléontol.* Suisse, XIII, 1886, pl. 1, fig. 5.

2 Fauna des Kelheimer Diceraskalkes, pl. II, fig. 3, p. 19.

Still more closely related perhaps is an Argentinian form which Burckhardt has described under the name of *Perisphinctes* aff. *pseudolictor* Choffat. With a slightly more pronounced curvature of the flanks and slightly more distinct "virgatotomy" of the ribs the South American fossil could be directly identified with the Indian species. A more detailed investigation of both areas may supply material enabling us to arrive at a more definite opinion regarding the possible specific identity of some of their fossils. The differences between *Perisphinctes pseudolictor* Choffat and the Argentinian form have been stated by Choffat himself in Burckhardt's description; they are essentially the same as between the Indian and Portuguese species. We agree with Choffat that the Argentinian and Portuguese forms cannot be specifically united.

One of the specimens is from Tongtak (? label not clearly decipherable), two others are from Laptal (Coll. Schlagintweit).

PERISPHINCTES (VIRGATOSPHINCTES) MULTIFASCIATUS, n. sp.

(Plate LX, fig. 1 *a*—*c*.)

Dimensions:—

Diameter . .	136 mm.	157 mm.	168 mm.
Width of umbilicus . .	57 ,,	64 ,,	71 ,,
Height of volution . .	46 ,,	54 ,,	56·5 ,,
Maximum thickness . .	39 ,,	46·5 ,,	52 ,,

Up to a diameter of 70-75 mm. this species is ornamented with dichotomous ribs. About half a volution further, rib-bundles make their first appearance on a portion of the shell which already belongs to the body-chamber. At first every fascicle consists of three branch-ribs and an intercalary rib. But the number of secondary ribs increases so rapidly that on the front portion of the body-chamber each main-rib is accompanied by 5 to 7, or even 8 secondary ribs. The main-ribs are stout, wide-spaced and rather strongly deflected forward. Between the main-ribs the shell is deeply sunk especially on the front part of the body-chamber, and the ribs grow much stouter before breaking up into rib-bundles. The cross-section has a regular oval shape; the umbilical wall slopes obliquely towards the umbilicus and the maximum thickness is situated at the junction of the flanks and umbilical wall. In the body-whorl, the volution-height exceeds the thickness, while the reverse is observed in the inner whorls.

The suture is not known. The length of the body-chamber is probably one complete volution. The figured specimen of this species is neither quite so large nor so well preserved as three other specimens of the Schlagintweit collection which, unfortunately, were received from Munich too late for illustration. Oppel referred these specimens to his *Ammonites frequens;* on closer inspection it is

[1] Profils géologiques transversaux de la Cordillère Argentino-Chilienne. *Anales del Museo da la Plata,* 1900, pl. XXIV, fig. 4. Beiträge zur Kenntniss der Jura-und Kreideformation der Cordillere. *Palaeontographica,* vol. 50, pl. IV, figs. 1, 2, p. 30.

found impossible to unite *P. frequens* and *P. multifasciatus*. *P. frequens* is more closely involute, and the ribs on the inner whorls are much more densely crowded. On the body-chamber the ribs do not become so massive, they are more crowded and the shell is not so deeply sunk between successive fascicles as it is in the case of *P. multifasciatus*. Moreover the volutions of *P. frequens* are relatively taller and more strongly bevelled externally than in the case of *P. multifasciatus*.

Perisphinctes kutianus is another closely allied form. The rib-bundles on the body-chamber of this species consist of fewer branch-ribs (four only), the cross-section is more cuneate, the flanks are more flattened, the ribs are somewhat more deflected forward, and the shell is somewhat smaller.

Locality.—Jandu, Sherik River Hundes (1 specimen), Laptal (3 specimens).

Perisphinctes (Virgatosphinctes) Haydeni, n. sp.

(Plate LXI, fig. 2 *a*—*d*.)

The present species has a flat discoidal shell, with a wide umbilicus. The flanks are distinctly flattened, the umbilical wall is rounded and steeply declivous, the external margin convex. The cross-section has a rounded-trapezoidal shape. The number of ribs is about 63 on the body-whorl and 68 on the penultimate one. They are densely crowded, strongly deflected forward and the branching points are situated above the middle-zone of the flanks. The ribs are probably exclusively dichotomous on the inner volutions; dichotomous ribs are still frequent in the posterior portion of the body-whorl whose middle and anterior portions carry ribs with three or four branches. It is quite close to the anterior end that the main-ribs become somewhat thickened and wider-spaced. The suture and the oral margin are not preserved; three-fourths of the last volution belong to the body-chamber, which probably occupied a complete whorl.

Perisphinctes Haydeni n. sp. is distinguished from its nearest ally *Perisphinctes subfrequens* owing to its wider umbilicus, slower rate of increase, and its more strongly deflected ribs whose branching-points lie at a higher level. Moreover the shape is somewhat flatter, and the flanks and external margin somewhat more complanate. In *Perisphinctes frequens* the body-chamber carries much more numerous branch-ribs and less numerous and stouter main-ribs; its umbilicus is narrower and the breadth is greater at the lower part of the flanks. In the case of *Perisphinctes multifasciatus* n. sp. the umbilicus is as wide as in *P. Haydeni*, but the branch-ribs are much more numerous, the main ribs fewer, and the cross-section of the volutions is more oval.

The figured specimen is from Jandu, Sherik River, Hundes. Two other specimens preserved in the Schlagintweit collection are from Laptal. One of them is somewhat flatter than the type, the other is perhaps somewhat thicker with a slightly narrower umbilicus, but its greater thickness and want of symmetry are probably connected with an injury noticeable in the right half of the shell.

Finally, a small specimen from Sirkia, South Hundes, is perhaps also referrable to the same species.

Perisphinctes (Virgatosphinctes) Kraffti, n. sp.

(Plate LIII, fig. 4 *a*—*d*; Plate LXII, figs. 1 *a*, *b*, 2 *a*—*c*.)

Dimensions:—

Diameter	92·4 mm.	88 mm.	74 mm.
Width of umbilicus	34·5 ,,	36 ,,	30·2 ,,
Height of volution	33 ,,	29·8 ,,	25 ,,
Maximum thickness	31·8 ,,	28 ,,	26 ,,

The shape is discoidal. The volutions are rounded and overlap by about one half of their height. The width of the cross-section exceeds the height when the shell is immature, the proportion becoming reversed with increasing age. The umbilical wall is rounded and slopes obliquely. The flanks are slightly arched and gradually merge into the strongly convex external margin.

The ornamentation consists of virgatotomous ribs; in one specimen there are 52 main-ribs on the last volution, in another 47. There are 3 or 4 branch-ribs to every main-rib on the last volution. The branching-point of the ribs lies above the middle zone of the volutions. There are three or four distinct constrictions per volution. The "virgatotomous" type of ramification is evolved at a very early stage, trichotomous ribs being already noticeable when the diameter measures only 55 mm.

The subsymmetrical first lateral lobe descends as low down as the external lobe. Its trunk is somewhat broader than in *P. frequens*, the saddles being also broader than in that species. The apices of the first auxiliary lobe and the inner main lateral branch of the first lateral lobe are fairly wide apart, so that the second lateral lobe is freely developed. There are four retrograde auxiliary lobes, the last one of which stands at about the same level as the apex of the first lateral lobe.

In one of the specimens the body-chamber is almost completely preserved and occupies a whole volution.

Perisphinctes Kraffti, like *P. frequens*, appears to vary within wide limits. The figured specimens are not alike: the smallest of them is proportionately thicker, and its suture-line is somewhat more compact; the largest specimen has a narrower umbilicus and much more convex flanks. Other specimens are still flatter, with taller volutions, and narrower umbilicus. Throughout all these variations, the species is characterized by its comparatively small size, the early appearance of trichotomous ribs, and its depressed and subcircular to oval cross-section.

Perisphinctes Kraffti is distinguished from *Perisphinctes subfrequens* by the early appearance of trichotomous ribs, its smaller size, and lower and more rounded volutions; from *Perisphinctes Broilii* by its less rounded, comparatively taller and narrower volutions and the characters of the body-chamber.

P. Choffat has described a closely allied species from the Abadia Marls of Portugal under the name of *Perisphinctes Ribeiroi.*[1] The question might even be raised as to the advisability of directly identifying *P. Kraffti* with *P. Ribeiroi.* In the case of the Portuguese species, however, the " virgatotomy " of the ribs is less pronounced and the volutions are less rounded, so that it seems advisable to keep both forms distinct. Another closely similar form is *Perisphinctes choicensis* Burckh. from the Argentine. It differs from *P. Kraffti* by its narrower umbilicus, trapezoid cross-section, simpler sutures and much more numerous branch-ribs. Lastly, mention should be made of *Perisphinctes Basilicae* E. Favre[2] from the *Acanthicus* strata of Switzerland, a species which has higher and flatter whorls, a narrower umbilicus and less distinctly " virgatotomous " ribs and which probably, therefore, differs specifically from *P. Kraffti.*

Localities.—Chidamu, Sirkia, Spiti valley, Laptal, Kuti. 13 specimens.

Perisphinctes (Virgatosphinctes) Broilii, n. sp.

(Plate XCI, fig. 1 *a*—*d*.)

Ammonites triplicatus (Sow.) : H. F. Blanford *in* Blanford and Salter, Palæontology of Niti, 1865, pl. I, fig. 1 *a*, *b*, (*non* 1 *c*), p. 80.

Ammonites triplicatus, Sowerby : G. C. Crick, The Cephalopoda in the Strachey Collection from the Himalaya. *Geol. Magazine* dec. V. vol. I, 1904, p. 9.

Dimensions :—

Diameter	99	mm.	87·5 mm.
Width of umbilicus	44	,,	36·5 ,,
Height of volution	31	,,	29·7 ,,
Maximum thickness between the ribs	34·5	,,	
Maximum thickness measured over the ribs	36	,,	31 ,,

In this species trichotomous ribs already make their appearance, when the diameter has only reached about 50 mm. soon after which a fourth branch-rib becomes intercalated and the main-ribs recede somewhat further from each other. On the anterior part of the body-chamber there are secondary ribs to every main-rib, the latter projecting in the form of a rather thick fold. There are 42 main-ribs on the last volution, part of which belongs to the body-chamber, 40 on the penultimate whorl, 35 on the antepenultimate one. The ribs are strong, and on the inner volutions they are sharply defined; the lower branching-point is situated at half the height of the volutions or somewhat lower down, sometimes as far down as the umbilicus. There are on an average two rather deep constrictions to each volution. The constrictions are anteriorly bordered by a simple rib.

The volutions have a subcircular cross-section, their breadth somewhat exceeds their height and they overlap by about half their height.

The suture generally exhibits the characteristic configuration of the genus. The apex of the lateral branch of the first lateral lobe and that of the first auxiliary

1 Faune jurass. du Portugal. Ammonites du Lusitanien, pl. 18, fig. 16, p. 491.

2 *Mém. Soc. paléontol. Suisse*, vol. IV, pl. III, figs. 9, 10, p. 43.

lobe approach each other pretty closely though without essentially interfering with the development of the second lateral lobe. The incomplete remnants of the body-chamber occupy rather more than two-thirds of the last volution, the oral margin being broken off.

H. F. Blanford's type from Niti is not quite so thick as the figured specimen and its ribs are somewhat more numerous, their number on the last volution being 49 instead of 42. In all other respects there is perfect agreement.

The present species is closely related to *Perisphinctes Kraffti*, from which it is distinguished by its stronger and less crowded ribs and its much more depressed and more nearly circular cross-section.

The appearance of the fold-like ribs with their numerous secondary ribs on the front portion of the body-chamber vividly recalls *Perisphinctes raja*, *Per. minusculus* and *Per. multifasciatus*. From the first-named species *P. Broilii* is distinguished by its much smaller size, its sharp and less numerous ribs on the inner volutions, the numerous constrictions, and the shape of the cross-section; from *Per. minusculus* it differs by the wider spacing of the ribs which are coarser and less strongly deflected forward, and also by the smaller number of branch-ribs and the shape of the cross-section; from *Per. multifasciatus* it differs by its smaller size, the early appearance of trichotomous ribs, the deeper ramification of the ribs and the proportionately lower and much more nearly circular cross-section.

Amongst European species the closest ally is *Perisphinctes exornatus* Catullo.[1] Like *Perisphinctes Broilii*, this species is distinguished by comparatively low volutions and a very early appearance of complex ramifying ribs. *Perisph. exornatus* Cat. sp. has, however, a wider umbilicus, flatter and less overlapping volutions, and the complex ramified ribs appear at a much earlier stage. The form which Zittel[2] has figured, under the same name and in which the trichotomous ribs appear somewhat earlier than in Catullo's form, cannot be identified with the Indian species because it is much flatter with a much wider umbilicus. *Perisphinctes exornatus* has been mentioned by Zittel from the Lower and Upper Tithonian, and by Neumayr[3] from the *Acanthicus* Strata.

The present species is represented by three specimens from Shangra and Laptal in Ngari Khorsum (Coll. Schlagintweit). The exact locality of Blanford's specimen from Niti is not known.

PERISPHINCTES (VIRGATOSPHINCTES) DISCOIDES, n. sp.

(Plate XLIX, fig. 2 *a*—*d*.)

Dimensions:—

Diameter (approximately)	106 mm.	95·8 mm.
Width of umbilicus	42 ,,	39 ,,
Height of volution	38 ,,	34 ,,
Maximum thickness	29 ,,	27·8 ,,

1 Prodromo di Geognosia paleoz. delle Alpi Veneti, 1847. Appendice III, pl. XIII, fig. 2, p. 10. Intorno ad una nuova classificazione delle calcarie rosse. *Memorie J. R. Instituto Veneto*, V. 1855, pl. III, fig. 2.

2 Aeltere Tithon, pl. 34, fig. 3, p. 106. Stramberger Cephalopoden, p. 116.

3 Acanthicus-Schichten, p. 179.

This species is distinguished by a rather discoid shell with complanate flanks, rounded external margin and rounded, rather low and moderately steeply inclined umbilical wall. The volutions overlap by about three-sevenths of their height; the umbilicus is rather flat and wide, though the branching-points of the inner whorls are concealed. The cross-section is approximately oval with its maximum width situated in the vicinity of the umbilical wall though the thickness does not differ very considerably when measured at higher levels.

There are 52 ribs on the last volution, and 46 on the penultimate one; they are slightly deflected forward. Dichotomous and trichotomous ribs alternate at the commencement of the last volution and are soon succeeded by exclusively trichotomous ribs, while on the anterior portion of the last volution a fourth and short intercalary rib is frequently added to the trichotomous rib-bundles. The branching-point of the ribs lies above the middle-line of the volutions. The points of origin of the two branches are situated quite close to each other, producing the impression of a swelling of the ribs in the region of ramification. There are no conspicuous constrictions.

The first lateral lobe is nearly as long as the external lobe; the second lateral lobe has a somewhat oblique direction and is scarcely more strongly developed than the first auxiliary lobe. The third and fourth auxiliary lobes are very small and almost combined into one; they stand at about the same level as the apex of the inner main lateral branch of the first lateral lobe. The external and first lateral saddle are nearly equal in height.

Although only two-thirds of the last volution of the figured specimen belong to the body-chamber, yet the anterior edge suggests the configuration of a final oral aperture. The lateral lappets are not preserved; but their base is visible. The shell at this place expands outward, and there is a broad and shallow constriction behind the oral margin. We must therefore conclude that the end of the specimen corresponds with the final aperture and that the body-chamber of the present species was comparatively short. In a second specimen, which agrees excellently with the figured one, half of the last volution belongs to the body-chamber; but as the remainder of the body-chamber is missing it does not help to elucidate this matter.

Perisphinctes discoides is distinguished from *Per. subfrequens* by its flatter and taller volutions, stronger ribs, shorter body-chamber and feebler constrictions.

Perisphinctes discoides is represented by specimens from Chidamu (Coll. Diener), Shangra in Puling, Ngari Khorsum (Coll. Schlagintweit) and the Kiangur Pass (Coll. Diener). A small specimen from Kibber perhaps belongs to the same species; it already shows trichotomous ribs at a diameter of 41 mm.

PERISPHINCTES (VIRGATOSPHINCTES) SUBQUADRATUS, n. sp.

(Plate LXVIII, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	116·5	mm.	At a diameter of	106·6	mm.
Width of umbilicus	48	„			
Height of volution	44·5	„		38·5	„
Maximum thickness	41·5	„		38·7	„.

In the present species the ribs are stout and crowded and strongly deflected forward. Dichotomous ribs amongst which are scattered a few trichotomous ones, decorate the posterior portion of the body-chamber while on the anterior portion, trichotomous ribs prevail. The body-whorl carries one broad and rather deep constriction in which one of the ribs becomes obliterated. The constriction is distinctly developed only on one side of the shell, the opposite side bearing a simple rib in its place. As the shell is strongly arched on the external margin behind the constriction, this must be a case of irregular growth.

In the chambered nucleus the thickness of the volutions considerably exceeds their height; at the commencement of the body-chamber the cross-section is depressed, trapezoidal with strongly convex external margin finally passing into a subquadrate form. This stage is represented in fig. 1*c*. It is only on the anterior portion of the preserved part of the last volution that the height of the cross-section exceeds its thickness by a small amount. The flanks are slightly flattened; the umbilical wall is rounded, rather tall, sloping gently on the body-chamber, steeper on the inner volutions. The volutions overlap by a little less than half. The branching-points of the inner whorls are concealed inside the umbilicus.

The suture is not preserved, but it is possible to ascertain that the greater part of the last volution belongs to the body-chamber.

P. subquadratus resembles *P. chidamensis* in the pronounced anterior deflection of the ribs, the small number of secondary ribs, the low volutions and the wide umbilicus, but is easily distinguished owing to its subquadrate cross-section, its more deeply ramified and stouter ribs and its narrower umbilicus.

From *Perisphinctes Burckhardti* the present species is distinguished by its sharper, stronger and more strongly deflected ribs, the greater crowding of the main-ribs on the body-chamber, the smaller number of secondary ribs and the much narrower umbilicus.

Perisphinctes subquadratus is one of those species which Stoliczka included in his *A. triplicatus*. The type-specimen is from Spiti (Coll. Gerard).

PERISPHINCTES (VIRGATOSPHINCTES) CONTIGUUS, (Catullo) Zittel.

(Plate LXVIII, fig. 2 *a*—*d*.)

Perisphinctes contiguus Zittel, Fauna der älteren Tithonbildungen, pl. 34, fig. 2 *a*—c, *non* pl. 34, fig. 1*a*, *b* (*non Amm. contiguus* Catullo, Pavlow, Toucas, Söhle).

Perisphinctes cf. contiguus Vetters, Fauna der Jurnklippen zwischen Donau und Thaya. *Beiträge zur Geologie und Pal. Oesterreich-Ungarns*, Wien, 1905, vol. 17, pl. 22, fig. 7, p. 235 (with extensive synonymy).

Dimensions of the figured specimen:—

Diameter	103	mm.
Width of umbilicus	39·3	,,
Height of volution	37·5	,,
Maximum thickness	31·8	,,

The shape is rather flat-discoidal. The umbilicus is comparatively narrow. The cross-section is oval, the maximum thickness coinciding with the junction of the flanks and umbilical wall. The sculpture of the body-chamber consists of sharp, deeply cleft, trichotomous ribs, between which are intercalated numerous oifurcate ribs especially on the older portion of the body-chamber. The suture-line is characterized especially by the shortness of the second lateral lobe and the nearly transverse disposition and strong development of the first auxiliary lobe. The last volution belongs almost entirely to the body-chamber though the oral aperture has not been preserved.

The form above described agrees perfectly as regards its sculpture, with the above-mentioned *Perisphinctes contiguus* of Zittel. In the figured specimen the shape does show certain differences, since it has a somewhat narrower umbilicus and somewhat higher volutions,[1] but these differences are not essentially greater than those which we have admitted within the range of variability in the case of certain other allied species. Moreover, there is a second smaller specimen which does not show any appreciable difference in the shape of the shell. Although the approximate diameter of this specimen is only 73 mm. yet the whole of the last volution belongs to the body-chamber. The sculpture coincides exactly with that of *P. contiguus;* but the number of bifurcate ribs is rather large, as would naturally be expected from the small size of the specimen.

Whether we should continue applying the name "*contiguus*" to Zittel's form, here selected, will depend on the result of some future revision of the species "*contiguus*," the necessity for which has already been pointed out in the description of *Perisphinctes subfrequens.*

P. contiguus is distinguished from *Perisphinctes frequens* by its small size, the smaller number of ribs and greater frequency of bifurcate ribs.

In Europe *Perisphinctes contiguus* is found especially in the Lower Tithonian, but it also occurs in the Upper Tithonian and in the *Acanthicus* Strata.

Locality.—Laptal, Middle Spiti Shales; Shalshal, Middle Spiti Shales.

PERISPHINCTES (VIRGATOSPHINCTES) INDISTINCTUS, n. sp.

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

Dimensions:—

Diameter	66·6 mm.
Width of umbilicus	24·6 ,,
Height of volution	26 ,,
Maximum thickness	29·5 ,,

The umbilicus is narrow. The volutions are rounded and overlap by nearly half their height, the maximum thickness being situated in the vicinity of the

[1] The volution height as drawn in fig. 2*b*, pl. LXVIII of this volume is too great by 1 mm.; moreover the specimen is somewhat distorted by compression at its anterior end so that the height of the cross-section appears proportionately greater than it should.

rounded umbilical wall. On the last volution there are 45 ribs which bifurcate at about half the height of the flanks. There are only four trichotomous ribs, the remainder being only dichotomous. The last volution belongs mostly to the body-chamber. The suture-line has not been preserved.

As there is no trace of an external furrow, the present form has to be placed in the subgenus *Virgatosphinctes*, its nearest allies being probably *Virg. contiguus* Zittel, *Virg. serpentinus*, and *Virg. similis*. *Virg. contiguus* differs from the above-described form by its relatively higher volutions and greater number of trichotomous rib-bundles; *Virg. serpentinus* differs by the more densely crowded ribs and the different outline of its more rounded cross-section, the greatest width of which lies closer to the middle of the volutions. *Perisph. similis*, finally, has also more crowded ribs and a more rounded cross-section.

Unfortunately there is only a single specimen of this species, and the oral margin is wanting. We cannot, therefore, be quite certain whether the specimen is really full-grown, in consequence of which there subsists a certain amount of uncertainty. A specimen from the *Acanthicus* Strata of the Freiburg Alps, described by E. Favre[1] under the name of *Perisphinctes* sp. ind. should perhaps be united with *Perisphinctes indistinctus*.

Locality.—Laptal, Hundes.

Perisphinctes (Virgatosphinctes), n. sp. ind.

The collection contains another new species which, unfortunately, is only represented by incompletely and badly preserved specimens approximately attaining the size of *Perisphinctes subfrequens* and of the smaller specimens of *Per. frequens*; the cross-section is similar to that of *P. frequens*. The most characteristic feature of the present species consists in the prevalence of bifurcate ribs even up to the middle of the body-chamber, or, in one instance, as far as its anterior portion. In the latter specimen the trichotomous ribs contrary to the usual disposition are more numerous on the older part of the body-chamber than on the newer portion.

The frequency of the bifurcate ribs on the newer portion of the shell recalls to some extent one of the forms which Zittel has figured under the name of *Perisphinctes contiguus* (Aelteres Tithon, pl. 34, fig. 1 *a*, *b*, *non* 2 *a*—*c*). The form determined as *Perisphinctes contiguus* by Pavlow also seems to be closely allied form. Both, however, are specifically distinct from the Indian form.

Fresh discoveries must be awaited in order to enable us to define this interesting species more accurately.

There are two specimens from Chidamu, and one from the Spiti valley (Survey number H. 47/448).

Perisphinctes (Virgatosphinctes ?), n. sp. ind.

In the present species the ribs are strongly deflected forward and slightly curved, their upper portion being ramified according to the "virgatotomous"

[1] Termin Kimmeridgien, *Mém. Soc. pal. Suisse*, vol. IV, fig. 1 *a*, *b*, p. 41.

plan. The position of this form within the subgenus *Virgatosphinctes* though probable is nevertheless not quite certain. This very characteristic species is clearly distinguished from all the other forms of the subgenus owing to the transverse expansion of the aperture which recalls *Perisph. bathyplocus* Waagen, *Perisph. pagri* Waagen and *Perisph. Freyssineti* Favre though the cross-section is still broader and lower than in any of the above-mentioned species. Moreover the oblique position of the umbilical wall, which merges gradually into the flanks, is very characteristic. The suture is extremely laciniated and the composite umbilical lobe is strongly retrograde.

One specimen is from Chidamu, another from Shangra (Coll. Schlagintweit).

PERISPHINCTES (VIRGATOSPHINCTES) INCERTUS, n. sp.

(Plate LXVII, fig. 2 *a*—*d*.)

Dimensions:—

Diameter	96	mm.
Width of umbilicus	43	,,
Height of volution	31·8	,,
Maximum thickness	35·8	,,

The umbilicus is rather wide, the cross-section rounded, its breadth being considerably in excess of its height; the maximum thickness lies at the junction of the flanks and the umbilical wall.

The ribs are strong, sharp and prominent; on the lower part of the flanks and on the umbilical wall they are strongly curved backwards. There are 47 main-ribs on the last volution. The inner volutions bear dichotomous ribs, the point of branching being situated higher than the middle of the volutions. On the body-chamber trichotomous ribs are occasionally associated with the dichotomous ones, their point of ramification being situated below the middle of the flanks. Exceptionally, in conjunction with a slight constriction, ramification may even originate in the lower part of the flanks.

The suture is unknown. Three-fourths of the last volution belong to the body-chamber, which is not completely preserved and which shows some healed up injuries on its anterior portion.

The species above described is allied to *Perisphinctes chidamensis*. The diagnostic characters consist in its more numerous ribs (56 in *P. incertus* instead of 47 in *P. chidamensis*), their stronger curvature and more massive development on the anterior part of the shell and the somewhat lower position of the points of ramification. Owing to the scanty material, it is not, however, possible to ascertain how closely the present species may actually approximate to *Perisphinctes chidamensis*.

A second allied species is *Perisphinctes euplocus* Waagen from the Katrol Sandstone of Kachh. *Perisphinctes incertus* agrees with this species as regards the strong curvature of the ribs and the great width of the umbilicus. But the

ribs of *Perisphinctes euplocus* are still more strongly curved and more deeply cleft even on the volution preceding the body-chamber, which, in *Perisphinctes incertus*, carries straight ribs whose branching-points lie at a higher level. Finally, in *Perisphinctes incertus* the cross-section is wider and less rounded than in *Perisphinctes euplocus*.

Locality.—Between Ting Jung La and Chhota Hoti.

PERISPHINCTES (VIRGATOSPHINCTES) LEMOINEI, n. sp.

(Plate XC$^{I}_{1}$, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	96	mm.
Width of umbilicus	41	,,
Height of volution	32·3	,,
Maximum thickness	38	,,

The cross-section of the inner volutions is broad, depressed, oblate-elliptical, whilst the cross-section of last volution so far as preserved assumes a roundish trapezoidal shape. The umbilical wall is rounded and steeply declivous; the maximum thickness occurs at the junction of the flanks and umbilical wall.

The last whorl has 49 main-ribs. On the posterior part of the last volution dichotomous ribs predominate, but on the anterior part they are replaced by treble and quadruple ramified bundles. The ribs are stout, very deeply cleft and are deflected forward on the lower part of the flanks and on the umbilical wall, the direction of curvature being reversed on the upper part of the flanks.

The suture is not distinctly preserved; the specimen is chambered up to its anterior end.

The specimen described here recalls *Perisphinctes subquadratus* owing to its stout ribs and trapezoidal cross-section during the middle stages of growth. But in *Perisphinctes Lemoinei* the ribs are much more deeply cleft and much more strongly curved, and, moreover, the number of ribs ramifying into three or four branches is much greater, so that there is no possible confusion with *Perisphinctes subquadratus*. From *Perisphinctes incertus* and *Perisphinctes chidamensis* the present species is distinguished by its thicker volutions, narrower umbilicus, more densely crowded and more strongly curved ribs and by the shape of the cross-section; from *Perisphinctes Mayeri* n. sp. it differs by its narrower umbilicus, thicker whorls, more strongly curved and less numerous ribs and the shape of the cross-section. It agrees with *Perisphinctes infundibulum* in its deeply sunk umbilicus and strongly curved ribs. Nevertheless the two species cannot be confounded owing to the great number of trichotomous ribs in *Perisph. Lemoinei* and the discrepancies in the form of the cross-section. Finally, we must mention *Perisphinctes euplocus* Waagen from the Katrol Sandstone the ribs of which are curved like those of *Perisphinctes Lemoinei*. But the ribs of *Perisph. Lemoinei* are more numerous and more crowded, their lower portion is less inflated, the umbilicus is narrower, the volutions are much thicker and less rounded.

The type-specimen of *Perisphinctes Lemoinei* is from Shangra in Ngari Khorsum. A second very fragmentary specimen from the same locality has somewhat thinner ribs (Schlagintweit collection in Munich).

PERISPHINCTES (VIRGATOSPHINCTES), sp., aff. EUPLOCUS Waagen.

(Plate LXXIII, fig. 3 *a*—*c*.)

Perisphinctes euplocus Waagen, Jurrassic Cephalopoda from Kutch. *Palæontologia Indica*, Calcutta, 1875, p. 189, pl. 52, fig. 2*a*.

Dimensions:—

Diameter (approximately)	81	mm.
Width of umbilicus	37	,,
Height of volution	24·2	,,
Maximum thickness	29·2	,,

The inner volutions have slightly flattened flanks, a rounded cross-section and straight, bifurcate ribs, slightly deflected anteriorly like those of *Perisphinctes Mayeri*. On the last volution, however, the sculpture and cross-section become very different: the cross-section becomes trapezoidal in consequence of the maximum thickness being shifted to the lower part of the flanks, the ribs become strongly curved with "virgatotomous" ramification into three or even four branches. On the lower part of the flanks the ribs are strongly deflected forward, while half-way up they bend round into a backward direction, and it is at this level that the "virgatotomous" branching takes place.

The sutures and oral aperture are unknown. The portion of the last volution which is ornamented with sigmoidal ribs belongs to the body-chamber, but its exact length cannot be ascertained.

The species above described belongs to the group of *Perisphinctes Lemoinei* and *Perisphinctes incertus*. From the former species it is distinguished by its flatter shell and the much stronger curvature and much deeper ramification of the ribs on the body-chamber; from *Per. incertus* it differs by its wider umbilicus, flatter shell and less numerous ribs which are stouter in their lower portion.

Several features of this fossil such as the comparatively strongly sigmoidal, deeply cleft ribs, thickened at their lower part, the flatness of the shell and the great width of the umbilicus strongly recall *Perisphinctes euplocus* Waagen from the Katrol Sandstone. But it is not specifically identical, because, in the present species, the ribs, especially on the chambered part of the shell, are not so deeply cleft or so strongly deflected forward on the lower part of the flanks, and because the cross-section of the body-chamber is more depressed and the lower part of the shell belonging to the flanks much broader.

Signs of a slight injury are visible at one place on the body-chamber which overlaps the preceding volution to a greater extent on one side than on the other; hence the specimen has a somewhat pathological character. It is, however, not possible to ascertain to what extent its characters have thereby been altered. We

have therefore refrained from creating a new name, though the specimen probably does actually represent a new species. Future discoveries may allow us to characterise more completely this interesting form which evidently bears a close relation to one of the species from the Jurassics of Kachh.

Locality.—Between Ting Jung La and Chhota Hoti.

C.—AULACOSPHINCTES, nov. subgenus.

The new subgenus here proposed corresponds essentially to the group of the so-called "Perisphinctes with ventral furrow," though it is characterised not merely by the ventral furrow alone, but by a whole series of distinct peculiarities.

Most of the members of this group are characterised by a very wide umbilicus, a slow rate of increase and low, rounded, subquadrate, or oblong very slightly overlapping volutions. The sculpture consists of dichotomous or simple, more rarely of virgatotomous ribs which are disposed radially or only slightly deflected forward and often deeply cleft. In many forms the ribs are sharp and prominent; but there also occur genuine representatives of this subgenus in which the ribs are finer and crowded; sometimes they may be indeed so much reduced as to become quite threadlike, for instance in *Perisphinctes linoptychus* n. sp., *Perisphinctes striolatus* Steuer and *Perisphinctes striolatissimus* Steuer. In many forms the external or ventral furrow is broad, deep, and clearly defined. The rib terminations on either side of the furrow may even develop into slight swellings. In other species, on the other hand, the ventral furrow is shallower and rather narrow, but in every case it is sharply marked off from the ribs. As is well known, its development is restricted to the chambered nucleus, and does not extend to the body-chamber. The furrow is deepest and broadest on the inner volutions and gradually decreases in sharpness with increasing growth; in many forms it has already disappeared before the development of the final body-chamber. The stage at which it finally disappears differs in different species or even amongst individuals of the same species.

The appearance of the shell alters very little during its gradual ontogenetic development; the only important change is the gradual obliteration of the furrow and, in some species, an increase in the frequency of trichotomous ribs.

The suture is only moderately ramified and is distinguished by the great length of the external lobe and the great breadth of lobes and saddles. The second lateral lobe and the first auxiliary lobe are, as a rule, short, the second and third auxiliary lobes are frequently united into a small, bifid, and moderately retrograde umbilical lobe.

Owing to the characters above alluded to, that is the simplicity of the ornamentation, the frequency of entire ribs, the occurrence of a ventral furrow, the slow rate of increase, the low volutions and the characteristic suture-line, the fossils here alluded to are so intimately connected together and generally so sharply separated from all allied forms that their association into a distinct subgenus is perfectly justified.

As the typical group we may take the forms connected with ***Perisphinctes Mörikeanus*** Oppel. These forms have a very simple suture-line, a very wide umbilicus, numerous simple ribs and a distinct ventral furrow. This group includes the following species in the Spiti Fauna :—

Perisphinctes (*Aulacosphinctes*) *Mörikeanus* Oppel.
,, ,, *spitiensis* n. sp.
,, ,, *rareplicatus* n. sp.
,, ,, *Hollandi* n. sp.
,, ,, *natricoides* n. sp.
,, ,, *La Touchei* n. sp.
,, ,, *pachygyrus* n. sp.
,, ,, *linoptychus* n. sp.
,, ,, *Mayeri* n. sp.
,, ,, n. sp. aff. *striolatus*, Steuer sp.
,, ,, *Kossmati* n. sp.
,, ,, *tibetanus* n. sp.
,, ,, *ophidoides* n. sp.
,, ,, *parvulus* n. sp.
,, ,, *pseudocolubrinus* Kilian.
,, ,, n. sp. aff. *Lorioli* Zittel.

In addition to these we have to add a second group in which simple ribs are rarer, the volutions widen out more rapidly, the lobes are somewhat more profusely ramified, the auxiliary lobes are more clearly differentiated, and the ventral furrow disappears at a very early age or is scarcely developed. The body-chamber and oral margin are known only in two species of this group, namely *Per. torquatus* and *Per. montanus* n. sp. In both these species the body-chamber occupies only three-fourths of the last volution and the oral margin is somewhat expanded. The mouth carries lateral lappets which are short and rounded in *Per. torquatus*, while they are borne on elongated stems in the case of *Per. montanus*. This group includes the following species :—

Perisphinctes (*Aulacosphinctes*) *torquatus* Sowerby (*non* Waagen).
,, ,, *subtorquatus* n. sp.
,, ,, *infundibulum* n. sp.
,, ,, *Smith Woodwardi* n. sp.
,, ,, *Willisi* n. sp.
,, ,, *hundesianus* n. sp.
,, ,, cf. *adelus* Gemmellaro.
,, ,, *chidamensis* n. sp.
,, ,, *sparsicosta* n. sp.

There is no escaping from the fact that the definiteness of the subgenus is greatly obscured by the inclusion of the above-mentioned species, and it would possibly be preferable to create for them a separate subgenus. Nevertheless some of them approximate very closely to the typical representatives of the subgenus *Aulacosphinctes* : for instance *Per. torquatus* is very closely related to *Per.*

pseudocolubrinus, and *Per. hundesianus* to *Per. tibetanus*. Moreover, there are certain peculiarities common to both groups, and they may be therefore united at least provisionally.

The subgenus *Aulacosphinctes* has a wide distribution but is only represented by fossils of rare occurrence. In Europe it includes, first, the numerous forms which various authors (Quenstedt, Zittel, Fontannes, Choffat, Herbich, E. Favre, de Loriol, Kilian, Toucas, de Riaz) have described under the name of *Ammonites colubrinus* Rein., and which are nearly all specifically different. Other members of the same subgenus are *Perisphinctes cimbricus* Neum., *Per. senex* Oppel, *Per. transitorius* Oppel, *Per. eudichotomus* Oppel, *Per. fraudator* Oppel, *Per. Witteanus* Herbich (*non* Oppel), *Per. prætransitorius* Font. There are also, amongst European fossils, many forms related to those of the *Torquatus* group. Various Extra-Alpine forms described under the names of *Per. Bleicheri* and *Per. Boidini* Lor. possibly belong to the *Torquatus* group. The connection is much closer in the case of certain Alpine-Carpathian forms, such as *P. Lorioli* Zittel, *Per. adelus* Gemm. and *Per. serranus* Canavari. One of the Indian species is perhaps identical with *Perisphinctes adelus*.

A surprisingly rich harvest of *Aulacosphinctes* was gathered by Steuer from South America, namely :—

Perisphinctes (*Aulacosphinctes*) *Parlowi* Steuer sp.
,, ,, *proximus* Steuer sp.
,, ,, *mangaensis* Steuer sp.
,, ,, cf. *stephanoides* Steuer sp. (*non* Oppel).
,, ,, *striolatus* Steuer sp.
,, ,, *striolatissimus* Steuer sp.
,, ,, *transitorius* (Opp.) Steuer sp.
,, ,, *colubrinus* (Rein.) Steuer.[1]

In addition to these we must mention several forms from Argentina, Chili, and Bolivia which have been described by Meyen[2], K. Burckhardt[3], and K. Gottsche[4], namely : *Ammonites biplex* Meyen (=*Aulacosphinctes* sp. n.), *Perisphinctes* (*Aulacosphinctes*) aff. *pseudocolubrinus* (Kil.) Burckhardt, *Per.* aff. *transitorius* (Oppel) Burckhardt, *Per. colubrinoides* Burckh.; further *Per.* (*Aulacosphinctes*) *Lorentzi* Gottsche, *Per.* sp. and *Per.* (*Aulacosphinctes*) *caracolensis* n. sp.[5]

In order to complete the enumeration of the members of the present subgenus, we should also mention several species from amongst the Kachh fauna,

[1] Steuer described the majority of these species under the generic name of *Reineckia*. Nevertheless, on closer examination it is found that these species cannot be classified with *Reineckia*, but must be regarded as a branch of the genus *Perisphinctes*, the development of which has proceeded along independent lines.

[2] Bemerkungen über die Identität der Flötzformation in der alten und neuen Welt. *Verhandl. d. kais. Leopoldinischen Carolinischen Akademie der Naturforscher*, 1835, XVII, part 2, p. 654, pl. 47, figs. 1, 2.

[3] *Palaeontographica*, Vol. 50.

[4] Jurassische Versteinerungen aus der argentinischen Cordillere. *Palaeontographica, Supplementband*, III, Cassel 1878.

[5] This species has been designated by Gottsche *Simoceras Doublieri* d'Orb. (*loc. cit.* p. 43, pl. VIII, fig. 6), but is not identical with this fossil. Instead of the narrow deep furrow, of the South American fossil, *Simoceras* has a smooth ventral band; moreover the ornamentation and shape of the shell of Gottsche's species agree thoroughly with those of *Aulacosphinctes*. I have, therefore, taken the liberty to rename the species *Aulacosphinctes caracolensis*.

namely, *Perisphinctes eudichotomus* (Zittel) Waagen, *Per. occultefurcatus* Waagen, *Per. Bleicheri* Waagen (*non* Loriol) from the Umia Beds, and perhaps also *Per. alterneplicatus* Waagen from the Katrol Sandstone.

The above enquiry into the distribution of the sub-genus *Aulacosphinctes* principally indicates that its main development coincided with the Tithonian. The more differentiated forms with a deep furrow bordered by slight swellings of the rib-terminations occur chiefly in the Upper Tithonian (Horizon of Stramberg), whilst the species belonging to the group of *Per. colubrinus* and *Per. adelus* already appear in the Kimeridgian. In the light of the present state of information it does not seem that this subgenus existed in Oxfordian times[1]; the earliest instance of a species which possibly may be classified with this genus is that of *Per. indogermanus* Waagen[2] in the passage beds from Oxfordian to Sequanian constituting the Dhosa oolite of Kachh.

Our present knowledge of the geographical distribution of the subgenus *Aulacosphinctes* is still rather incomplete. It is evident that this subgenus is widely distributed over the Indian, Pacific, and Mediterranean Provinces where it can be regarded as indigenous. *Colubrinus*-types are also found in the southern districts of Neumayr's "Middle European Province", but they are much rarer in the northern parts. They are practically absent from the Russian Zoological province. It is true that certain forms of *Perisphinctes* with very simple ribs and primitive suture such as *Per. Pallasi* d'Orb. (= *biplex auct. angl.*), are met with in this area, but they lack the ventral furrow and are not closely related to *Aulacosphinctes*. Even the Rjazan Horizon does not contain any forms related to this group.

The relations of the present group to the remaining species of *Perisphinctes* and the significance of the ventral furrow have been ably discussed especially by M Neumayr[3]. This naturalist, whose acquaintance with the Cephalopoda was so intimate and extensive, saw in the ventral furrow a contrivance connected with the position of the siphon and serving for its protection. He further supposed that this character had been independently acquired by the different branches of the genus *Perisphinctes*. As a matter of fact several branches of the genus *Perisphinctes* evince a tendency towards a reduction of the ornamentation on the external margin; such is the case for instance in the group of *Per. hospes* and *Per. Balderus* (*Idoceras* n. gen. Burckhardt), in *Grossouvria, Paraboliceras, Ataxiceras* and others; but in those cases we have to deal with a gradual obscuration of the ribs and not with a sharp deep furrow whose formation may even proceed simultaneously with a slight swelling of the ribs. So far as we know, a genuine furrow is only observed in the subgenus *Aulacosphinctes* which so many other characters isolate as a well marked natural group.

[1] The forms from the *Transversarius* Zone of Trept, which de Riaz figured under the name of *Per.* cf. *colubrinus* certainly do not belong to the present group.

[2] *Loc. cit.* pl. XLVIII, fig. 4, *non* XLVII, fig. 1, p. 185.

[3] Fauna der Acanthicuszone, *Abh. geol. Reichsanstalt*, V, p. 172. *Zeitschrift der deutsch geol Gesellschaft*, 1875 p. 926.

Neumayr traces the origin of this subgenus to *Perisphinctes cimbricus*. It is unquestionable that this species together with *Per. colubrinus*[1] are geologically the oldest forms belonging to the present group. Even if we trace its descent as far back as *Per. indogermanus*, the *Aulacosphinctes* group, compared with the *Grossouvria* branch, appears as a *Perisphinctes* branch of late origin and rapid evolution, but of short duration.

Unfortunately our knowledge of the geologically oldest forms of *Aulacosphinctes* is very deficient, so that we are unable to arrive at any definite conclusions regarding the exact ancestry and derivation of the present subgenus. We might be justified in conjecturing that it had a polyphyletic origin in so far as the typical group of *Aulacosphinctes Mörikeanus* did not perhaps originate from the same stock as the aberrant group of *Aulacosphinctes torquatus*. To go beyond this in the assumption of different radicals appears to be superfluous, since both groups separately considered, constitute well circumscribed units.

The ultimate ancestry of the typical group of *A. Mörikeanus* still remains doubtful, owing to the abrupt appearance of its oldest representatives, namely *Perisphinctes indogermanus*, *Per. cimbricus*, and *Per. colubrinus*. The group of *Aulacosphinctes torquatus* appears to bear certain relations to the subgenus *Virgatosphinctes*, especially to *Virg. incertus*. New discoveries may perhaps reveal a connection between the two. The mere existence of " virgatotomous " ribs cannot be accepted as a decisive factor, for we meet with this type of ornamentation among members of the typical *Mörikeanus*-group. This fact may be brought forward as evidence for the correctness of the contention already advanced when discussing the subgenus *Virgatosphinctes*, that " virgatotomy " may be developed independently in various branches of the genus *Perisphinctes* taken in its wider sense. The forms with distinctly virgatotomous rib-branching are all from the higher strata of the Upper Jurassic. In strata older than the Oxfordian there do not appear to be any *Perisphinctes*-forms with genuine and distinct virgatotomous ornamentation. So far as we know, most of the species of *Aulacosphinctes* appear to die out in the Tithonian. The only forms that appear to have undergone any further evolution are those like *Aulacosphinctes transitorius* and *Aulacosphinctes eudichotomus* which may be safely regarded as the radicals of the perisphinctoid *Hoplites* (*Berriasella* and *Blanfordia*) and of the Neocomian *Hoplites* as has already been explained in our discussion of the genus *Hoplites*[2].

Owing to the occurrence of swellings of the rib-terminations on the external margin one might feel inclined to include *A. Mörikeanus* and its nearest allies in the group of the primitive perisphinctoid *Hoplites*. But this is not admissible because, in the case of the perisphinctoid species of *Hoplites* not only are the swellings of the rib-terminations much more strongly developed, but the ribs are more strongly curved and the auxiliary lobes more reduced than is the case in

[1] Quenstedt, Ammoniten des schwäbischen Jura III, pl. 101, p. 927.

[2] See also: Einige Bemerkungen über die Gattung *Hoplites* Neumayr. *Sitzungsberichte der kais. Akademie der Wissenschaften, Math.-Nat. Klasse*, vol. 114, 1905, p. 599.

Aulacosphinctes Mörikeanus. In this respect the group of *Aulacosphinctes* is closely connected with *Perisphinctes* proper.

Perisphinctes (Aulacosphinctes) Mörikeanus, Oppel sp.

(Plate XXXIII, fig. 2 *a*—*c*; Plate XXXVIII, fig. 6 *a*, *b*.)

Ammonites Mörikeanus, Oppel; *Palaeontologische Mitteilungen*, 1864, I, p. 281, pl. 80, fig. 2 *a*, *b*.
Ammonites Parkinsoni Stoliczk *p. p.*, *Mem. Geol. Survey of India*, Calcutta, 1866, V, p. 98.

	Oppel's specimen.	Plate XXXIII, fig. 2.	Plate XXXVIII, fig. 6.
Dimensions:—			
Diameter (approximately)	45 mm.	61 mm.	38 mm.
Width of umbilicus	23 ,,	29·2 ,,	18 ,,
Height of volution	12 ,,	18 ,,	9·5 ,,
Maximum thickness	11 ,,	17·5 ,,	

Oppel described *Ammonites Mörikeanus* as a small species with wide umbilicus, with partly simple, partly bifurcate ribs, an evenly oval cross-section, arched flanks and a rounded umbilical wall.

He further assumed that his specimen was completely preserved up to the vicinity of the oral aperture. This assumption is not borne out by a closer study of the actual specimen. It is more probable that the specimen is not full-grown, but consists only of the inner volutions of a large shell. It is on this supposition that we have referred to *Perisphinctes Mörikeanus* the specimen illustrated in pl. XXXIII, fig. 2 *a*—*c*. If this be so, *Perisphinctes Mörikeanus* is one of the species in which isolated virgatotomous ribs make their appearance with increasing growth. The anterior branch-rib of the virgatotomous bundles originates at a remarkably low level, almost on the umbilical wall. A rib-bundle of this kind is already noticeable at the anterior end of Oppel's specimen. The external margin is deeply grooved. The rib terminations on either side of the external furrow are slightly thickened. The last volution of the larger specimen carries three moderately deep constrictions.

The suture is not preserved.

We have referred four specimens to *Perisphinctes Mörikeanus*, in one of which (plate XXXVIII, fig. 6) the ribs are somewhat more crowded : on the lower part of the last volution there are 35 ribs, while in Oppel's specimen there are only 30.

Oppel compared *Ammonites Mörikeanus* with *Ammonites Parkinsoni* and *Ammonites Eugeni*. Stoliczka went so far even as to unite all these species with *Amm. Parkinsoni*. At the present day it is superfluous to comment on the incorrectness of such a procedure. *Amm. Mörikeanus* is not closely related either with *Amm. Eugeni* or *Amm. Parkinsoni*. There are safer grounds for a comparison with *Amm. Wallichi* which was also united with *Amm. Parkinsoni* by Sto-

liczka. The impracticability of classifying this species with *Blanfordia* or *Berriasella* has already been emphasized in the Introduction to the genus.

The differences between *Ammonites Mörikeanus* and other allied Indian species will be discussed under their respective headings. Among the European species we may mention *Perisphinctes eudichotomus* Zittel as probably its nearest ally; but the latter species differs by its narrower umbilicus, thicker volutions, quicker rate of increase, much denser costation (50-60 ribs on the last whorl) and the absence of virgatotomous ribs; there is no possible confusion therefore with *Amm. Mörikeanus*.

Aulacosphinctes proximus Steuer sp. (*Reineckia proxima* Steuer) from Argentina is distinguished by somewhat more strongly rounded flanks, greater thickness, quicker rate of increase, and the absence of trichotomous ribs. *Perisphinctes Falloti* Kilian, a species with a shallow external furrow and isolated trichotomous ribs is somewhat more distantly related. *Perisph. Falloti* has a much narrower umbilicus, higher volutions and more crowded ribs, and cannot therefore be confounded with *Perisph. Mörikeanus*.

Oppel's specimen is from Ki in Spiti, while of the two specimens figured here one is from Jandu, Sherik river (Coll. Griesbach) and the other from Gieumal. There is a fourth specimen from Kuti, Byans.

PERISPHINCTES (AULACOSPHINCTES) SPITTENSIS, n. sp.

(Plate XXXIII, figs. 1 *a*—*c*, 3 *a*—*c*; Plate XLI, fig. 1 *a*—*c*.)

Dimensions:—

	Plate XLI, fig. 1.	Plate XXXIII, fig. 1.
Diameter	74 mm.	67 mm.
Width of umbilicus	37 ,,	32 ,,
Height of volution	21 ,,	19·3 ,,
Maximum thickness	22 ,,	21·5 ,,

The umbilicus is rather wide. The thickness of the cross-section only very slightly exceeds its height. The whorls overlap by one-third of their height. The external margin is deeply furrowed, the umbilical wall is rounded and steeply declivous. The flanks are slightly arched, somewhat complanate towards the external margin and mutually converging.

On the innermost volutions the ornamentation consists of fine, densely crowded ribs, strongly deflected forward. When however the diameter has increased to no more than 8 to 10 mm., the ribs recede from each other and become somewhat less deflected. At the middle stages of growth there are 41 to 44 ribs per volution. On the inner whorls the ribs are partly simple, partly bifurcate; at a subsequent stage, isolated trifid "virgatotomous" ribs become intercalated amongst the dichotomous ones, while finally some of them bear even four branches. In the case of the trichotomous ribs the anterior secondary rib branches off at

about half-way up the flanks or even lower, while the posterior rib is given off above the level of the middle zone. On the anterior portion of the last volution of the largest-sized specimen (plate XLI, fig. 1) the ribs become flatter at half the volution height and the connection between main-rib and secondary ribs becomes indistinct. On the external margin, the ribs are interrupted by a deep furrow. The last volution bears on an average three rather deep constrictions.

The suture is moderately ramified, with rather broad trunks to the lobes and broad sellar phylla. The external lobe is somewhat longer than the first lateral lobe; the latter is subsymmetrically ramified, the external lateral main branch originating at a somewhat lower level than the inner one. The second lateral lobe is much shorter than the first and disposed slightly obliquely. The three auxiliary lobes are only slightly retrograde; they are situated at a somewhat lower level than the apex of the second lateral lobe, but somewhat higher than the apex of the inner lateral branch of the first lateral lobe. The first auxiliary lobe is only slightly smaller than the second lateral lobe. The septa follow each other at wide intervals.

The largest-sized specimen, figured on plate XLI, fig. 1, is entirely chambered. In both the smaller specimens (pl. XXXIII, figs. 1 and 3), on the other hand, the anterior portion of the last volution seems already to belong to the body-chamber. The oral margin is unknown.

The figured specimens agree very well with each other as regards their shape and ornamentation. The specimen represented in fig. 3, pl. XXXIII, is somewhat less copiously ribbed than the other two.

The specimen, fig. 1, Pl. XXXIII, was referred to *Amm. Parkinsoni* by Stoliczka. *Perisphinctes spitiensis* is closely related to *Per. Mörikeanus*, from which it is distinguished merely by its more crowded and less deeply cleft ribs and by the greater thickness and more pronounced overlap of the volutions.

The specimen pl. XLI, fig. 1 is from Jandu, Sherik River, Hundes (Coll. Griesbach); the specimen pl. XXXIII, fig. 1 is from Gieumal, the specimen pl. XXXIII, fig. 3 was found near Chidamu (Coll. Diener). In addition to the figured specimens there is also a smaller specimen from Jandu, Sherik River.

PERISPHINCTES (AULACOSPHINCTES) RAREPLICATUS, n. sp.

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

The distinctive feature of the present species consists in its exceedingly sharp, prominent and wide-spaced ribs, the number of which amounts to 23 on one of the inner volutions. Their number per volution increases slightly with increasing growth, though they still remain wider-spaced than in any other species of this group. On the innermost volutions the ribs are rather strongly deflected forward, but the degree of deflection soon decreases rapidly, so that the-

ibs assume a radial direction. Up to a diameter of 50 mm. the ribs are mostly ichotomous, there being but one isolated trichotomous rib. It is only on the last olution, belonging to the body-chamber, that the dichotomous ribs become asso- iated also with trichotomous ribs of the virgatotomous type, in which the lower ranching-point occurs at or even below the middle-zone of the volution. On the econd half of the last volution there are 10 dichotomous and 7 trichotomous ribs.)n the external margin the ribs are interrupted by a deep furrow intersecting hem at right angles.

The thickness of the volutions greatly exceeds their height; they have convex lanks, a depressed external margin and a rounded and steeply sloping umbilical vall. On the body-chamber the external region of which is unfortunately miss- ng, the cross-section tapers more decidedly outward and consequently assumes a lunt wedge shape.

The dimensions can only be measured in the inner volutions, and are recorded n the following table :—

Approximate diameter	51 mm.	31 mm.
Width of umbilicus	27 ,,	15·8 ,,
Height of volution	12 ,,	8·5 ,,
Thickness of volution	18 ,,	12 ,,

Owing to the unsatisfactory state of preservation of the suture, all that can e made out is that the auxiliary lobes are feebly developed and slightly retro- grade. The degree of ramification is only moderate and the septa are distributed t wide intervals.

Perisphinctes rareplicatus is distinguished from *Perisph. spitiensis* by its ess overlapping, thicker, and lower volutions, its sharper and less numerous ribs nd its wider umbilicus; from *Perisph. Hollandi* by its less numerous and less igmoidally curved ribs, the more frequent development of virgatotomous ribs on he last volution, the taller cross-section, the more strongly flattened flanks and its teeper umbilical wall.

The wide-spaced ribs vividly recall *Aulacosphinctes* cf. *stephanoides* (Oppel) Steuer sp. (*non Ammonites stephanoides* Oppel) from the Argentine. The ribs of the Argentinian species are less deeply cleft and are mostly dichotomous; it is possible however, that with more abundant material the two forms might prove to e specifically identical.

Perisphinctes rareplicatus is represented by a single specimen. Locality— North of Ting Jung La (Pass), Hundes (Coll. Griesbach).

PERISPHINCTES (AULACOSPHINCTES) HOLLANDI, n. sp.

(Plate XXXII, fig. 1 *a*—*d*; Plate XLII, fig. 3 *a*, *b*.)

Dimensions:—

Diameter	89 mm.
Width of umbilicus	46 ,,
Height of volution	24 ,,
Thickness of volution	25 ,,

The innermost volutions of the present species with their rather wide-spaced sharp, bifurcate ribs bear a considerable resemblance to those of *Perisphinctes rareplicatus*. But even at this stage the number of ribs is somewhat greater than in *Per. rareplicatus* (25 : 22) and the volutions narrower. With increasing age the differences become gradually more pronounced : The ribs become much more numerous (50 on the last volution), less prominent, more decidedly deflected forward and, at the same time, assume a slight curvature. Moreover, they are as a rule simply bifurcate, and only exceptionally virgatotomous. The branching-points of the ribs on the last volution are situated half-way up the flanks. The external furrow is rather deep and broad. The volutions overlap by about one-fourth of their height and have a rounded-trapezoid cross-section, this shape becoming especially pronounced on the last volution. The maximum thickness lies in the vicinity of the steeply declivous, and at the same time rounded umbilical wall; the flanks are slightly flattened and converge towards the strongly flattened external margin. The cross-section of the inner volutions is more rounded than that of the body whorl, with the thickness greatly in excess of the height. With increasing growth the height increases at a faster rate than the thickness, so that at the end of the chambered nucleus the thickness only very slightly exceeds the height.

The external lobe is longer than the first lateral lobe. The latter has a fairly long and broad trunk and subsymmetrically arranged lateral branches. The second lateral lobe is obliquely disposed and only slightly longer than the first auxiliary lobe. The first auxiliary lobe and the umbilical lobe subdivided into three small branches do not reach as far down as the apex of the first lateral lobe. The external saddle is very broad, the first lateral saddle rather narrow and placed somewhat higher than the external saddle. The antisiphonal lobe is nearly as long as the first lateral lobe and subsymmetrically ramified.

The specimen is almost entirely chambered to its end; the body-chamber is unknown.

The most important diagnostic characters which distinguish the present species from *Perisphinctes rareplicatus* have already been pointed out; in addition to the divergence in the ornamentation, the differences in the cross-section would suffice to prevent any possible confusion. The rare occurrence of virgatotomous ribs and the trapezoidal cross-section distinguish *Perisphinctes Hollandi* from the other larger-sized species belonging to the same group. Amongst the species from Argentina described by Steuer *Aulacosphinctes Pavlowi* Steuer sp. exhibits a certain resemblance to the present species, but it differs by its more rounded and relatively taller cross-section and by the great number of undivided ribs.

Perisphinctes Hollandi n. sp. is represented by a single specimen from north of Ting Jung La (Pass), Hundes (Coll. Griesbach).

Together with *Perisphinctes Hollandi* we may provisionally connect under the name of *Perisphinctes* cf. *Hollandi*, the specimen figured on plate XLII, fig. 3 *a*, *b*. With respect to the number and character of the ribs and the form of the

shell this specimen does not differ essentially from the type of *Per. Hollandi.* But it carries deep constrictions (four on the last volution), and it is considerably smaller, since the body-chamber is already developed at a diameter of only 50 mm.; the body-chamber is unfortunately only partially preserved. The suture seems to be less copiously ramified, but this difference may be due merely to the smaller size of the specimen combined with its rather bad state of preservation. Much more abundant material will be needed before we were able to decide whether this is a form really distinct from *Perisphinctes Hollandi.* The specimen in question is from Jandu, Sherik River, Hundes (Coll. Griesbach).

PERISPHINCTES (AULACOSPHINCTES) NATRICOIDES, n. sp.

(Plate XXXII, fig. 3 *a, b;* Plate XLI, fig. 2 *a—c.*)

Dimensions:—

Diameter	65 mm.	49 mm.
Width of umbilicus	35 ,,	24 ,,
Maximum thickness	19·5 ,,	17·3 ,,
Height of volution	17 ,,	15 ,,

This species is represented by two specimens. The characters have been chiefly established on the larger one whose last volution carries about 62 ribs which are rather thin, slightly deflected forward, and about half of which are bifurcate while the remainder remain simple. The point of bifurcation lies close to the external margin and is slightly swollen. Across the external margin the ribs are intersected at right angles by a shallow groove which becomes somewhat obscured on the anterior part of the shell.

The umbilicus is very wide; the thickness of the volutions exceeds their height and the external margin exhibits an abnormal breadth and shallow curvature, while the flanks are complanate and the umbilical wall rounded. The flanks are clearly marked off from the external margin, and, in the vicinity of the umbilical suture, the cross-section is only slightly broader than in the upper region where the flanks merge into the external margin. The specimen is chambered up to its extremity, but the suture is not distinctly preserved.

The ornamentation of the smaller specimen is similar to that of the larger one; only the ribs are somewhat more deflected and are perhaps somewhat more prominent and sharper. Moreover, the umbilicus is somewhat narrower. The shape of the cross-section is similar except that the maximum thickness is shifted somewhat higher up and coincides with the junction of the flanks and external margin. The ventral furrow is practically obsolete on the last volution, a difference possibly due to the fact that the last volution belongs to the body-chamber.

It might be that the second specimen represents an independent species; but owing to the scantiness of available material, this point cannot be definitely

settled. In any case, as we cannot satisfactorily characterize this species, it is preferable to unite it provisionally with *Perisphinctes natricoides*.

Perisphinctes natricoides differs from *Perisphinctes ophidoides* owing to the greater width of the umbilicus, the greater number of the ribs, the higher position of their branching-points, the greater thickness of the volutions, the more pronounced flattening and greater breadth of the external margin, and the sharper boundary between the flanks and external margin. The characters in which it differs from *Perisph. tibetanus* and *Perisph. Perrin-Smithi* are referred to in the description of those two species.

The large-sized specimen is from Chidamu, the smaller one from Shalshal (Coll. Diener).

Perisphinctes (Aulacosphinctes) La Touchei, n. sp.

(Plate XLI, fig. 4 *a*—*c*.)

Dimensions:—

Diameter	54 mm.
Width of umbilicus	26·2 „
Height of volution	15 „
Maximum thickness	17·5 „

The species has been established from a single specimen which is entirely chambered. The shell is only slightly involute. The flanks are slightly arched and the umbilical wall is rounded and moderately declivous. The external margin is rather narrow; the upper parts of the flanks are somewhat flattened and converge towards the external margin. The last volution bears 36 long ribs five of which remain undivided, while the remainder bifurcate at half the height of the flanks or a little higher. On the external margin, on either side of the deep ventral furrow, the ribs constitute slight ridge-like swellings, and are occasionally somewhat deflected forward. One isolated trichotomous rib-fascicle occurs. In some of the bifurcate ribs the two branches keep very close together, and it may even happen that a bifurcate rib on one side of the shell corresponds with a simple one on the opposite side.

The sutures are not distinctly preserved.

The species described above is distinguished from *Perisphinctes ophidoides* by its slightly wedge-shaped cross-section, its narrower external margin, and its less numerous and less regular ribs; it differs from *Per. pachygyrus* by its narrower and more depressed cross-section, its shallower constrictions, its less deeply cleft and less deflected ribs; from *Perisphinctes Pavlowi* Steuer sp. (*Reineckia Pavlowi*) it is distinguished by its greater thickness, its trapezoidal cross-section, its narrower umbilicus, its more strongly deflected ribs and the small number of undivided ribs; from *Per. proximus* Steuer sp. (*Reineckia proxima* Steuer) it is distinguished by its thicker and lower volutions and its narrower umbilicus. *Perisphinctes Lorentzi* Gottsche is very closely related to the present species as far as

its dimensions are concerned, but it is distinguished by the earlier disappearance of the ventral furrow, the frequent occurrence of trichotomous ribs and the uniformly rounded cross-section.

Perisphinctes La Touchei is from Chidamu (Coll. Diener).

PERISPHINCTES (AULACOSPHINCTES) PACHYGYRUS, n. sp.

(Plate XLI, fig. 3 *a*—*c*.)

Dimensions:—

Diameter	60	mm.
Width of umbilicus	30·8	,,
Height of volution	16	,,
Maximum thickness	23	,,

This species is very closely related to *Perisphinctes La Touchei*, from which it differs owing to its relatively thicker volutions, the form of its cross-section, and the more crowded costation. The maximum thickness of the volutions is situated close to the rounded, steeply declivous and tall umbilical wall. The volutions are strongly convex at the lower part of their flanks, and slightly flattened towards the external face, while in the case of *P. La Touchei* the greatest thickness lies closer to the middle of the flanks, the umbilical wall is lower and less declivous, and the upper part of the flanks less flattened. In *Perisph. La Touchei* the last volution bears 36 long ribs, while there are 45 in the present species. Moreover the ribs of the present species are more deeply cleft, their forward deflection is more pronounced, and they are more strongly developed on the lower part of the flanks than in *Perisph. La Touchei*. Finally, the constrictions are more numerous and deeper. The ventral furrow is deep and rather broad, and bordered by the slight swellings of the rib-terminations.

The specimen is entirely chambered. The suture is only imperfectly preserved, the sellar phylla and lobe trunks are broad and only feebly ramified. The external lobe is longer than the first lateral lobe. The two main lateral branches of the latter are rather feebly developed, the other lateral branches being reduced to short blunt serrations. The second lateral lobe and the auxiliary lobes are not developed. The septa are spaced at wide intervals.

Locality.—North of Ting Jung La (Coll. Griesbach).

PERISPHINCTES (AULACOSPHINCTES) LINOPTYCHUS, n. sp.

(Plate XLII, fig. 4 *a*—*c*.)

Dimensions:—

Diameter	45	mm.
Width of umbilicus	21	,,
Height of volution	13·8	,,
Maximum thickness	13·9	,,

The crowded ribs are narrow, and, at the same time, prominent and sharp. Their number on the last volution of the figured specimen amounts to 55. Most of them bifurcate at half the volution-height, the others remaining undivided. On the external margin they are interrupted by a narrow groove intersecting them at right angles and becoming gradually fainter on approaching the anterior end of the body-chamber.

The volutions overlap by about one-fourth of their height; they have slightly arched flanks and a rounded moderately steep umbilical wall. The external margin is slightly flattened. The height and thickness of the cross-section are equal; its shape is roundish-quadrate.

The sutures are only incompletely preserved, but the position of the last septum is, nevertheless, visible as is also the lowest portion of the final oral aperture in the shape of a deep, anteriorly deflected constriction (unfortunately overlooked by the artist). It is thus possible to ascertain that the last volution corresponds almost entirely with the body-chamber. The width and the pronounced deflection of the oral constriction indicate that it must represent the final oral aperture and that *Perisphinctes linoptychus* is a species of small size.

In addition to the figured specimen, the collections include three more none of which entirely agrees with the type. One has its ribs more densely crowded, a second one has proportionately higher volutions and a more rapid rate of increase, the third one is somewhat thicker. All these specimens are of small size with preserved body-chamber.

Perisphinctes linoptychus is distinguished from all other species of the Spiti Shales owing to its fine and close costation and its comparatively small thickness. Amongst European species the closest allied are *Perisphinctes eudichotomus* and *Per. transitorius*. Both have relatively higher volutions and fewer undivided ribs; moreover in *Per. eudichotomus* the ribs are somewhat wider-spaced while *Per. transitorius* is larger, more involute, and has a narrower umbilicus. *Perisphinctes striatulus* (*Reineckia striatula* Steuer) from the Argentine deviates by its narrower umbilicus, comparatively taller volutions, and more crowded ribs.

The figured specimen is labelled : " On horizon of Laptel shales, N. Kumaon." The other localities are Sirkia, South Hundes, Shalshal (Middle Spiti Shales).

Perisphinctes (Aulacosphinctes) Mayeri, n. sp.

(Plate XCII, fig. 2 *a*—*c*.)

Dimensions :—

Diameter	87	mm.
Width of umbilicus	40	,,
Height of volution	28·5	,,
Maximum thickness	32·2	,,

The shell is discoidal and rather flat. It consists of six volutions, which overlap one another by about one-third of their height. The umbilicus is rather

wide. The cross-section of the volutions is rounded; the thickness somewhat exceeds the height, the maximum thickness coinciding with the lower part of the flanks. The umbilical wall is steep and rounded.

The penultimate volution carries 49 main ribs, the last one 61. The inner volutions and the posterior portion of the body-chamber are ornamented with bifurcate ribs the branching-points of which are situated above the middle of the volution. The anterior part of the body-chamber is ornamented principally with trichotomous ribs which are somewhat more deeply cleft and are slightly curved. On each of the two last whorls one notices two shallow constrictions.

The suture has not been preserved. At least three-fourths of the last volution belong to the body-chamber.

The present species shows no trace of a ventral furrow, at least not on the last two volutions, but in the totality of its features it approximates so closely to *Perisphinctes linoptychus*, that notwithstanding the absence of this feature I have decided to place it in the subgenus *Aulacosphinctes*. From *Perisphinctes linoptychus* it is distinguished by its coarser and fewer ribs, its larger size, the trichotomous ribs of the body-chamber and the more convex external margin. The inner volutions also remind us of *Perisphinctes torquatus*, but they are not so thick and the ribs are less curved.

A second specimen of smaller size than the figured type has somewhat more densely crowded ribs and therefore approaches *Aulacosphinctes linoptychus* still more closely. For this reason the specimen in question is also of interest as it is therefore the nearest known ally to *Aulacosphinctes transitorius*,[1] the well-known zone fossil of the Stramberg Horizon. It differs from *Aulacosphinctes transitorius* solely on account of its somewhat wider umbilicus, somewhat lower volutions and the greater number of simple ribs. The presence of slightly curved trichotomous ribs on the body-chamber of the large specimen of *Aulacosphinctes Mayeri* n. sp., constitutes the only reliable specific distinction from *Aulacosphinctes transitorius* Oppel.

I have named this species in honour of Herr Rudolf Mayer of Vienna, the eminent artist who has illustrated the present monograph.

The figured specimen is from Shangra in Ngari Khorsum (Coll. Schlagintweit, Munich); the smaller specimen is from Jandu, Sherik River, Hundes.

PERISPHINCTES (AULACOSPHINCTES), sp. aff. STRIOLATUS, Steuer.

Reineckia striolata, Steuer, Argentinische Juraablagerungen, *Paläontolog. Abhandlungen*, Vol. VII, Jena, 1897, p. 162, pl. XIV, figs. 8, 9.

The collections from the Spiti Shales include two small specimens which are very closely related to the exceedingly fine-ribbed *Perisphinctes striolatus* Steuer from the Argentinian Jurassics; the only differences are the somewhat

[1] Zittel, Stramberg, pl. XXII, figs. 1–6 p. 103. Toucas: *Bull. Soc. géol. France*, 3 ème sér., Vol. XVIII, pl. XVI, figs. 5, 6, p. 599.

more rounded and more depressed outline of the cross-section, the slower rate of increase, and a wider umbilicus. In the case of the larger of the two specimens, which has a diameter of about 33 mm., the ventral furrow is still distinct on the older portion of the last volution, but becomes gradually obliterated towards its anterior margin. The ventral furrow of the smaller specimen becomes obsolete at an earlier stage.

The larger-sized specimen is from Jandu, Sherik River, Hundes (Coll. Griesbach), the smaller one from Kuti (Upper and Middle Spiti Shales, Coll. Krafft).

Perisphinctes (Aulacosphinctes) Kossmati, n. sp.

(Plate XXXVII, fig. 3 *a*—*d*.)

Ammonites Braikenridgei Stoliczka (*partim*), *Mem. Geol. Surv. of India*, Vol. V, 1866, p. 106.

Dimensions:—

Diameter	90	mm.
Width of umbilicus	44·7	,,
Height of volution (approximately)	26·4	,,
Maximum thickness (,,)	36	,,

The present species is strikingly characterized by its depressed thick volutions and coarse sculpture. The volutions overlap by one-fourth of their height. Their thickness considerably exceeds their height. The broad external margin is slightly convex and sharply marked off from the feebly convex flanks. The umbilical wall is rounded, its declivity moderately steep. The cross-section has a broad depressed shape; the greatest thickness measured between the ribs lies at about the middle of the volutions, but at the ribs it shifts to their upper part, and practically coincides with the branching-points of the ribs.

The last volution carries 40 stout, rounded ribs, slightly deflected forward, ten of which are undivided, while the remaining 30 bifurcate on the upper part of the flanks. At the anterior part of the shell the points of bifurcation of the ribs are slightly swollen. The last volution carries two rather deep constrictions. On the external margin the ribs are not interrupted and there is a mere trace of a slight reduction along the median line. The changes occurring during the ontogenetic development are insignificant. On the inner volutions the ribs are sharper, and their relative thickness decreases slightly with advancing age.

The suture is not known.

The stout ribs of the last volution and the slight swellings at the points of bifurcation recall the Alpine-Mediterranean genus *Simoceras*, particularly *Simoceras agrigentinum*. In this genus we meet with an extensive process of gradual obliteration of the sculpture with increasing growth, while in the Indian species under discussion there is barely a trace of a narrow ventral furrow and the ribs gradually increase in stoutness on the external margin. We are dealing therefore certainly with an *Aulacosphinctes* and not with a *Simoceras*.

At first sight *Reineckia Steinmanni* might be taken for an allied form, but in reality this Argentinian species belongs to the genus *Acanthodiscus*.

Aulacosphinctes Kossmati is related to *Aulacosphinctes mangaensis* Steuer sp., and is distinguished from the latter species by its much greater thickness and stouter, less deeply cleft ribs. The great relative thickness of the shell and the massive ribs with their tendency to become tuberculate clearly differentiate the present species from all the other *Aulacosphinctes* forms of the Spiti Shales. Among European forms *Perisphinctes fraudator* Zittel is the nearest ally to the present species. Both species exhibit the same tendency to develop swellings at the branching-points of the ribs; *Perisph. Kossmati*, however, has stouter and fewer ribs and much thicker and lower volutions and consequently cannot be united with *Perisphinctes fraudator*.

Locality.—Kibber. One specimen.

PERISPHINCTES (AULACOSPHINCTES) TIBETANUS, n. sp.

(Plate LXX, figs. 3 *a*—*c*, 4 *a*—*c*.)

Dimensions:—

Diameter . .	. 56 mm.	59 mm.
Width of umbilicus .	. 26 ,,	29·5 ,,
Height of volution	16·5 ,,	17·5 ,,
Maximum thickness .	. 21·5 ,,	23 ,,

The present species is established on two specimens which do not completely agree with each other. The ornamentation consists of sharp ribs which are slightly deflected forward and only slightly curved and which are continuous across the external margin which they traverse normally. The majority of the ribs break up into two branches above the middle of the flanks, the others remaining undivided. The last volution bears 55 main ribs in the smaller specimen, 50 in the larger one. The constrictions are sparse and not particularly deep. The cross-section is somewhat rounded, its thickness generally exceeding its height; but whilst in the smaller specimen the curvature of the flanks and umbilical wall is uniform, in the larger specimen the upper part of the flanks is slightly complanate, and the umbilical wall is somewhat lower. These differences in the external form and costation do not appear sufficient to justify a specific separation of the two specimens. A somewhat more serious difference resides perhaps in the fact that the body-chamber of the smaller specimen occupies more than three-quarters of the volution, while in the larger sized specimen it scarcely occupies three-fourths. It is therefore still possible that we are dealing with two distinct species. The discovery of further material must be awaited to decide this point.

In the larger specimen the body-chamber is preserved close up to the oral edge. We notice here an expansion of the apertural cross-section similar to that of *Perisphinctes torquatus*.

The closest ally to the present species is *Perisph. Perrin-Smithi.* The distinguishing characters are dealt with under the heading of that species. *Perisph. natricoides* differs by its more orthogonal cross-section, its smaller thickness, its complanate flanks, wider umbilicus, slower rate of increase, and the characters of its ribs which are straighter, less sharp, interrupted on the outer margin, with the branching-points situated at a higher level. *Perisphinctes mangaensis* Steuer sp. is distinguished by its less crowded ribs, which are interrupted on the outer margin, and by its comparatively taller cross-section. *Perisphinctes colubrinus* Steuer (*non* Rein.) from Argentina is distinguished by its less crowded and less deflected ribs.

The larger specimen is from Laptal, the smaller one from Chidamu. There is also a fragment from Chidamu and a small specimen, provided with its body-chamber, from Chojan, Middle Spiti Shales.

Perisphinctes (Aulacosphinctes) Perrin-Smithi, n. sp.

(Plate LXX, fig. 2 *a*—*c*.)

Dimensions:—

Diameter	79	mm.
Width of umbilicus	37	,,
Height of volution	21	,,
Maximum thickness	27·8	,,

The shell is thick. Its shape is discoidal. The volutions overlap only slightly. The flanks are feebly convex and pass rather abruptly into the broad somewhat flattened external margin. The rounded umbilical wall slopes with a rather steep declivity; the cross-section resembles a transverse rectangle with rounded corners.

The sculpture consists of prominent ribs which are very sharp, even on the internal cast. They are slightly curved backward on the umbilical wall, while on the flanks they are rather prominently deflected forward. The great majority of the ribs bifurcate at the junction of the flanks and the external margin, both branches running normally across the external margin where they do not suffer any interruption in the case of the last volution. Very few ribs remain undivided. Constrictions occur only here and there and are not very deep.

The suture and oral margin are unknown. The greater part of the last volution belongs to the body-chamber, the exact length of which cannot be ascertained.

The present species is allied to *Perisphinctes tibetanus, Perisph. torquatus, Perisph. natricoides, Per. ophidoides* and *Perisph. hundesianus. Perisphinctes tibetanus* has a more rounded and less expanded cross-section, more crowded and deeper cleft ribs and more numerous simple ribs. *Perisph. torquatus* differs by its relatively much taller cross-section, smaller thickness, a more convex external margin, more deeply cleft and less sharp ribs and the nearly complete absence of

simple ribs. The form of the cross-section recalls that of *Perisphinctes natricoides*, but in the latter species it is narrower and the flanks and external margin are somewhat less rounded than in *Per. Perrin-Smithi*. Further, the ribs of *Per. natricoides* are more numerous, more crowded, less curved and less sharp than in *Perisph. Perrin-Smithi*. Moreover the number of simple ribs is greater and the ventral furrow is sharply excavated even on the last volution, whilst in *Perisph. Perrin-Smithi* the body-chamber bears no ventral furrow. From *Perisph. ophidoides* the present species is distinguished by its smaller size, its much lower and much broader cross-section, its more rapid rate of increase, its deeper umbilicus and its sharper, more prominent and more decidedly curved ribs; from *Perisph. hundesianus* it differs by a comparatively lower and broader cross-section and by the higher situation of the branching-points.

Perisphinctes Perrin-Smithi is represented by only two specimens from Chidamu.

Perisphinctes (Aulacosphinctes) ophidoides, n. sp.

(Plate LI, fig. 1 *a*—*d*.)

Dimensions:—

Diameter	159·5 mm.
Width of umbilicus	83·5 „
Height of volution	44·8 „
Maximum thickness	45·5 „

The shape is discoidal. The rate of increase is slow. The shell consists of numerous volutions overlapping by one-fourth to one-fifth of their height. The cross-section is rounded-subquadrate; the flanks are flattened and merge gradually into the rounded external margin; the umbilical wall is rounded and steeply declivous.

The ribs are rather stout, prominent and slightly deflected forward. They number 65 on the last volution. Nine of these are simple, and the others bifurcate above the middle of the flanks. The ribs traverse the external surface normally, and, along the median line they are intersected by a slight furrow even beyond the commencement of the last volution.

Although in places the inner whorls are somewhat distorted by compression, it is yet possible to ascertain that in the case of the innermost volutions, the height exceeds the thickness, and that this relation becomes reversed only in the two outer whorls. The following dimensions are recorded from measurements taken on three successive volutions :—

Thickness of volution	13 mm.	23 mm.	43 mm.
Height of volution	16 „	21 „	41 „

The sculpture does not undergo any change worth mentioning during the course of ontogenetic development, except that on the most anterior part of the

shell, which belongs to the body-chamber, one of the branch-ribs, usually the anterior one, or, in rare instances the posterior one, becomes disconnected from the other at its point of origin, so that the ornamentation comes to consist of alternating simple long ribs, and short intercalary ones. There is one shallow constriction on the last whorl.

The suture is only moderately ramified and is characterized by the remarkable breadth of the external saddle and the resulting displacement of the lateral saddle. The external lobe is somewhat longer than the first lateral lobe; the second lateral lobe is slightly oblique and does not reach so far down as the lateral branch of the first lateral lobe. The first auxiliary lobe is only slightly shorter than the second lateral lobe; the second auxiliary lobe is bipartite and its apex lies nearly at the same level as that of the first lateral lobe.

The present species differs from *Aulacosphinctes natricoides* n. sp. by the rarer occurrence of simple ribs, its smaller thickness, its narrower umbilicus, and a more convex and less distinctly marked off external margin; from *Aulacosphinctes La Touchei* n. sp., it is distinguished mainly by its more crowded ribs, its flattened flanks and the disposition of the ribs across the ventral face. *Aulacosphinctes Mörikeanus* is somewhat flatter, its ribs are more frequently simple, they are less crowded and their branching-points are situated at a much lower level. *Aulacosphinctes tibetanus* and *Aulacosphinctes Perrin-Smithi* are relatively much thicker. *Aulacosphinctes Hollandi* is much more decidedly flattened externally, its cross-section is more trapezoidal, its ribs are deflected forwards, somewhat more curved, and more deeply cleft, and the suture-line also exhibits differences.

The relation of the present species to *Aulacosphinctes parvulus* will be discussed when dealing with the latter species.

Locality.—Chidamu. One specimen.

Perisphinctes (Aulacosphinctes) parvulus, n. sp.

(Plate XXXII, fig. 4 *a*—*d*.)

Dimensions:—

Diameter	40	mm.
Width of umbilicus	31	,,
Height of volution	10·8	,,
Maximum thickness	12	,,

The umbilicus is very wide. The shell is very slightly involute and consists of five whorls. The cross-section is quadrate with rounded-off corners. The ribs are sharp, slightly deflected forward, partly simple, partly dichotomous. On the last volution their number amounts to 39 of which 7 are simple, whilst the rest are bifurcate. The anterior portion of the last volution carries a rather deep constriction. The ventral furrow is deep and sharply defined.

The suture exhibits two characteristic features: the extraordinary length of ıe external lobe and the nearly complete fusion of the auxiliary lobes into a ngle umbilical lobe.

The specimen described above bears such a close resemblance to *Aulacoıhinctes ophidoides* that I felt doubtful as to whether it should not be specifiılly united with the latter species or whether we may not happen to be dealing ith sexual differences. The discussions regarding the supposed sexual differıces among Ammonites having hitherto led to little or no result, it did not ɔpear opportune to be guided by considerations of so little value. A comparin with *Aulacosphinctes ophidoides* brings to light the following differences: ıring its earlier stages, the volutions of *Aulacosphinctes ophidoides* are more erlapping and comparatively taller than those of *Aulacosph. parvulus*, and the ıture exhibits a relatively shorter external lobe and well individualised auxiliary bes. If we regard the actual body-chamber of the specimen of *Aulacosph. ırvulus* as the final one, a supposition, however, which cannot be regarded as ɔsolutely certain, we should be justified in laying stress on the great difference ı size. The specific distinctness of such a remarkably large form as *Aulacoıhinctes ophidoides* and such a diminutive one as *Aulacosphinctes parvulus* is, ı say the least, highly probable, and we think ourselves justified in applying fferent names to both.

From *Aulacosphinctes Mörikeanus*, *Aul. parvulus* is distinguished by its ore numerous, more densely crowded ribs, the branching-points of which lie at higher level; further, by the smaller number of single ribs and by thicker and mparatively lower volutions. Burckhardt's *Perisphinctes colubrinoides* seems at st sight very similar to *Perisph. parvulus*; we learn, however, from Burckhardt's scription that the ribs of the small-sized Argentinian species traverse the ntral face uninterruptedly, whilst *Perisph. parvulus* possesses a deep ventral rrow; further, that the external lobe is smaller than the first lateral lobe, while our species the excessive length of the external lobe is one of the most conicuous features.

Locality.—Shalshal, "Middle Spiti Shales."

PERISPHINCTES (AULACOSPHINCTES) PSEUDOCOLUBRINUS, W. Kilian.

Perisphinctes colubrinus Zittel, Fauna der älteren Tithonbildungen, *Paläontol. Mitteil.* II, 1870, p. 225, pl. 33, fig. 6; pl. 34, figs. 4—6.

Perisphinctes colubrinus : Neumayr, Acanthicus-Schichten, *Abhandl. geol. Reichsanstalt*, 1873, V, p. 177.

Perisphinctes colubrinus : E. Favre, Zone à Amm. acanthicus des Alpes Suisses. *Mem. pal. Suisse*, III, 1877, p. 41. Terr. Oxfordien, pl. V, fig. 2, p. 46. Terrain Tithonique, *Mém. Soc. pal. Suisse*, vol. VI, p. 32, pl. II, fig. 12.

Perisphinctes colubrinus : W. Kilian, Mission d'Andalousie, pl. 29, figs. 1, 2, p. 649, 1889.

Perisphinctes colubrinus : Toucas, Faune des couches Tithoniques de l'Ardeche. *Bull. Soc. geol. France*, 3 ème serie, Vol. XVIII, 1890, p. 580, pl. XIV, fig. 1.

Perisphinctes pseudocolubrinus : W. Kilian, Note stratigraph. sur les environs de Sisteron, *Bull. Soc. géol. France*, 3 ème sér., Vol. XXIII, 1896, p. 679.

Perisphinctes colubrinus : Steuer, Argentinische Jurablagerungen, *Paläontol. Abhandl.*, VII, part 3, Jena 1897, p. 62, pl. XV, fig. 11.

Perisphinctes Zitteli v. Siemiradzki, Monographie der Gattung Perisphinctes, *Palæontographica*, 1898, Vol. 45, p. 158.
non ***Perisphinctes colubrinus*** (Reinecke) Quenstedt, Fontannes, Loriol, Herbich.
non ***P.*** cf. ***colubrinus*** Bogdanowitsch,
non ***P.*** cf. ***colubrinus*** Choffat,
non ***P.*** aff. ***pseudo-colubrinus*** Burckhardt.

In his description of *Perisphinctes colubrinus* from the Alpine-Carpathian Tithonian, Zittel remarks that this form deviates from the original type of *Perisphinctes colubrinus* from the Zone of *Ammonites tenuilobatus* in Franconia on account of its smaller size and a certain difference in its general appearance. Zittel considered these differences as too ill-defined to justify a specific separation and he therefore united the Alpine and Carpathian form with that from Central Europe. Choffat[1] and Kilian, and, independently of them, v. Siemiradzki, ascribed a higher value to these discrepancies and declared themselves in favour of a specific separation. The Alpine-Carpathian species received the name of *Perisphinctes pseudo-colubrinus* from W. Kilian, and, somewhat later, that of *Perisphinctes Zitteli* from J. v. Siemiradzki; the former name has priority. Siemiradzki discussed the existing differences briefly but exhaustively; it is true these differences are not great, yet they suffice for the purposes of a specific separation. It has also become evident that several other forms which have been described under the name of *Perisphinctes colubrinus* are identical neither with the Franconian type so beautifully figured by Quenstedt, nor with the Alpine form.

In the collections from the Spiti Shales there are nine specimens of *Perisphinctes pseudo-colubrinus*. Five of these agree so closely with each other and with Zittel's type that it is not possible to mention any appreciable difference. The ribs of some of these specimens are slightly more deflected forward than in Zittel's illustration on plate 33, fig. 6, of his work, but this discrepancy is exceedingly unimportant and disappears entirely on comparison with Zittel's illustration figs. 4 and 5 of plate 34. None of these specimens has a diameter of more than 50 mm. Three of the specimens clearly show the interruption of the ribs on the external margin of the inner volutions, already commented on by Zittel. The ventral furrow is finer, however, than in most of other species of *Aulacosphinctes*. One of the specimens has an exceptionally wide umbilicus and rather wide-spaced ribs; three other specimens have a somewhat narrower umbilicus and more rapid rate of increase. It may perhaps become necessary to separate them as a distinct species. One of them has a diameter of 71 mm. Another exhibits a pathological monstrosity without any mark of injury similar to that described by Quenstedt[2] with regard to *Perisphinctes colubrinus*.

The suture is completely known only in the case of one specimen belonging to the form with a narrow umbilicus. It agrees with the typical suture-line of the subgenus *Aulacosphinctes* with respect to the great breadth of the external

[1] Lusitanien, p. 34.
[2] Ammoniten des schwäbischen Jura, III, p. 928, pl. 101, fig. 3.

saddle, the considerable length of the external lobe and the scantiness of the ramifications. The second lateral lobes and the umbilical lobe are comparatively well developed.

Aulacosphinctes colubrinus makes its first appearance in Europe in the Mediterranean *Acanthicus* Strata[1] and has its chief centre of distribution in the Tithonian, more especially in the lower Tithonian.

Localities.—Shangra and Laptal in Ngari Khorsum, 4 specimens, Coll. Schlagintweit. The pathological specimen is from Chidamu, the two with a narrow umbilicus are from Sirkia and Chhota Hoti, Hundes.

PERISPHINCTES (AULACOSPHINCTES), n. sp. aff. LORIOLI, Zittel.

Ammonites Lorioli Zittel, Cephalopoden der Stramberger Schichten, pl. 20, figs. 6, 7, p. 103.
Perisphinctes Lorioli Kilian, Mission d'Andalousie, pl. 28, fig. 3, p. 652.

For the sake of completeness we must mention here another species which occupies an intermediate position between *Perisphinctes subcolubrinus* and *Perisphinctes Lorioli*, but which is somewhat nearer the latter than the former. It differs from *Perisphinctes Lorioli* by its somewhat lower volutions and wider umbilicus. In one of the specimens the ribs are fairly distinctly interrupted on the external margin.

Unfortunately the specimens of this species have reached me too late for illustration. Its description will be treated in greater detail in an appendix.

Perisphinctes Lorioli characterises the Tithonian of Europe (Stramberg, Andalusia, Montagne de Lure).

Locality.—Shangra in Ngari Khorsum, 3 specimens. Coll. Schlagintweit.

PERISPHINCTES (AULACOSPHINCTES) SUBTORQUATUS, n. sp.

(Plate LXX, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	90·4 mm.
Width of umbilicus	43·8 „
Height of volution	27 „
Maximum thickness	29·2 „

The figured specimen shows 52 ribs on the last volution about nine-tenths of which belong to the body-chamber. The ventral furrow is indicated only by slight traces at the commencement of the body-chamber. The last volution carries two not very deep constrictions each of which is accompanied by a simple rib; all the other ribs are dichotomous. The cross-section has a rounded-quadrate shape; the flanks are slightly flattened, the external margin is rounded. The oral edge is not preserved; but the expansion of the foremost portion of the shell of the figured specimen suggests that it is not far off the definite oral aperture.

[1] According to E. Favre the occurrence of the species in the Oxfordian of the Freiburg Alps is not quite certain.

Perisphinctes subtorquatus n. sp. is very closely allied to *Perisphinctes torquatus* Sowerby. The latter species can only be distinguished by its relatively more depressed cross-section, its greater thickness and its shorter body-chamber. The general appearance of the two forms is so similar as to suggest a possible case of sexual difference. But as we are unable to arrive at any definite conclusion on this matter, we consider it preferable to treat *Per. subtorquatus* and *Per. torquatus* as separate species. Of *Perisphinctes subquadratus* only three specimens are available, whilst *Per. quadratus* is represented by numerous specimens.

From *Perisphinctes Smith-Woodwardi* n. sp. the present species is distinguished by a more strongly flattened external margin, a relatively lower body-chamber and the absence of distinctly trichotomous ribs; from *Perisphinctes beltranensis* Burckhardt[1] by a wide umbilicus and a somewhat more distinctly rounded cross-section; from *Perisph. eudichotomus* Zittel by a weaker ventral furrow, thicker volutions and the existence of constrictions; from *Perisph. serranus* Canavari by a more decidedly flattened external margin and less deeply cleft ribs, from *Perisph. adelus* (Gemm.) Canavari by the more rapid rate of increase, and the sharper and less curved ribs. *Perisphinctes subtorquatus* is also very closely allied to *Perisph. Bleicheri* Waagen (*non Perisph. Bleicheri* Loriol) from the Umia Stage. The much narrower umbilicus and the closer crowding of the ribs clearly distinguish the Kachh species from *Perisph. subtorquatus*.

There exist three specimens of *Perisphinctes subtorquatus*. They are from Laptal and Shangra.

Perisphinctes (Aulacosphinctes) torquatus, J. de C. Sowerby sp.

(Plate LXIX, fig. 2 *a—d;* Plate LXXI, figs. 1 *a—d*, 2 *a—c*.)

Ammonites torquatus James de Carl Sowerby, *Trans. Geol. Soc. London*, V, p. 719, pl. 61, fig. 12, and explanation.
Non Perisphinctes torquatus Blanford, 1864, *non Perisph. torquatus* Waagen.
Ammonites biplex Blanford, Palæontology of Niti, pl. 12, fig. 1 *a*, *b* (*non* pl. 11, fig. 1), p. 79.

Dimensions:—

Diameter	85·8 mm.
Width of umbilicus	41 ,,
Height of volution	25·2 ,,
Maximum thickness	30 ,,

The sculpture of the present species consists mainly of bifurcate ribs which are slightly deflected forward and which on the umbilical wall constitute a small posteriorly convex arch. Simple and trichotomous ribs are not totally wanting, but they occur only in some specimens and then only in very small numbers (one or at most two on the last whorl). On the penultimate volution immediately preceding the body-chamber or including its posterior extremity, the number of ribs

[1] Argentinische Jurablagerungen, p. 41, pl. V, figs. 10—12.

fluctuates between 52 to 58. On the earlier volutions the number of ribs becomes proportionately smaller. Branching takes place a little above half the height of the volutions. The branch-ribs traverse the external margin normally and exhibit a slight median furrow on the inner volutions. The median furrow entirely disappears on the body-chamber and also on the anterior portion of the chambered nucleus.

The umbilicus is rather wide. The rate of increase is slow. The volutions overlap by about one-third of their height. The cross-section is subcircular to rounded-trapezoidal; the flanks are slightly flattened; the ventral face is rather broad and rounded. More closely ribbed specimens have a somewhat lower cross-section than specimens with wider-spaced ribs. The maximum thickness is situated either just below the middle of the volutions or it may be found shifted downwards nearer to the umbilical wall.

The posterior part of the body-chamber subsists in several specimens, while in two specimens the anterior portion also is preserved. The only change of ornamentation noticeable on the anterior portion of the body-chamber consists in a slight downward shifting of the branching points of the ribs. At the anterior end the cross-section becomes expanded and the oral aperture shows a broad, short lateral lappet (see plate LXIX, fig. 2 *c*). The body-chamber of the figured specimen occupies very nearly three-fourths of the last volution.

As in all species of *Aulacosphinctes* the suture-line has a long external lobe, a broad external saddle and feebly developed, feebly retrograde auxiliary lobes. The ramification of the lobes is somewhat more profuse than in most other species of the subgenus and the auxiliary lobes are somewhat better developed. The specimen depicted in plate LXIX, fig. 2, has a particularly long external lobe and its second lateral lobe is rather broad.

Perisphinctes torquatus is the commonest species in the Spiti Shales and varies accordingly within rather wide limits. Extreme forms are illustrated on plate LXIX, fig. 2, and on plate LXXI, fig. 1; the other specimens occupying intermediate positions.

The species *Ammonites torquatus* was founded by James de Carl Sowerby on specimens from the desert north-east of Kachh. Later on Waagen applied the name *torquatus* to a very large specimen from the Katrol Stage. A comparison of the Spiti Shales specimens with Sowerby's illustration evinces such a complete agreement that it is not possible to point out any differences worth mentioning. Notwithstanding the somewhat primitive technique of Sowerby's drawing, we at once recognise its identity with the form under discussion. Sowerby's concise description is also quite applicable to our species. On the other hand Waagen's "*Perisphinctes torquatus*" shows very little resemblance with Sowerby's species. Waagen's interpretation consequently does not appear to be correct.

H. F. Blanford was more correct in his interpretation of *Ammonites torquatus* (on Gerard's collection of Spiti fossils, 1863, p. 130), when he assigned this

name, with a query, to a closely allied form which is here designated as *Perisph. infundibulum*. Later on, in 1865, he referred this same form to *Perisphinctes biplex*, an identification which also has to be rejected, for the Indian species is neither identical with the original type of *Ammonites biplex* Sowerby nor with that form which for a long time has been mistaken for it in England.[1]

Among the forms from the Spiti Shales those closest related to *Perisphinctes torquatus* are *Perisphinctes subtorquatus*, *Perisph. Smith-Woodwardi*, and *Perisph. infundibulum*. *Perisphinctes subtorquatus* differs by its relatively taller volutions, its smaller thickness, less crowded ribs and a longer body-chamber; *Perisph. Smith-Woodwardi* is distinguished by taller volutions, more strongly flattened flanks and the greater number of trichotomous ribs on the body-chamber; *Perisphinctes infundibulum* is thicker with a narrower and deeper umbilicus, and more strongly curved ribs. At first sight *Perisphinctes ophidoides* also seems very similar, but on closer examination it is found that *Perisph. ophidoides* has a wider and flatter umbilicus and more strongly flattened flanks and a slower rate of increase. In *Perisphinctes ophidoides* the ribs are less deeply cleft, less curved, and more numerous; the number of undivided ribs is also greater. The innermost volutions of *Perisphinctes ophidoides* are flat; those of *Perisph. torquatus* are rather strongly inflated. *Perisphinctes torquatus* is represented by many specimens with a portion of their body-chamber preserved, none of them exceeding 90 mm. in diameter, whilst *Perisph. ophidoides* reaches a diameter of 159 mm. Finally, the suture of *Perisphinctes ophidoides* is less profusely ramified, its lobe-trunks are somewhat narrower, its saddles somewhat broader, and the external lobe much shorter than in *Perisph. torquatus*.

Of European forms *Perisph. Lorioli* Zittel, *Perisph. serranus* Canavari and *Perisph. adelus* Gemm. may be specially mentioned as closely allied. *Perisph. Lorioli* has much flatter and taller volutions and is therefore easily distinguished from *Perisph. torquatus*. *Perisph. serranus* Canavari has convergent flanks and more strongly curved ribs. *Perisph. adelus* Gemm. is less involute with a wider umbilicus, and more strongly curved ribs. *Perisph. colubrinus* has a slower rate of increase with lower subcircular volutions. *Perisphinctes biplex* Loriol and Pellat (*non* Sowerby-Healey) has a much wider umbilicus, a lower cross-section and straighter ribs. *Perisphinctes Pallasi* d'Orb. (*Perisph. biplex auctor. anglicorum*) differs by its straight and less numerous ribs whose branching-point lies at a higher level, and probably belongs to a group of *Perisphinctes* different from that of which *Perisphinctes torquatus* is a member.

Perisphinctes torquatus is represented by numerous specimens from the following localities: Laptal (Hundes), Chidamu, Shalshal (Middle Stage), North of Ting Jung La, between Ting Jung La and Chhota Hoti, Jandu (Sherik River), Sirkia (S. Hundes), Gieumal, Spiti Valley.

[1] Maud Healey, On Upper Jurassic Ammonites, *Quarterly Journal Geol. Soc.*, vol. 60, 1904, p. 62.

PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM, n. sp.

(Plate LXVI, fig. 3 *a*—*c*; Plate LXXII, figs. 1 *a*—*c*, 2 *a*—*c*, 3 *a*, *b*, 4 *a*—*c*.)

Ammonites torquatus Sowerby (?), H. F. Blanford, on Gerard's collection of Spiti fossils, *Journ. Asiat. Soc. Bengal*, 1864, vol. 32, p. 130, pl. III, figs. 6, 7, 8.

Ammonites biplex, H. F. Blanford, Palæontology of Niti, 1865, pl. 11, fig. 1 *a*—*c*, p. 79 (*non* pl. 12, fig. 1).

Ammonites biplex, G. C. Crick, The Cephalopoda in the Strachey Collection from the Himalaya, *Geol. Magazine*, n. s., Dec. V, 1904, p. 8.

Dimensions:—

Diameter	81 mm.	83 mm.		70 mm.
Width of umbilicus	39 ,,	37·5 ,,		32·7 ,,
Height of volution	25 ,,	26·5 ,,	(approximate)	21 ,,
Maximum thickness	34 ,,	31·4 ,,		29 ,, (approximate)

Typical specimens of *Perisphinctes infundibulum* with their funnel-shaped umbilicus and the strongly curved and anteriorly deflected ribs convey the impression of a well-characterized, easily recognisable species. It is not difficult to distinguish it from its nearest relation, namely *Perisphinctes torquatus*, for the volutions of *Perisph. infundibulum* are considerably thicker and lower, its flanks are more strongly arched, its umbilical wall is more steeply inclined, and its external margin broader. The umbilicus is narrower and forms a funnel-shaped cavity. The ribs are much more deflected forward; they are more strongly curved on the lower part of the flanks and on the umbilical wall, and they are more deeply cleft. Moreover the interruption of the ribs on the external margin is somewhat more distinct than in *Perisph. torquatus*. In large specimens of *Perisph. infundibulum* the number of main-ribs on the last volution amounts to 40—43, while in *Perisph. torquatus* it is somewhat more. The sutures do not exhibit any noteworthy differences, though the septa are distributed at somewhat wider intervals in the case of *Perisph. infundibulum*. The body-chamber is not completely preserved in any of the specimens.

The distinctness of the species soon loses its precision, however, the moment that we take into account the less typical specimens, such as that represented on plate LXXII, fig. 2. This specimen is somewhat flatter with strongly curved ribs, and approaches *Perisph. torquatus* very closely. At the same time there are certain specimens of *Perisph. torquatus* which exhibit a similarly close approach to *Perisph. infundibulum*. Yet it is impossible to trace an absolutely continuous transition from one to the other from amongst the available material.

As in the case of *Perisph. torquatus*, there is a considerable range of variation amongst the specimens of *Perisphinctes infundibulum*. The specimen represented in fig. 3, plate LXXII, differs from the type represented in fig. 1 of the same plate, owing to its considerably narrower umbilicus, more densely crowded, somewhat finer ribs, its somewhat more convex external margin and its flatter flanks. The form represented in fig. 4 of the same plate has the same umbilical width as the type, but the ribs are more crowded and less curved, while the flanks are more flattened. The specimen shown in fig. 2 of the same plate has a narrower

umbilicus, narrower volutions and less distinctly curved ribs. The specimen illustrated in plate LXVI, fig. 3, represents an immature individual with deep constrictions. It is evident therefore that hardly a single specimen entirely agrees with any one of its fellows.

In all specimens the height increases with increasing age at a quicker rate than the thickness. The sculpture does not undergo any noteworthy changes during the course of ontogenetic development.

The forms figured by H. F. Blanford under the names of *Ammonites torquatus* (Asiat. Soc., plate III, figs. 6—8) and *Ammonites biplex* (Palæontology of Niti, plate 11, fig. 1 *a*—*c*) belong to *Perisphinctes infundibulum*, and are remarkable for their very thick, low and rounded volutions and their strongly curved ribs. Nevertheless, the form depicted on plate 12, fig. 1 *a*, *b* of the Palæontology of Niti, probably does belong to *Perisphinctes torquatus*, on account of its narrower whorls and straight ribs less strongly deflected forward.

In addition to *Perisphinctes torquatus*, we must also take into consideration *Perisph. montanus* n. sp., *Perisph. sparsiplicatus* Waagen and *Perisph. subcolubrinus* Waagen in the present discussion of the affinities of *Perisph. infundibulum*. *Perisph. infundibulum* is distinguished from *Perisph. montanus* by its more convex flanks, its more depressed cross-section, and its stouter ribs which are more decidedly deflected forward; from *Perisph. subcolubrinus* it is distinguished by its greater thickness and narrower umbilicus.

Very closely allied to *Perisphinctes infundibulum* is a species from the Lower Teschener Schiefer of Silesia which, some years ago, I described under the name of *Perisphinctes* aff. *Lorioli* Zitt. The pronounced curvature of the ribs on that small fragment suggests specific identity; but since the Silesian specimen is distorted by compression and consequently the form of the shell cannot be clearly made out, we are unable to arrive at a final decision on the point. In any case we have to deal here with a very closely allied species.

Localities.—Chidamu (5 specimens); Jandu, Sherik River; country between Ting Jung La and Chhota Hoti; Spiti Valley.

Perisphinctes (Aulacosphinctes) Smith-Woodwardi, n. sp.

(Plate LXIX, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	131	mm.
Width of umbilicus	60	,,
Height of volution	42	,,
Maximum thickness	38·5	,,

The umbilicus is wide. The ribs are prominent, slightly deflected forward, and bifurcate above the middle of the flanks. Their number on the last whorl is 60, and on the penultimate whorl 52.

Trichotomous ribs are almost absent except on the last quarter of the last volution where they are occasionally developed, the lower branch starting much lower than the upper one. On the internal cast the ribs appear rather sharp and fine, but when the shell is preserved, they project in the shape of prominent rather stout ridges. The external region is slightly rounded, the flanks are somewhat flattened and slightly bevelled towards the external margin. The maximum thickness coincides with the junction between the flanks and the oblique, rounded umbilical wall. The cross-section has a rounded-trapezoidal shape.

The suture is not preserved. The last volution belongs entirely to the body-chamber. The oral margin is not preserved but the most anterior preserved part of the body-chamber, is probably close to the final oral aperture.

Perisphinctes Smith-Woodwardi is very closely allied to *Perisph. Bleicheri*, but is distinguished from the latter by the relatively greater height of its cross-section and its rounded-trapezoidal outline as well as by the stronger curvature of the external margin of the body-chamber. Both species possess a long body-chamber in contradistinction to *Perisphinctes torquatus*. From this latter species *Perisphinctes Smith-Woodwardi* is also distinguished by its relatively greater volution-height, its smaller thickness, the presence of trichotomous ribs and the shape of the cross-section; from *Perisph.* cf. *adelus* Gemm. it differs by its smaller thickness, the smaller number of trichotomous ribs and the shape of the cross-section.

The figured specimen is from the Spiti Valley. The matrix contains also Belemnites and a small *Oppelia* (*Streblites*). A second specimen is from Puling (Ngari Khorsum); a third specimen from Chidamu, perhaps belongs also to the same species.

PERISPHINCTES (AULACOSPHINCTES) WILLISI, n. sp.

(Plate LXV, fig. 3 *a—d;* Plate LXXIII, fig. 1 *a—c.*)

Dimensions:—

Diameter (approximately)	84 mm.
Width of umbilicus	36·3 ,,
Height of volution (measured over the ribs)	26·8 ,,
Maximum thickness	33·3 ,,

Notwithstanding the undoubtedly close relationship between this fossil and *Perisph. infundibulum*, it is impossible to unite it with the latter species. Although its ribs are fairly distinctly deflected forward, their course is straight, and there is no trace of the curvature of the ribs on the lower part of the flanks and on the umbilical wall, which is so characteristic of *Perisph. infundibulum*. The constrictions are somewhat more pronounced. The umbilical width is about the same but the funnel shape of the umbilical cavity is not as clearly developed. The cross-section of the volutions is relatively somewhat higher than in *Perisph.*

infundibulum and the flanks, which in the latter species are strongly arched, are distinctly flattened.

Perisph. Willisi is distinguished from *Perisph. torquatus* by its greater thickness, the more pronounced flattening of its flanks and of its external region, and the more pronounced anterior deflection of the ribs; from *Perisph. hundesianus* it is distinguished by its relatively taller volutions, its more complanate flanks, its greater thickness and the different shape of its cross-section.

The suture of *Perisphinctes Willisi* does not differ essentially from that of *Perisph. torquatus* and *Perisph. infundibulum;* but the distances between the septa are nevertheless somewhat greater. The oral aperture recalls that of *Perisphinctes torquatus* in so far as the cross-section of the oral aperture is somewhat wider than the adjacent portion of the shell. But while the lateral lappets of *Perisph. torquatus* are short and broad, those of *Per. Willisi* are narrow and produced into a spoon-shaped appendix. The last rib is blurred and much flatter than the remainder from the last of which it is separated by a rather deep groove. The oral edge proper is smooth and expanded outwards, particularly on the external margin. The length of the body-chamber cannot be ascertained exactly; it certainly does not occupy more than three-fourths of the last volution and consequently is comparatively short. In the figured fragment of the inner set of volutions the constrictions are particularly deep and numerous and are accompanied on one side by a strongly thickened rib.

Of this species we possess several specimens from the following localities: Country between Chhota Hoti and Ting Jung La; Laptal (Hundes); Gieumal.

Perisphinctes (Aulacosphinctes) hundesianus, n. sp.

(Plate LXXI, fig. 3 *a—c;* Plate LXXIII, fig. 2 *a—c.*)

Dimensions:—

Diameter	65·8 mm.	69 mm.
Width of umbilicus	28·8 ,,	29 ,,
Height of volution	21 ,,	22 ,,
Maximum thickness	29 ,,	28·5 ,,
	Measured at the ribs.	(approx.)

Only after some hesitation did I decide to separate this species from *Perisphinctes torquatus* with which it agrees so closely that a separate description is superfluous and all we need do is to point out the differences.

Perisphinctes hundesianus is somewhat thicker than *Perisph. torquatus* and has a lower and more rounded cross-section. The ribs are stouter and somewhat more deeply cleft, so that the branching-point is frequently shifted below the middle of the flanks. On the last whorl there are two deep constrictions, whilst in *Perisph. torquatus* constrictions are either entirely wanting or only feebly developed.

Certain specimens of *Perisph. infundibulum* are also very closely related to *Perisph. hundesianus*, especially that represented on pl. LXXII, fig. 4. The more decided anterior deflection of the ribs of *Perisph. infundibulum* justifies its specific separation from *Perisph. hundesianus*.

Perisph. hundesianus is represented by four specimens of which two are from Chidamu, whilst the third was found between Laptal and Chidamu and the fourth was collected north of Ting Jung La.

PERISPHINCTES (AULACOSPHINCTES) cf. ADELUS, Gemmellaro.

(Plate LXVII, fig. 1 *a*—*c*.)

Perisphinctes adelus Gemmellaro 1872, Faune giurese e liasiche, No. 2, p. 51, pl. III, fig. 7, 1877 ; No. 7, p. 198.
Perisphinctes adelus Canavari 1897, Fauna degli strati con *Aspidoceras acanthicum*, *Palæontographica Italica*, III, p. 203, Pl. XXII, figs. 1, 2 ; Pl. XXVII; fig. 3.

Dimensions:—

Diameter (approximately)	101	mm.
Width of umbilicus	46·5	,,
Height of volution	31	,,
Maximum thickness	32·7	,,

The inner volutions of this species with their relatively low cross-section, flattened flanks and deeply cleft bifurcate ribs scarcely differ from those of *Perisphinctes torquatus*. The body-chamber, however, with its numerous trichotomous ribs exhibits specific differences which, on the one hand, preclude its reference to *Perisphinctes torquatus*, while, on the other hand, they remind us vividly of *Perisphinctes adelus* Gemmellaro from the *Acanthicus*-strata of Sicily.

The agreement with the Sicilian form is, however, not complete; for *Perisph. adelus* Gemm. has a somewhat wider umbilicus and somewhat less numerous ribs than the Indian form. The other characters, namely the roundish cross-section, slightly flattened flanks, and the suture-line appear to agree well, judging from Gemmellaro's description. Whether a ventral furrow exists on the inner volutions of the Sicilian species is not known. The figured Indian specimen distinctly shows the ventral furrow behind the commencement of the body-chamber. Owing to the insufficiency of the available material it is not possible to decide whether the differences mentioned are sufficient to preclude specific identification. Richer material both from India and from the Mediterranean might include absolutely identical forms. Until this can be ascertained, we consider it wiser to designate the Indian species as *Perisphinctes* cf. *adelus*. In any case its relationship to *Perisph. adelus* is exceedingly close.

Whether the form described by Canavari under the name of *Perisph. adelus* is specifically identical with Gemmellaro's type appears to be somewhat doubtful, for its rate of increase is still slower, the trichotomous ribs are fewer and the curvature of the ribs is more pronounced.

Among Indian species, besides *Perisph. torquatus*, already referred to, those most closely related are *Perisph. chidamensis*, *Perisph. Smith-Woodwardi*, and *Perisph. sparsicosta*. *Perisphinctes chidamensis* has a relatively more rapid rate of increase, thicker volutions and a narrower umbilicus. *Perisph. sparsicosta* is similarly distinguished by its greater thickness and fewer ribs; *Perisph. Smith-Woodwardi* differs by the relatively greater height of its body-chamber, its less densely crowded costation, and fewer trichotomous ribs.

The body-chamber of the Italian *Perisph. adelus* occupies three-fourths of the last volution, agreeing in this respect with *Perisphinctes torquatus* and *Perisphinctes Willisi*.

Perisphinctes adelus has been described by Gemmellaro from the *Acanthicus*-strata (Kimeridgian) of Burgilamuni in the province of Girgenti, by Canavari from the *Acanthicus*-strata from Monte Serra near Camerino. According to Seguenza this species occurs also in the *Acanthicus*-strata near Taormina. Canavari mentions a *Perisph.* cf. *adelus* from the Tithonian of Caprino. A *Perisphinctes* cf. *adelus* Gemm. has been reported by G. C. Crick[1] from Somaliland.

The Indian species is represented by three specimens of which two are from Chidamu whilst the third is from Laptal.

PERISPHINCTES (AULACOSPHINCTES) CHIDAMENSIS, n. sp.

(Plate LXXIV, fig. 1 *a*—*d*.)

Dimensions:—

Diameter . .	. 104 mm.	106 mm.
Width of umbilicus .	. 46 ,,	46 ,,
Height of volution .	. 34·2 ,,	34 ,,
Maximum thickness .	. 38 ,,	40 ,,

The whorls have a sub-circular section, exposing a wide umbilicus. The inner volutions are ornamented with only moderately numerous dichotomous ribs. With advancing age the main-ribs become relatively more numerous, and, on the last volution, which belongs for the most part to the body-chamber, they number 56. The ribs are fairly strongly deflected forward and bifurcate at about half the height of the volutions or a little higher. On the body-chamber the level of branching-points becomes shifted somewhat lower down. Up to the commencement of the body-chamber dichotomous ribs prevail; on the posterior part of the body-chamber trichotomous ribs become interspersed amongst the dichotomous ones, though the latter still remain mere numerous, while on the anterior portion of the body-chamber there only subsist a few isolated dichotomous ribs scattered amidst the now predominating trichotomous ones. The constrictions are few but deep.

1 On the fossil Cephalopoda from Somaliland collected by Donaldson Smith. (Through unknown African countries. London and New York, 1897.)

The first lateral lobe is somewhat shorter than the external lobe, it has a very broad trunk and close-set rather scantily ramified lateral branches. The second lateral lobe is fairly large, only slightly oblique; its free development is not impeded by the adjacent sutural inflections. Of the auxiliary lobes only the first is normally developed, the second one being very insignificant and combining with the remaining auxiliaries, which are reduced to the state of mere denticulations, to form a slightly retrograde umbilical lobe. The apex of this umbilical lobe is approximately on a level with the apex of the inner lateral main-branch of the first lateral lobe. As regards the development of the saddles, the great breadth of the external saddle and the anterior displacement of the first lateral saddle are worth noticing.

In the figured specimen about two-thirds of the last volution belong to the body-chamber, which, however, is not completely preserved. In a second specimen (Coll. Schlagintweit) the body-chamber occupies more than three-fourths of the last volution though the oral margin is not preserved. In this specimen, the foremost preserved portion of the body-chamber bears ribs which are deeply cleft and strongly deflected forward, while this portion of the body-chamber also appears to expand laterally in a very decided manner, just as in the case of *Perisph. torquatus*.

Perisphinctes chidamensis belongs to the group of forms particularly closely related to *Perisph. torquatus*. This relationship is particularly expressed by the similarity of the suture-lines, the resemblance of the inner volutions, and the existence of a slight median furrow on the inner whorls of *Perisphinctes chidamensis*. The specific distinctness is based on the greater thickness and convexity of the volutions and the greater number of trichotomous ribs on the body-chamber.

Closely connected with *Perisphinctes chidamensis* are *Perisph. sparsicosta* and *Perisph.* cf. *adelus* Gemm. The distinguishing characters are pointed out in the descriptions of these species.

Among the species of the genus *Virgatosphinctes*, *Perisph. himalayanus* and *Perisph. Burckhardti* bear a certain resemblance to *Perisphinctes chidamensis*. The first-mentioned species is larger, with thicker and more depressed volutions, more copiously cleft ribs and a different suture. The second species has relatively taller volutions and its ribs are more abundantly ramified.

Localities.—Chidamu, 1 specimen; Shangra in Ngari Khorsum, 4 specimens (Coll. Schlagintweit).

PERISPHINCTES (AULACOSPHINCTES) SPARSICOSTA, n. sp.

(Plate LXXIV, fig. 2 *a*—*f*.)

Dimensions:—

Diameter	98	mm.
Width of umbilicus	44·8	,,
Height of volution	31	,,
Maximum thickness (approximately)	33	,,

Perisphinctes sparsicosta is one of the nearest relatives to *Perisph. chidamensis*. With a wider conception of the zoological value of species the two might be united. As however there are very few specimens available of either species, it is impossible to ascertain whether they are connected by intermediate forms. For the present therefore we consider it advisable to maintain the specific distinctness of *Perisph. sparsicosta*. If later discoveries should establish the existence of transitional forms, the specific name here proposed may be utilised to designate a variety.

The external shape and outline of the cross-section are practically identical with both forms as can easily be verified from an examination of the illustrations and a comparison of the tables of dimensions. The exceptionally tall outline of the cross-section of *Perisph. sparsicosta* indicated in the view showing the aperture represented in pl. LXXIV, fig. 2*b* results from a slight lateral compression of the most anterior portion of the shell. The true cross-section is represented by the outline drawing, fig. 2*e*.

The ornamentation of both species is very similar but the ribs are much fewer in the case of *Perisph. sparsicosta*, their number on the last volution being respectively 39 in the case of *P. sparsicosta*, and 56 in that of *P. chidamensis*. Moreover, the ribs of *P. sparsicosta* are somewhat stronger and less curved. The constrictions are very deep and are bounded anteriorly by an undivided rib and posteriorly by a rib-bundle. Such rib-bundles are wanting in *P. chidamensis*. The " virgatotomous " type of branching seems to set in somewhat earlier (see fig. 2 *f*) than in *P. chidamensis*.

The differences in the suture are as follows : in *P. chidamensis* the first lateral saddle is anteriorly displaced more than the external saddle; the second lateral lobe is long, the first lateral lobe is rather broad; in *P. sparsicosta* the external and lateral saddles are at the same level; the second lateral lobe is very short, and the first lateral lobe has a rather narrow trunk.

The exact position of the last septum cannot be ascertained, but it seems that about three-fourths of the last volution belong to the body-chamber. The oral margin is not preserved. The deep constriction near the front end of the preserved part of the body-chamber was probably situated close to the final oral aperture.

Locality.—Chidamu (Coll. Diener); one specimen.

D.—ISOLATED TYPES.

Perisphinctes (Pseudovirgatites), sp. ind.

The specimen here alluded to is a chambered fragment 65 mm. high with a rounded-trapezoidal cross-section and a sculpture recalling the ornamentation of the body-chamber in *Pseudovirgatites scruposus* Oppel[1]. The specimen is too

1 Zittel, Cephalopoden der Stramberger Schichten, p. 115, pl. XXIV, fig. 3*a*, *b*. Vetters, Die Fauna der Juraklippen wischen Donau und Thaya, *Beiträge zur Geologie und Palaeontologie Oesterreich-Ungarns*, XVII, p. 227, pl. XXI, fig. I and XXII figs. 1—4.

fragmentary to enable us to determine it accurately; but although not specifically identical with the European *Perisphinctes scruposus*, yet it probably belongs to the group of *Perisphinctes scruposus*.

The specimen is from Kuti.

PERISPHINCTES (PSEUDOVIRGATITES?) aff. ERINOIDES, Burckhardt.

This is a small fragment of a body-chamber the volution height of which is 71 mm. and the thickness 65 mm., the sculpture recalling that of *Perisphinctes erinoides* Burckhardt[1] from the Kimeridge-Portlandian of the Argentinian Cordillera. Its bad state of preservation precludes a more exact determination.

Locality.—Chidamu.

PERISPHINCTES BIPLICATUS, n. sp.

(Plate LVII, figs. 1 *a*—*c*, 2 *a*—*d*, 3; Plate LIX, fig. 1 *a*—*c*.)

Dimensions:—

	Plate LIX, fig. 1.	Plate LVII, fig. 2.
Diameter	153 mm.	99 mm.
Width of umbilicus	68 ,,	40 ,,
Height of volution	50 ,,	33·5 ,,
Maximum thickness	48·5 ,,	32·5 ,,

The shape is discoidal. The ribs are very prominent, thick and at the same time sharp, regularly dichotomous, rather wide-spaced and slightly deflected forward. The branching-point of the ribs occurs at about half the height of the flanks or a little higher; the branch-ribs traverse the external margin normally in the shape of thick, sharp ridges. The largest specimen exhibits two simple ribs, but trichotomous ribs are entirely absent. The number of main-ribs on the last volution of the specimen illustrated in pl. LVII, fig. 2 is about 42, while in the largest specimen it probably rises to 47.

The flat flanks are sharply marked off from the steep and rounded umbilical wall, but they merge gradually into the slightly convex external margin which is somewhat flattened along its middle zone. The cross-section of the body-chamber is approximately that of a square with rounded corners. The outer volution is only slightly thicker at its base than at its upper part, and its height only very slightly exceeds its thickness. On the other hand, the thickness of the inner volutions is greater than their height. The following table records these dimensions for four successive whorls in the case of the specimen figured in pl. LVII, fig. 1 and conveys an idea of the mode of growth of the present species.

	Height of volution.	Thickness.
Body-chamber	35·5 mm.	35 mm.
Penultimate volution	21 ,,	25 ,,
Antepenultimate volution	10 ,,	16 ,,
Next inner volution	5·5 ,,	10 ,,

1 *Palaeontographica*, vol. 50, pl. VIII, fig. 1, p. 51.

The suture is characterized by its scanty ramification, the great breadth of the saddles and the great length of the external lobe. The first lateral lobe is rather short and has a broad trunk, the second lateral lobe is scarcely or not at all oblique. The auxiliary lobes are rather feebly developed and scarcely retrograde. The first lateral saddle is displaced forward. In the large specimen figured on plate LIX the second lateral lobe is somewhat obliquely disposed. The suture-line of a third specimen (pl. LVII, fig. 3) differs by the somewhat narrower trunk of the first lateral lobe and the somewhat greater breadth of its first lateral saddle. Whether this specimen represents a separate species cannot be ascertained with certainty owing to its poor state of preservation.

Notwithstanding the somewhat considerable divergence in dimensions, a portion of the body-chamber subsists in every one of the figured specimens.

The present species occupies an isolated position among the *Perisphinctes* of the Spiti Fauna, and it is difficult to establish its exact relationship. It possesses a certain degree of external resemblance to *Perisphinctes bathyplocus* Waagen from the Katrol Stage of Kachh, also to *Perisphinctes lacertosus* and *Perisph. crusoliensis* Dumortier et Fontannes from the Kimeridgian of the Ardèche, but none of these forms are truly related to *Perisph. biplicatus*, which they only resemble in general habit.

Much more intimate are the relations with *Perisphinctes Bleicheri* Loriol[1] (*non* Waagen) and *Perisphinctes Boidini* Loriol[2] from the Portlandian of Northern France.

The two specimens figured by Loriol under the name of *Perisphinctes Bleicheri* appear to belong in reality to two separate species. One of these differs from *Perisphinctes biplicatus* by a much wider umbilicus and relatively lower volutions, the other by the presence of trichotomous ribs, which are entirely wanting in *Perisph. biplicatus*. *Perisphinctes Boidini* has narrower and relatively taller whorls. Otherwise the resemblance of *Perisphinctes biplicatus* with the above-mentioned species is so great that we might feel inclined to admit that it is closely related. Unfortunately we possess no information regarding the shape of the suture and the characters of the chambered nucleus of *Perisphinctes Bleicheri* so that, for the present, it is impossible to form any clear conception of this species. In consequence of its sharp, dichotomous, and only moderately numerous ribs *Perisphinctes biplicatus* bears a certain resemblance to the group of *Perisphinctes Pallasi* d'Orb. (*Perisph. biplex aut. anglic.*) of Northern Europe and Russia.[3] In this group also the lobes are only scantily ramified and the saddles are very broad; but the auxiliary lobes are scarcely or not at all

1 Loriol et Pellat, Formation jurassique des environs de Boulogne-sur-Mer, *Mém. Soc. de physique et d'histoire naturelle de Genève*, XXIII, 1874, pl. IV, figs. 1, 2.

2 Compare also A. Pavlow, *Bull. Soc. Imp. Natural. de Moscou*, 1889, pl. III, figs. 7, 12, p. 60.

3 To this group belong *Perisph. rotundus* Sov., *Perisph. Panderi* d'Orb., *Perisph. dorsoplanus* Vischniakoff, *Perisph. Lomonossowi* Vischn., *Perisph. Pralairei* Nikitin (*non* Favre), *Perisph. apertus* Nikitin, *Perisph. solovaticus* Bogosl., *Perisph. clementinus* Bogosl. (?) and others. The forms of this group are often referred to as *Holcostephanus*; it would be preferable to establish for them a special generic term.

oblique to the umbilical suture in consequence of which the suture is displaced forward, while the auxiliary lobes of *Perisph. biplicatus* are somewhat distinctly retrograde towards the umbilicus. It is probable therefore that *Perisphinctes biplicatus* does not belong to the group of *Perisphinctes Pallasi*. We might perhaps imagine that *Perisphinctes biplicatus* is related to the *Pallasi* group, but that under the specal conditions of life obtaining in the Indian Province it acquired an aberrant form of septa, receding in this respect from the Russo-North-European species; but we have no satisfactory data to support this supposition.

Finally we must compare the present species with *Perisphinctes torquatus*. In all the forms of this group the ribs are much more densely crowded, they are much more distinctly interrupted on the external margin and the sutures are somewhat more laciniated.

The available material is too scanty to determine the exact relationships of *Perisphinctes biplicatus*. We have therefore to be satisfied at present with a description of this species and postpone the elucidation of its relationships until further opportunities arise.

Localities.—The three figured specimens are from Kibber. One specimen is from Sirkia, South Hundes, another one was found 3 miles west of Chikkim. Finally there are two specimens from Shangra in the Schlagintweit Collection.

PERISPHINCTES, n. sp. ind. aff. BIPLICATUS, n. sp.

Apparently connected with *Perisphinctes biplicatus* are two specimens from Kuti which are unfortunately badly preserved and which differ from *Perisphinctes biplicatus* principally owing to their wider umbilicus and relatively lower volutions. They bear a remarkable resemblance to *Perisphinctes versicolor* Trautsch.[1] The Russian species is characterized by the anterior displacement of the auxiliary lobes, whilst in the present instance they are strongly retrograde. It is possible that we have to deal only with a case of external similarity and not of close relationship.

BOCHIANITES, P. Lory.

BOCHIANITES GERARDIANUS, Stoliczka sp.

(Plate LXXIX, fig. 3 *a*—*f*.)

Anisoceras Gerardianum Stoliczka, *Memoirs, Geological Survey of India*, V, 1866, p. 110, pl. X, fig. 3.

This remarkable species is represented only by a fragment representing the middle portion of the shell; the earlier and later portions are missing. The

1 A. Pavlow places this species together with *Perisphinctes inversus* and *P. inverselobatus* in his genus *Simbirskites*. (A. Pavlow, Argiles de Speeton, *Bull. Soc. Imp. Natural de Moscou*, 1891, p. 113, M. Pavlow, Ammonites du groupe *Oloost. versicolor*. *Bull. Soc. Imp. Natural de Moscou*, 1886, p. 6.)

preserved middle portion shows two distantly placed septa near its commencement, the remaining portion belonging to the body-chamber.

The shell is slightly curved in such a way that contrary to the ordinary rule the antisiphonal side is feebly convex, whilst the siphonal side is slightly concave. Besides this the shell has a slight curvature from right to left, a feature not ordinarily observed in uncoiled forms. This irregular curvature of the shell suggests that we have only to deal here with an unimportant accidental distortion, and that the shell of this species was essentially straight and rod-like. At the lower end the cross-section is nearly circular; at the upper end the flanks and antisiphonal face are slightly complanate.

The sculpture consists of simple, approximately straight, fairly stout ribs which ascend from the antisiphonal towards the siphonal side and increase in thickness in the same direction. On the antisiphonal margin they are reduced or nearly interrupted; on the siphonal margin one can detect a feeble trace of a narrow interruption of the ribs. There seems to be a constriction at the broken anterior end.

The suture consists of a siphonal, an antisiphonal, and a lateral lobe. Between these are two broad saddles which are subdivided almost symmetrically by small secondary lobes. The lobes have a very simple configuration. The lateral and antisiphonal lobes have a rather short and broad trunk which bears a short terminal and two small lateral branchlets. The apices of the lobes lie at about the same level.

Owing to the absence of the anterior and posterior portions, it is very difficult to determine the genus of the fossil. Similar rod-like and helical types occur both in the Dogger and in the Lower Cretaceous. The older forms such as *Spiroceras* Quenstedt, *Patoceras*, *Apsorroceras* Hyatt seem related to *Parkinsonia* and cannot therefore be closely related to the present species, whose resemblance to some of these fossils can only constitute another of those striking instances of convergence which are not uncommon amongst Ammonoids. On the other hand, the resemblance of the present species to the small uncoiled Ammonoids of the Lower Cretaceous which I have designated as *Leptoceras*[1], and also to the Tithonian *Ancyloceras Gümbeli* Oppel and *Ancyloceras gracile* Oppel[2] seems to be connected with a real relationship. None of these forms, however, are likely to be mistaken for the present species.

As already noticed it is not impossible, and it is indeed probable that the species above described possessed essentially a rod-like shell. On this supposition we shall have to look to the Lower Cretaceous genus *Bochianites* for the points of closest contact. Amongst the members of this genus, *Bochianites neocomiensis* d'Orb. sp. is very closely allied, and appears to differ from the present species merely on account of its somewhat closer-set ribs. Its resemblance to the Indian

1 Cephalopodenfauna der Wernsdorfer Schichten, *Denkschriften der kais. Akademie der Wissenschaften*, Vol. 46, 1883, p. 260.

2 Zittel, Aelteres Tithon, p. 233, pl. 36, figs. 1, 2,3.

fossil confirms the reference of the latter to *Bochianites.*[1] Somewhat less marked is the similarity to *Bochianites Weteringi* G. Boehm and *Bochianites Versteeghi* G. Boehm[2] from the passage-beds between the Jurassics and Cretaceous of the Sula Islands.

A definite opinion about the present form cannot be arrived at without further material. In the meanwhile the most appropriate course is to unite it with the genus *Bochianites.*

As far as its locality is concerned, Stoliczka remarks: "It is undoubtedly from the Spiti-shales, but the exact locality is not noticed; it was collected by Capt. Hutton."

B.—BELEMNOIDEA.

The group of BELEMNITES (BELEMNOPSIS) GERARDI, Oppel.

The lower stage of the Spiti Shales is constituted by group of strata abounding in Belemnites; at the same time numerous Belemnites occur also in the higher strata. A closer examination has disclosed the fact that all these Belemnites belong to one group, that of the *Canaliculati*, which we may designate as the group of *Belemnites Gerardi* Oppel.

As early as 1833, Everest[3] figured these Belemnites, later on single specimens were described by Blanford[4] as *Belemnites sulcatus* Mill., by Oppel[5] as *Belemnites Gerardi*, by Stoliczka[6] as *Belemnites canaliculatus* Schloth. *Belemnites Gerardi* was also recorded by W. Waagen[7] from the Upper Kelloway and the Lower Oxfordian of Kachh, and by A. Rothpletz[8] from Rotti.

It has not escaped Blandford's attention that the dorsoventral diameter of the rostrum of the specimens from the Spiti Shales is somewhat greater than that of the European forms cited above. The comparatively strong lateral compression of the guard and the exceptionally deep and broad canal which extends right down to the tip lends to the specimens from the Spiti Shales a very striking and characteristic appearance which fully justifies the special name given to them by Oppel.

Neumayr[9] also studied *Belemnites Gerardi.* He placed this species, together with *Belemnites sulcatus* Phillips, *Belemnites absolutus* Pander, and *Belemnites volgensis* d'Orbigny, in a special group, that of the "Absoluti," which, in contra-

1 P. Lory, sur le crétacé inf. du Dévoluy et des régions voisines. *Trav. du laboratoire de Géologie de l'Univ. de Grenoble*, IV, 1898, p. 129.

2 *Palaeontographica*, Supplement IV, 1904, pp. 26, 27, pl. II, figs. 5, 6.

3 Memorandum on the fossil shells discovered in the Himalaya Mountains. *Asiatic Researches*, 1833, vol. 18, pl. II, fig. 17.

4 *Journal, Asiatic Society*, XXXII, 1864, p. 125, pl. I, figs. 1, 2 *a—c*. Palæontology of Nitti, 1865, p. 76, pl. 10.

5 Palaeontolog. Mitteilungen, II, 1865, pp. 273, 296, pl. 88, figs. 1—3.

6 *Memoirs, Geol. Survey of India*, Calcutta, 1866, V, pp. 111, 112.

7 *Palaeontologia Indica*, Ser. IX, I, Jurassic Fauna of Kutch, vol. I, 1, p. 13, pl. II, fig. 3.

8 *Palaeontographica*, vol. 39, pp. 104, 105.

9 *Verhandlungen der Geologischen Reichsanstalt*, 1889, p. 52.

distinction to the "Canaliculati" were supposed to be characterised by the absence of the ostracum lamella, by the obscuration or entire disappearance of the canal towards the alveolar extremity of the rostrum and finally by the supposed circumstance that concentric rings of the rostrum were interrupted by the canal. That this peculiarity of the canal is not to be found in Oppel's original specimen has already been pointed out by Rothpletz who, however, has observed it in other specimens.

Neumayr's views were emphatically opposed by G. Boehm[1] who declared that *Belemnites Gerardi* is a genuine *Canaliculatus*.

As far as the canal is concerned I can entirely concur with the correctness of G. Boehm's assertions. The individual concentric rings of the guard show regular inflexions at the canal; the specimens in which the canal seems to cut right through the concentric rings are old specimens and, as already remarked by G. Boehm, this feature most probably results from an exfoliation of the thinned-out lamellæ at the edges of the very deep canal.

With respect to the ostracum lamella G. Boehm did not have the opportunity of making any decisive observations, and the Spiti Shale material is not in a suitable condition for investigating the delicate ostracum lamella. The canal of the forms belonging to the group of *Belemnites Gerardi* is so deep that it frequently causes the rostrum to split, and thus prevents the examination of the delicate ostracum lamella. Some observations, which, unfortunately could not lead to any definite result, were made on a specimen which, although attenuated to a certain extent in the direction of the alveolar extremity, appears to belong to the *Belemnites Gerardi* group. At that part of the specimen where the investigation was carried out the alveolus has a dorsoventral diameter of 14 mm., whilst the diameter of the rostrum is 21 mm. The canal experiences here a slit-like contraction, and the individual concentric layers of the rostrum bend round nearly at right angles as they approach the narrow canal. On the inner surface of the canal we observe a calcareous lamella which seems to thicken towards the canal and apparently belongs to the ostracum. It is not possible, however, to ascertain clearly whether the substance of this calcareous mass penetrates into the rift of the canal.

A similar thickening of the inner side of the canal is also to be observed in another specimen with an alveolar diameter of 11·8 mm.; but in this case the thickening, clearly belongs to the fibrous mass of the guard. This tallies exactly with G. Boehm's illustration of a specimen from Misol (*loc. cit.*, p. 54, text-figure 19).

The problem concerning the ostracum lamella does not yet admit of a solution and should be made the subject of special palæontological investigation. The uncertainty regarding this point does not, however, preclude our uniting the *Gerardi* group with the European *Canaliculati*, as has been lately advocated by G. Boehm. At present there do not exist safe grounds for merging the *Gerardi*

1 *Palaeontographica*, Supplement A, IV, pp. 53—55.

group into that of the *Absoluti* nor to ascribe to this group, which is so rich in individuals, a Russo-Boreal derivation in accordance with Neumayr's ideas.

Oppel and Waagen looked upon *Belemnites subhastatus*, as the closest ally of *Belemnites Gerardi*, but G. Boehm has suggested that the latter is perhaps nearer related to *Belemnites canaliculatus*. The length of the canal of *Belemnites Gerardi* and the fact that the cross-section of the rostrum of this species undergoes no distinct attenuation near its alveolar extremity favour a comparison with *Belemnites canaliculatus*. Nevertheless the special features of *Belemnites Gerardi* entitle it to a position of specific independence both with respect to *Belemnites canaliculatus* and *Belemnites subhastatus*.

Far more difficult than the elucidation of the relationships of the *Gerardi* group to other groups is the systematic distribution of the forms actually included within the group. In addition to *Belemnites Gerardi* Oppel and Rothpletz the following species probably belong to this group: *Belemnites aucklandicus* Hauer[1] *Belemnites africanus* Tate, *Belemnites tanganensis* Futterer,[2] possibly also *Belemnites kuntkotensis* Waagen and *Belemnites orientalis* Waagen. Whether Waagen's *Belemnites Gerardi* really corresponds with the Himalayan species is somewhat doubtful, since the canal of this form is rather narrow, judging at least from Waagen's figure.

Of the greatest importance are those forms of this group which G. Boehm[3] has described from the Oxfordian of the Wai Galo and from the upper Lagoi on Taliabu. G. Boehm distinguishes the following species: *Belemnites alfuricus* G. Boehm, *Bel. galoi* G. Boehm, *Bel. taliabuticus* G. Boehm, *Bel. Sularum* G. Boehm, *Bel. moluccanus* G. Boehm. The differences between these forms, especially between the first three, and again between the last two are, however, almost imperceptible, as admitted indeed by Boehm himself, so much so that the differences can sometimes scarcely be expressed in words.

As in the case of G. Boehm's specimens, those which I have had to deal with are also very difficult to sort out. The horizons and localities from which the various specimens were obtained, are evidently, in many instances, rather wide apart. Very elongated slender forms occur side by side with moderately thick or else very ponderous cylindrical ones, and the variety at first conveys the impression that several species can be evolved from amongst this diversity of forms. But on closer inspection we soon find that even the most extreme forms appear to be connected with each other by every intermediate gradation. The difficulties are further increased by the fact that in almost every instance the exact geological horizon is unknown. Lastly, the material, although plentiful, is not very well preserved. The large alveolar fragments are invariably disconnected from their respective rostrum and the fragmentary rostra themselves are often broken and weathered.

[1] Reise der osterreich. Fregatte Novara, Geolog., section I, part II, p. 99, pl. 8, figs. 2, 3.

[2] Beiträge zur Kenntniss des Jura in Ostafrica. *Zeitschrift der deutsch. geol. Gesellsch.* 1895, vol. 46, p. 30, pl. 5, figs. 2, 3.

[3] *Palaeontographica*, Supplement IV, Die Südküsten der Sula Inseln Taliabu und Mangoli, Stuttgart, 1907, p. 53, etc.

Under such unfavourable conditions, I should have preferred to follow Oppel's example and unite all the specimens under the name of *Belemnites Gerardi*, reserving the attempt to discriminate between possible separate species until fresh material has been collected with better regard to its stratigraphical distribution. Since however the majority of the Spiti forms evidently correspond exactly with the forms described by G. Boehm from the Sula Islands, we find ourselves compelled to come to some definite decision with respect to these. We have attempted to follow the diagnoses of G. Boehm, but have failed to attain satisfactory results. It is far from improbable that the more slender forms which G. Boehm has designated under the name of *Belemnites alfuricus* may eventually turn out to represent a distinct species. On this supposition we have assigned the name of *Belemnites alfuricus* to the most slender forms of the *Gerardi* group. All the remaining forms have had to be united provisionally under the name of *Belemnites Gerardi* for want of definable differences.

The relation of *Belemnites Geradi* to the forms from the Sula Islands is far more distinct than to *Belemnites africanus*, *Bel. orientalis*, *Bel. aucklandicus*, and *Bel. tanganensis*. In *Bel. aucklandicus* the canal is narrower and shallower, the cross-section of the guard more nearly circular, the guard itself is smaller. The rostrum of *Belemnites tanganensis* Futterer is slightly attenuated towards the alveolar extremity indicating an approximation to the *Hastati*, and in connection therewith the dorsoventral diameter of the middle portion of the rostrum is somewhat less than the transverse diameter. *Belemnites africanus* from the Neocomian Uitenhage-formation exhibits the same external form as *Belemnites Gerardi*, but the canal does not extend down to the apex of the rostrum. *Belemnites orientalis* Waagen from the Dhosa Oolite possesses a conical rostrum and shallower canal.

Although we have to concede that these forms are specifically distinct, the frequency of canaliculate Belemnites in the Upper Jurassic and perhaps also in the Lower Cretaceous of the Indo-African and Indo-Australian regions deserves special attention, as will be explained more in detail when stating the general remarks on *Belemnites Gerardi*.

Belemnites (Belemnopsis) Gerardi, Oppel.

(Plate XCIII, figs. 1, 2, 5*a*, *b*, 7*a*—c, 9*a*, *b*, 10*a*—*c*, 11, 12*a*, *b*, 13*a*, *b*; Plate XCIII A, figs. 1*a*—*c*, 2*a*, *b*, 4*a*, *b*, 5*a*—*c*.)

The majority of the specimens of this exceedingly common species are of medium size and correspond in their dimensions with those illustrated by Oppel. Boehm's *Belemnites taliabuticus* excellently represents this medium stage, in which the guard has a diameter of 10—15 mm. This stage is connected by a complete series of transitional forms with thicker specimens in which the diameter of the guard measures 20 to 28 mm. Thicker specimens of this kind are designated by G Boehm as *Belemnites sularum* and *Belemnites moluccanus*. They are of rarer occurrence than the rostra of medium and small size. The existence of transitional

forms and the absence of definable differences indicates that the less common, stout, large specimens should in all likelihood be regarded as full-grown specimens of the same species. Moreover we not unfrequently find very small specimens in which the relative breadth of the canal is very disproportionate as compared with the diameter of the guard. The guard, at all stages, is more or less rod-shaped; in young specimens the lower end is drawn out into a long, fine point, while in old and thick specimens it is somewhat truncated and rounded. The cross-section increases from the apex towards the alveolar extremity, at first rapidly, further on very gradually and finally remains almost constant. There is only rarely a slight tendency towards a hastate form, in which case one observes a very slight contraction of the cross-section at the commencement of the alveolus.

In immature individuals the cross-section is circular. Later on a slight flattening sets in on the flanks and the dorso-ventral diameter becomes somewhat greater than the lateral one. Although the difference between the two dimensions is only slight, yet it communicates a characteristic appearance to the middle stages of growth. In full-grown specimens the cross-section acquires again a more circular shape and there is either no noteworthy difference between the dorso-ventral and the lateral diameters, or the lateral slightly exceeds the dorso-ventral diameter.

The ventral furrow is characterized by its remarkable breadth and depth. It is bordered by bluntly rounded edges and reaches right down to the apex of the guard, where it becomes gradually shallower, especially in older specimens. At the alveolar end of some specimens the canal assumes the shape of a narrow and deep groove. Lateral grooves, which, in general, are not distinctly developed in canaliculate Belemnites, appear here also to be wanting. (Compare with the description of *Belemnites* sp. ind. and with Pl. XCIII, fig. 8, and Pl. XCIII A, fig. 3.) The apical line has a subcentral position.

The alveolus penetrates into the guard to a considerable depth, constituting a cone whose angle is at first 15° to 14°, further on narrowing down to 13°. The septa follow one another at first in close succession, but the distance between them gradually increases until it amounts to as much as 8 mm. The last septa of the largest phragmocones, which attain a dorso-ventral diameter of 60 mm., follow each other again at somewhat closer intervals. The cross-section of the phragmocone is at first subcircular, becoming gradually more elliptical, the dorso-ventral diameter being appreciably greater than the lateral one. The longest amongst the available phragmocones were not found connected with any rostra, but as already pointed out by Blanford, there is every reason to believe that they belong to *Belemnites Gerardi* as they agree in their characters with smaller phragmocones, undoubtedly belonging to this species, and also because *Belemnites Gerardi* is the only common belemnite of the Spiti Shales.

Belemnites Gerardi has been found in many localities. The bulk of the specimens occur in the Belemnite Beds at the base of the Spiti Shales. Stoliczka already noticed the occurrence of the Belemnites at the boundary between the Spiti Shales and the Tagling Limestone. The majority of the specimens of the

Schlagintweit Collection examined by A. Oppel are from Kalabagh, where according to Oppel they are found together with forms of *Macrocephalites.* The latter are probably forms of the Oxfordian Stage. The Belemnite Beds of the Spiti Shales examined by Diener and Griesbach may well be referred to the Oxfordian Stage, a subject which will be discussed at greater length in a subsequent chapter. *Belemnites Gerardi* is, however, not restricted to this horizon, but is distributed throughout the whole of the Lower and Middle division of the Spiti Shales. It appears to occur even in the highest stage of the Spiti Shales; at any rate we have before us a strongly weathered fragment from the Upper Spiti Shales of Lochambelkichak (Tithonian-Neocomian), which probably belongs to *Belemnites Gerardi;* the identification is, however, not quite certain. In the islands of Taliabu and Mangoli also *Belemnites Gerardi* occurs in Oxfordian strata. The exact horizon of the occurrence at Rotti is not known.

The locality of many of the specimens is unfortunately unknown. In the following we enumerate all the localities which are explicitly stated: Spiti Valley, Niti, Chidamu, (Belemnite Beds); Chanambaniali, (Lower Spiti Shales); Kuti, (lowest Belemnite Shales); Jandu, Sherik River, (Hundes); Ting Jung La, (Hundes); Chikkim, (Spiti); Sirkia, (South-Hundes); Laptal; Chojan (2nd Stage); Saddle of Manirang, (Spiti); between Ting Jung La and Chhota Hoti.

Belemnites (Belemnopsis) alfuricus, G. Boehm.

(Plate XCIII, figs. 3 *a*, *b*, 4, 6.)

Belemnites alfuricus G. Boehm, *Palaeontographica,* Supplement IV, Pl. VIII, figs. 4, 5, 7, 11, pp. 55, 57.

Certain rostra belonging to the group of *Belemnites Gerardi* in its wider sense are remarkable for their slenderness. The alveolus forms a more acute angle, the guard is comparatively long and somewhat more strongly flattened laterally than in the common form of *Belemnites Gerardi.* Even with a length of rostrum such as would already correspond with a considerable thickness in the case of the normal form of *Belemnites Gerardi,* the present form still maintains its slender outline.

The present form is perhaps even more slender than that illustrated by Boehm.

Immature specimens of *Belemnites alfuricus* can scarcely be distinguished from specimens of *Belemnites Gerardi* at the same stage of development. A more careful stratigraphical exploration of the Spiti Shales may perhaps enable us to formulate a more precise diagnosis, but at present there appears to be little hope of success in this direction.

The slender build of *Belemnites alfuricus* recalls *Belemnites kuntkotensis* Waagen; it is easy, however, to distinguish the latter species from *Belemnites alfuricus* owing to the more pronounced dorso-ventral depression of its rostrum and its shallow canal.

Belemnites alfuricus is represented by several specimens three of which were found in Jandu, Sherik River. The original specimens are from Spiti, but the exact locality has not been noted.

Belemnites, sp. ind.

(Plate XCIII, fig. 8; Plate XCIII A, fig. 3 *a—d.*)

The collections from the Spiti Shales include a few belemnites which perhaps indicate the existence of a second species in addition to *Belemnites Gerardi.* Of the two figured specimens the larger one is distinguished by its conspicuously hastate shape. At the alveolar extremity the canal is very deep, near the apex of the guard it is very narrow and shallow. The flanks exhibit feeble, but distinct traces of the lateral grooves. The alveolar portion of the smaller specimen is not preserved, but a slight attenuation in an upward direction is nevertheless recognisable. In this specimen the canal is rather deep and the dorso-lateral grooves are particularly distinct. In addition to these specimens there are two more fragments also exhibiting the dorso-lateral grooves and showing a tendency towards a hastate configuration.

The canal of the larger figured specimen exhibits the same characteristics near its alveolar extremity as that of *Belemnites Gerardi.* Moreover the specimen is greatly exfoliated near its upper end and not quite regularly developed conveying the impression that it may merely represent a pathological individual of *Belemnites Gerardi.*

The three other specimens which show a tendency towards the development, of a hastate form are also characterized by the presence of dorso-lateral grooves, and we know that these lines occur much more frequently and distinctly amongst the *Hastati* than amongst the *Canaliculati.* It is therefore possible that these specimens represent a separate species. Nevertheless, I feel inclined to look upon them as pathological variations of *Belemnites Gerardi.* The available material is too deficient to permit a definite settlement of the question.

Spiti Shales; exact locality not noted.

Diploconus, sp. ind.

(Plate XCIII A, fig. 6 *a, b.*)

A single phragmocone appears to belong to the rare genus *Diploconus* and deserves therefore a few words' notice notwithstanding its deficient state of preservation. The phragmocone tapers towards its lower extremity at an angle of about 33°. The chambers increase very little in length in an upward direction; they are usually lower than in the majority of Belemnites and are deflected upwards on the dorsal side. Hence, a side view shows the septa not as horizontal lines, but running obliquely towards the "axis" of the phragmocone. The

siphuncle, of which some traces still subsist (see fig. 6 *b*), is almost strictly marginal; it indicates the middle line of the ventral face. The exact shape of the cross-section cannot be ascertained owing to a partial distortion of the specimen, but generally speaking it is subcircular.

Unfortunately neither the guard nor the ornamentation of the phragmocone has been preserved. The generic identification is therefore doubtful, but there is a possibility of its belonging to *Diploconus*. The contrast with the phragmocone of *Belemnites Gerardi* is very striking. At any rate, this specimen proves that *Belemnites Gerardi* was not the only Belemnoid form of the Spiti Fauna.

Diploconus has been described by Zittel[1] from the Upper Tithonian of Stramberg. If the generic determination which at present is only conjectural should turn out to be correct, the mediterranean element of the Spiti Fauna would thereby be strengthened.

The exact locality of the specimen is not noted, but it is certainly derived from the Spiti Shales.

[1] Cephalopoden der Stramberger Schichten, p. 38, Pl. 1, figs. 14—17.

APPENDIX TO THE AMMONOIDEA.

Oppelia (Streblites) crassicostata, n. sp.

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

This species is only represented by a fragment of a body-chamber 46 mm. high and 18·8 mm. thick. Nevertheless it exhibits such characteristic features that it can be specifically diagnosed and located in the subgenus *Streblites* notwithstanding our ignorance concerning the suture.

The sculpture bears the closest resemblance to that of *Streblites Griesbachi* n. sp., *Streblites Kraffti* n. sp., and *Streblites Adolphi* Oppel, but is much more pronounced. Whilst in the above-mentioned three species the ribs are only slightly indicated, in the present species they project as massive folds on the upper region of the flanks. The spiral ridge is also more pronounced and the tubercular crest on the external margin, although incompletely preserved, is more prominent and stronger than in any other species. On the lower part of the flanks, the ribs are only faintly developed, shallow grooves intervening at long intervals. On the more anterior part of the shell the ornamentation becomes slightly reduced, indicating the proximity of the oral margin, which, however, is not preserved. The external margin in the anterior region appears to become a little broader, depressed, and rounded, a feature which is in accordance with the characteristics of the subgenus *Streblites*. The tubercular crest, which is still strongly developed on the middle portion of the existing fragment, appears to become flatter and finally obsolete on its anterior portion, supposing, of course, that this is not an illusion resulting from the poor state of preservation of the specimen.

The above-described species is so well characterized by its prominent sculpture that it can easily be distinguished from the most closely allied species such as *Streblites Adolphi* Oppel, *Streblites Griesbachi* n. sp., *Streblites Nouhuysi* G. Boehm, and *Streblites Kraffti* n. sp. Since the available specimen consists of a portion of the body-chamber, it seems that the present species must have been of a somewhat smaller size than *Streblites Adolphi* and *Streblites Kraffti*.

The specimen here described is from Hundes (Coll. T. L. Walker).

Oppelia (Streblites) sphenodoma, Uhlig et Suess.

(Plate LXXXII, fig. 1 *a*—*c*.)

(See p. 58, Pl. VI, fig. 3 *a*—*d*, of the present volume.)

Dimensions:—

Diameter	82·5 mm.
Width of umbilious	18·4 „
Height of ultimate whorl	38 „
Thickness of ultimate whorl	23·8 „

The above dimensions refer to a specimen from Kuti, which shows great resemblance to *Streblites sphenodoma*, and had been overlooked in our description of the species. The fine small tubercles of the external margin appear to be somewhat more distinctly indicated on the body-chamber of the present specimen than on the original type; the present specimen is also considerably larger and its umbilical edge less sharply marked. The other characters agree. The suture of the larger specimen is apparently somewhat more ramified, but this feature is almost certainly connected with its larger dimensions.

Although there is some discrepancy between the two specimens, the differences do not seem to be sufficiently important to justify the creation of a new species.

The above-described specimen has its test partly preserved. About one-half of the last volution belongs to the body-chamber, the anterior part of which is not preserved.

Locality.—Kuti (Coll. F. H. Smith).

Oppelia (Streblites) pygmæa, Uhlig et Suess.

(Plate LXXIX, fig. 4 *a*—*d*.)

(See p. 65, Pl. VI, fig. 7; Pl. VII, fig. 6, of the present volume.)

Among the fossils belonging to a later set examined by us there is an *Oppelia pygmæa* having a diameter of 13 mm. and ornamented with exceedingly fine but well preserved external tubercles. The specimen in question, in which a portion of the body-chamber is preserved, has been figured for the sake of showing the simplified suture which in none of the other specimens is so clearly visible. The trunks of the lobes are comparatively broad and the simplification affects chiefly the inner lateral branches of the first lateral lobe.

Locality.—Kuti, Byans. Besides the figured specimen there are five others from the same locality (Coll. F. H. Smith).

Aspidoceras, sp. ind.

In the text devoted to the genus *Aspidoceras* it has been stated that this genus is represented by a single specimen only. Since the publication of this statement a second specimen has been discovered also belonging to the group of the *Inflati* (*Physoderoceras* Hyatt). The bad state of preservation of the small fragment prevents us from deciding whether it belongs to *Aspidoceras avellanoides* Uhlig or to another species. It is from Jandu, Sherik River.

Holcostephanus (Spiticeras) Tobleri, n. sp.

(Plate LXXIX, fig. 1 *a*—*c*.)

Dimensions:—

Diameter	82·3 mm.
Width of umbilicus	29 ,,
Height of ultimate volution	30·3 ,,
Thickness of ultimate volution	28·5 ,,

In spite of the large number of *Spiticeras* already described, it is nevertheless impossible to unite the present species, latterly discovered by T. L. Walker, with any of those already described. It is distinguished by a remarkably flat, rather narrowly umbilicated shell with a high, nearly elliptical cross-section and an oblique umbilical wall. The inner volutions too are comparatively flat. The shape of the cross-section does not show any distinct change at successive stages, which may be due to the fact that the only available specimen is a chambered nucleus stopping short at the commencement of the body-chamber.

The last volution exhibits two obliquely disposed constrictions; round the umbilicus there are 16 tubercles from which originate about 115 ribs, so that 7 or 8 ribs correspond to each tubercle. On the narrow external margin the ribs from opposite sides meet at a distinct angle. The double-tubercle stage of the innermost volutions is recognisable up to a diameter of 18 mm. The external saddle is very broad and subdivided by two secondary lobes, of which the inner one is somewhat shorter than the outer one. The first lateral lobe has a comparatively narrow and short trunk, the second lateral lobe is disposed slightly obliquely and constructed subsymmetrically.

Spiticeras Tobleri is closely related to *Spiticeras subbilobatum*, but is distinguished from it by its somewhat flatter and relatively taller volutions, its narrower umbilicus, its more numerous tubercles and more numerous ribs. Moreover the suture of *Spiticeras Tobleri* differs in the greater breadth of the saddles and the subsymmetrical configuration of the second lateral lobe. In *Spiticeras Tobleri* the inner secondary lobe of the external saddle is shorter than the outer one, while the opposite is observed in *Spiticeras subbilobatum*. *Spiticeras obliquelobatum* Uhlig and Suess has less numerous ribs and less strongly retrograde auxiliary lobes, narrower saddles and longer lobes, and a more wedge-shaped cross-section. The present species differs from *Spiticeras spitiense*, *Spiticeras subspitiense* and *Spiticeras Groteanum* by its more oval cross-section at the commencement of the body-chamber, its flatter shell, its narrower inner volutions, fewer ribs and various details in the suture.

The high and slender volutions of the present species recall *Spiticeras Cautleyi* Oppel, *Spit. subcautleyi* and *Spit. planum*. Since, however, in these species the number of ribs constituting a rib-bundle is much less and the suture exhibits marked discrepancies, it is not difficult to discriminate these species from *Spiticeras Tobleri*.

Spiticeras Tobleri is represented by a single inner cast almost entirely chambered. It is from Hundes.

Holcostephanus (Spiticeras), sp. ind.

(Plate XXXVIII, fig. 7.)

The collection contains one large fragment with badly preserved external surface, probably belonging to the group of *Spiticeras Stanleyi*, and exhibiting

the dorsal portion of the suture in a remarkably fine state of preservation. We notice a long antisiphonal lobe cut up into numerous lateral segments, on either side of which is a somewhat curved internal lateral lobe and a retrograde internal umbilical lobe consisting of three branches. The general disposition is identical with that of the corresponding portion of the suture of *Spiticeras obliquelobatum* Uhlig et Suess (Pl. XV, fig. 3), but the ramifications are more profuse.

The specimen is from the Spiti Valley; the exact locality is not recorded.

Holcostephanus (Spiticeras), n. sp. ind.

(See *Holcostephanus* (*Spiticeras*) n. sp. ind., page 117, Pl. IX, figs. 1 *a*—*c*, 3 *a*—*d*; Pl. VIII, fig. 5, of the present volume.)

A specimen latterly received agrees well with those already referred to. Unfortunately it is too badly and too incompletely preserved to add much to our knowledge of the species, but in any case it favours the impression that we have to deal here with an independent, although insufficiently characterized species.

Locality.—Kuti, Byans (Coll. F. H. Smith).

Holcostephanus (Astieria) cf. convoluta, v. Koenen.

(Plate LXXVIII, fig. 1 *a*—*c*.)

Astieria convoluta A. v. Koenen, Ammonitiden des norddeutschen Neokom. *Abhandlungen der preussischen geologischen Landesanstalt*, Berlin, 1902, p. 146, Pl. 39, fig. 4 *a*, *b*.

Of this species only a body-chamber is preserved, so that its exact determination is at present impossible. Nevertheless, the specimen deserves a detailed discussion.

The specimen may have had a diameter of 148 mm. and an umbilical width of 45 mm. The height of the last volution amounts to 57 mm., its thickness to 72 mm.; the height of the penultimate volution is 38·5 mm. and its thickness 48 mm. The present species has, therefore, a comparatively wide umbilicus and is moderately inflated. The cross-section is rounded on all sides, its breadth somewhat exceeding its height. From the pointed spines originate sharp, filiform ribs, some of which commence actually at the spines, others between them, while additional ribs are also intercalated on the flanks. At the commencement of the last volution there are about 7 ribs per spine, at its anterior portion about 10. The body-chamber occupies the full length of a volution, but considering that the oral margin is wanting, its length is really greater. Like Koenen's *Astieria convoluta*, the Indian specimen possesses a fairly uniformly convex shell. The costation of the two cannot be exactly compared because the North-German species is represented only by the chambered nucleus, while the Indian form only exhibits the body-chamber. It is true that the number of ribs per node is somewhat less in *Astieria convoluta*, but since, as is well known, the number of ribs in all species of *Astieria* tend to increase with age, this difference is probably not a specific one.

Similarly the steeper slope of the umbilical wall in the European *Astieria convoluta* is perhaps connected with the smaller size of the specimen.

We must therefore regard the specific identity of the present form with *Astieria convoluta* as highly probable. In any case all other species of *Astieria* are more remote. The Indian species differs from *Astieria Schenki* Oppel by its flatter shell, relatively taller oral aperture, wider umbilicus and more densely crowded ribs. The body-chamber fragment of *Astieria Schenki* is considerably smaller than that of *Astieria* cf. *convoluta*. There exists possibly therefore a difference also in the size of the two species. *Astieria ventricosa* Koenen (*A. multiplicata* Neumayr and Uhlig[1]) has a relatively higher volutional cross-section, a narrower umbilicus and less crowded ribs. *Astieria Atherstoni* Sharpe[2] deviates by its wedge-shaped cross-section and its nearly perpendicular umbilical wall. In *Astieria psilostoma* Neumayr et Uhlig the costation is not so dense, the external margin is more flattened, the body-chamber is shorter, the test much smaller. But it is not impossible that the difference between the small species *Astieria psilostoma* with its short body-chamber and the large *Astieria* cf. *convoluta* with its long body-chamber may be only due to a difference in sex. For the present, however, such theoretical conjectures should not be allowed to influence systematic considerations and we must therefore abandon any attempt at viewing the matter from the standpoint of sexual differences.

The shape of the cross-section and the rather dense crowding of the ribs recall *Astieria Mittreana* d'Orb,[3] but the costation of the French species is much finer. According to the statements of d'Orbigny and Baumberger *Astieria Astieri* has higher and narrower volutions. We need scarcely take into account, for purposes of comparison, the numerous fine ribbed types like *Astieria filosa* Baumb., *Astieria scissa* Baumberger,[4] *Astieria Bachelardi* Sayn,[5] *Astieria Chaignoni* Sayn, nor the smaller-sized *Astieria Bigueti* Sayn, nor the almost non-tuberculate, somewhat problematical forms which Karakasch[6] has lately described from the Crimea (*A. elegans* Karak., *A. taurica* Karak., *A. cadoceroides* Karak.), nor finally *A variegata* Paquier, *A. madagascariensis* Lemoine and *A. Wilfriedi* Karak.

The discovery of the chambered nucleus of the present species would be necessary in order to confirm the specific identity of the Indian and North-German species. In any case there can be no doubt about their close relationship.

According to A. von Koenen *Astieria convoluta* occurs in the zone of *Hoplites radiatus* in the lowermost Hauterivian or Middle Neocomian. We may conjecture that *Astieria* cf. *convoluta* likewise occupies a Neocomian horizon within the Spiti Shales.

Locality.—Lochambelkichak.

[illegible]

[1] Neumayr and Uhlig. Hils-Ammonitiden, *Palaeontographica*, XXVII, p. 150, Pl. XXXVIII, fig. 2.

[2] Description of fossils from the Secondary Rocks of Sunday River, South Africa. *Transact. Geol. Soc. London*, Ser. II Vol. VII, p. 196, Pl. XXIII, fig. 1.

[3] Matheron, Recherches pal. dans le midi de la France, Pl. B 20, fig. 8.

[4] *Denkschriften Schweiz. pal. Gesellschaft*, Vol. 34, 1907, p. 29, 31.

[5] Bull. Soc. géol. France, 3me, sér. XVII, 1889, Pl. XVII, p. 679.

[6] Crétacé inf. de la Crimée. *Soc. Imp. des Natural. de St. Peterborg*, Vol. XXXII, fasc. 5, 1907.

PLATE XLIX.

Fig. 1 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) SUBFREQUENS n. sp.
Page 327. Internal cast, with the body-chamber preserved. Natural size. 1*a*, Lateral view. The lobes figured here indicate the position of the ultimate septal wall. 1*b*, View of the external periphery. 1*c*, 1*d*, Cross-sections. See also pl. LXI, fig. 1 *a—d*. From Chidamu.

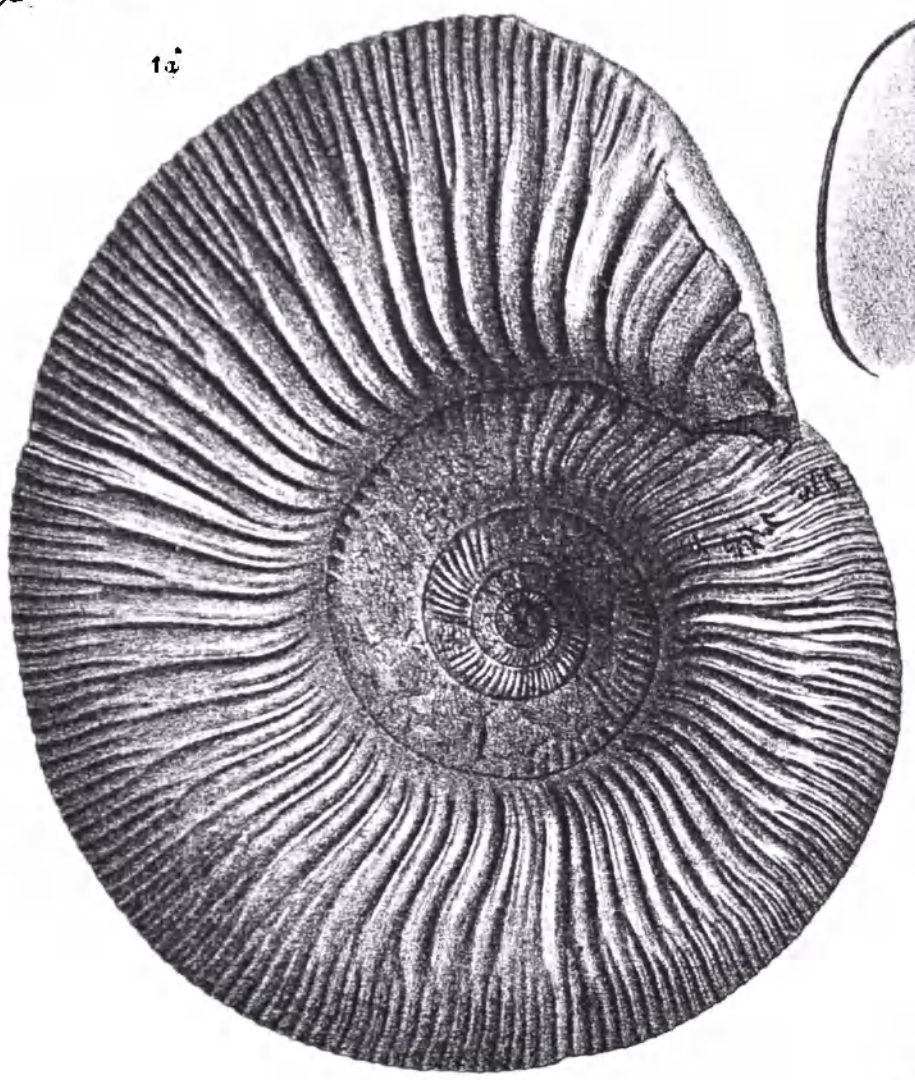
Fig. 2 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) DISCOIDES n. sp.
Page 337. Specimen with the body-chamber preserved. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. From Chidamu.

Geol. Surv. of India.

JURASSIC FOSSILS (HIMALAYA).

Pl. XXXXIX.

1a



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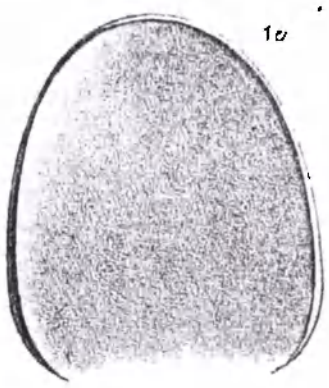

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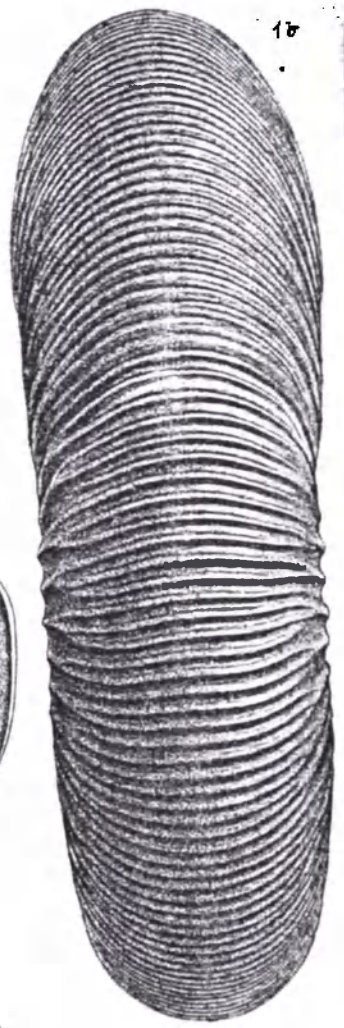
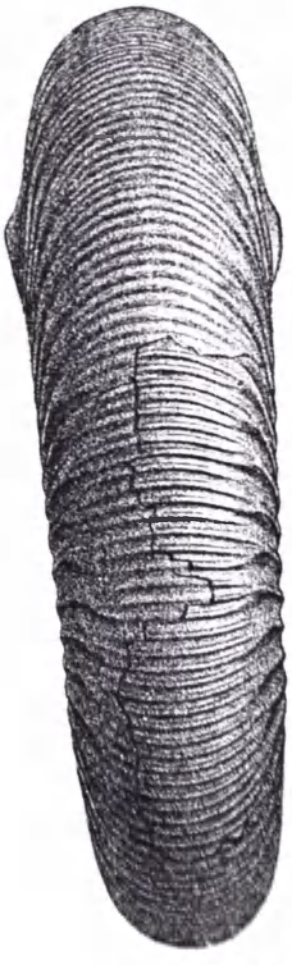


1d

2d

2c



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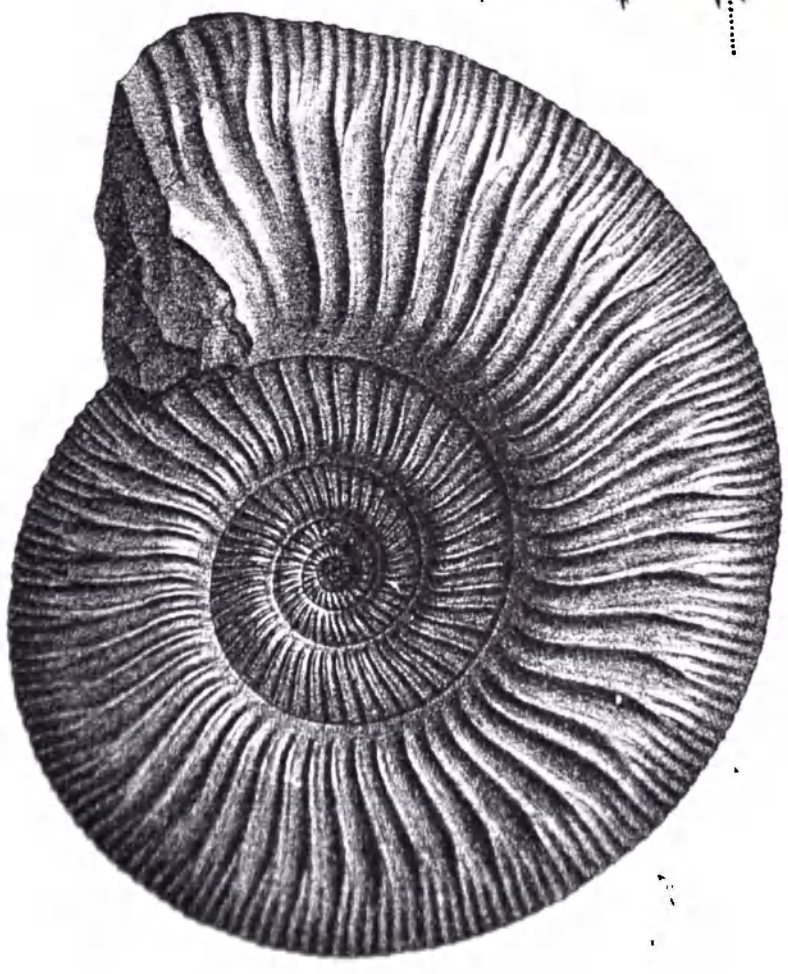


2b

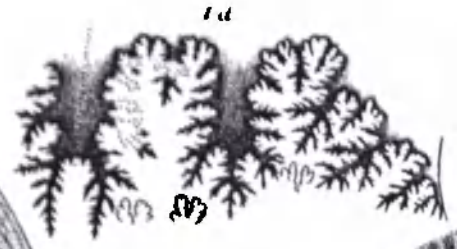
W. Mayes del. et lith.

Albert Berger print

PLATE L.

Fig. 1 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) RAJA n. sp.
Page 316. Internal cast. Natural size. 1*a*, Lateral view. The last whorl belongs almost entirely to the body-chamber. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Chidamu.

1a



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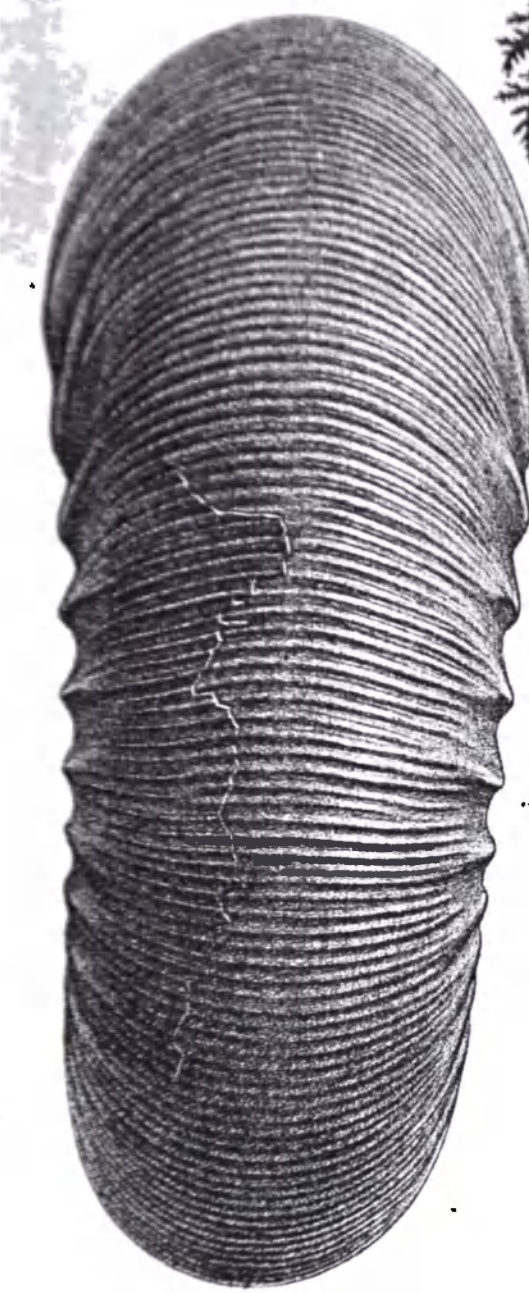

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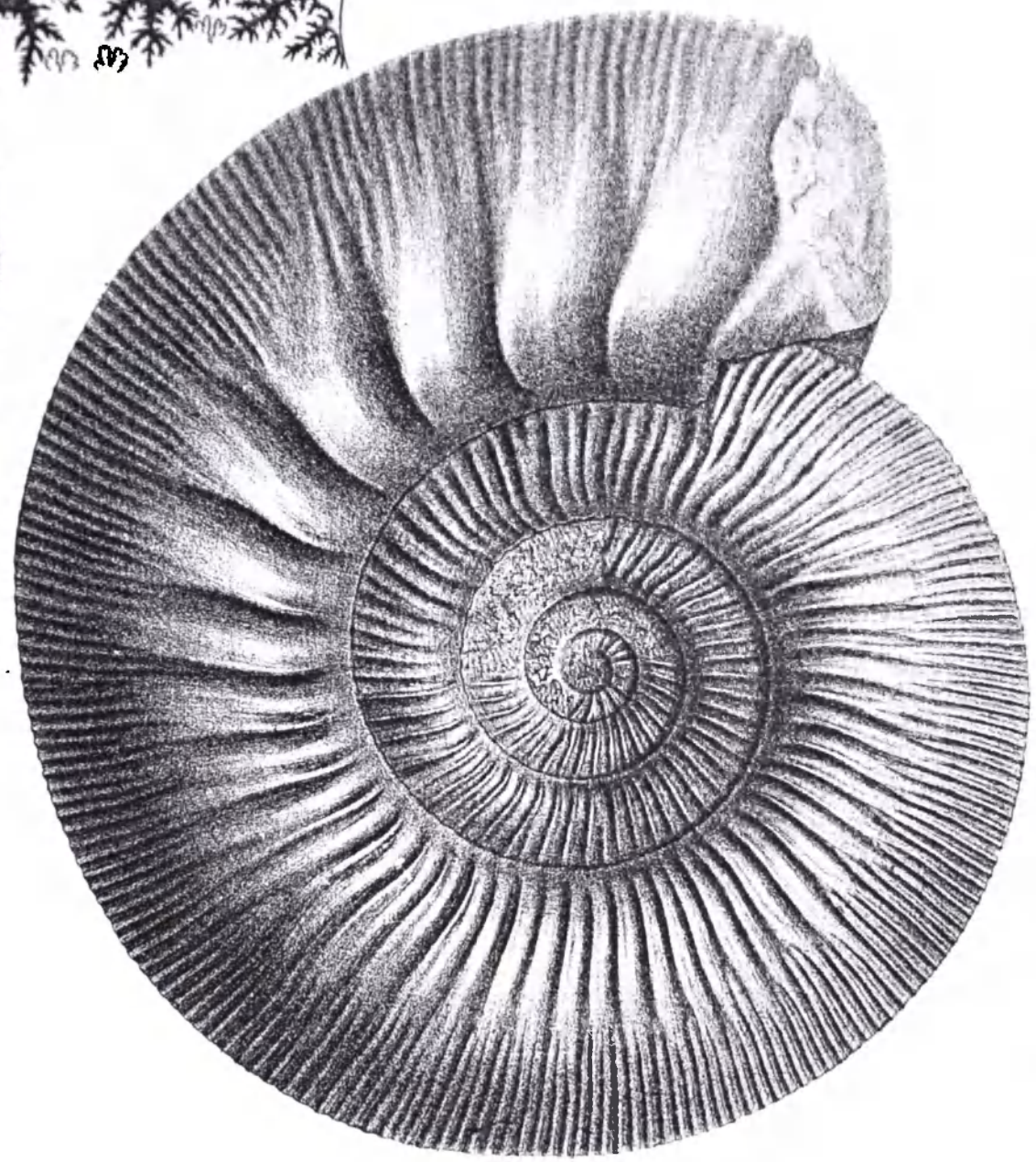

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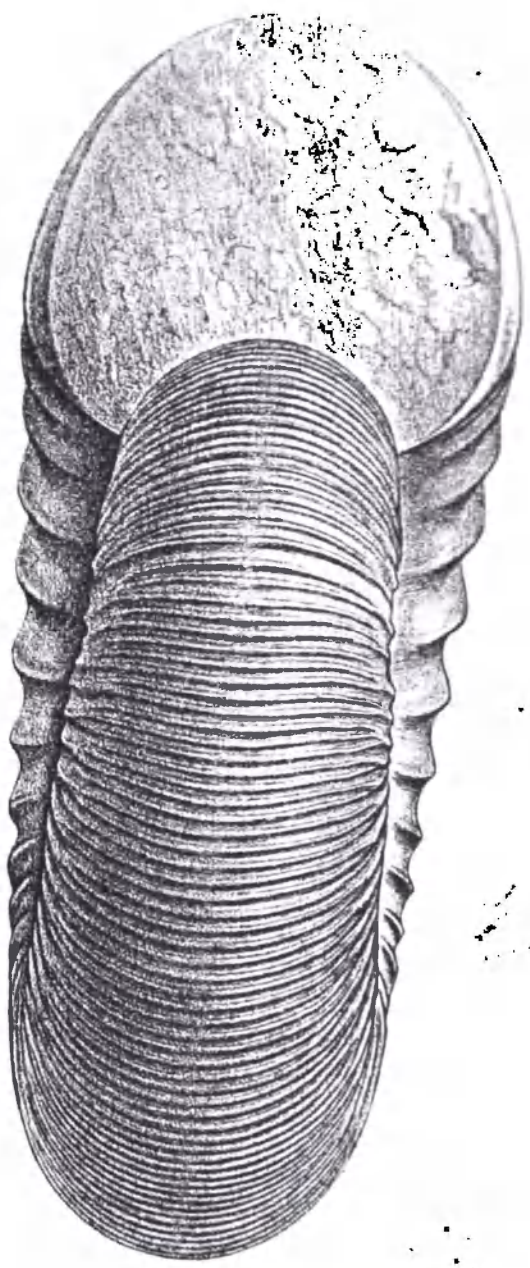


R. Meyer del. et lith.

Albert Berger phot.

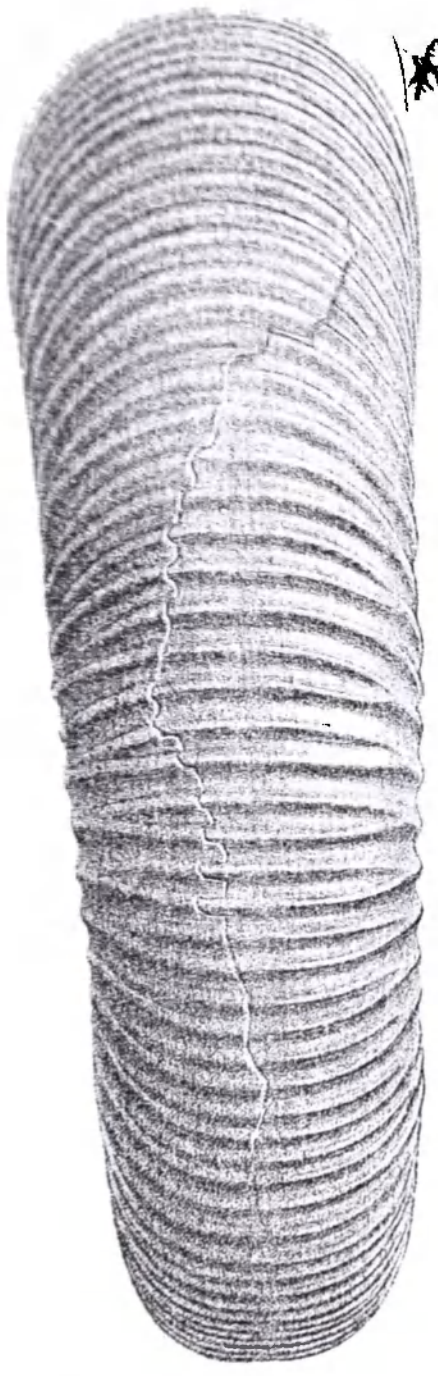
PLATE LI.

Fig. 1 *a*—*d*. PERISPHINCTES (~~AULACOSPHINCTES~~) OPHIDOIDES n. sp.

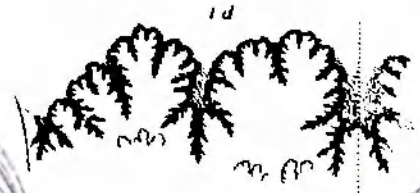
Page 363. Specimen with part of the body-chamber preserved, and the shell partly adhering. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. Chidamu, Chidamu-beds.

JURASSIC FOSSILS (HIMALAYA).

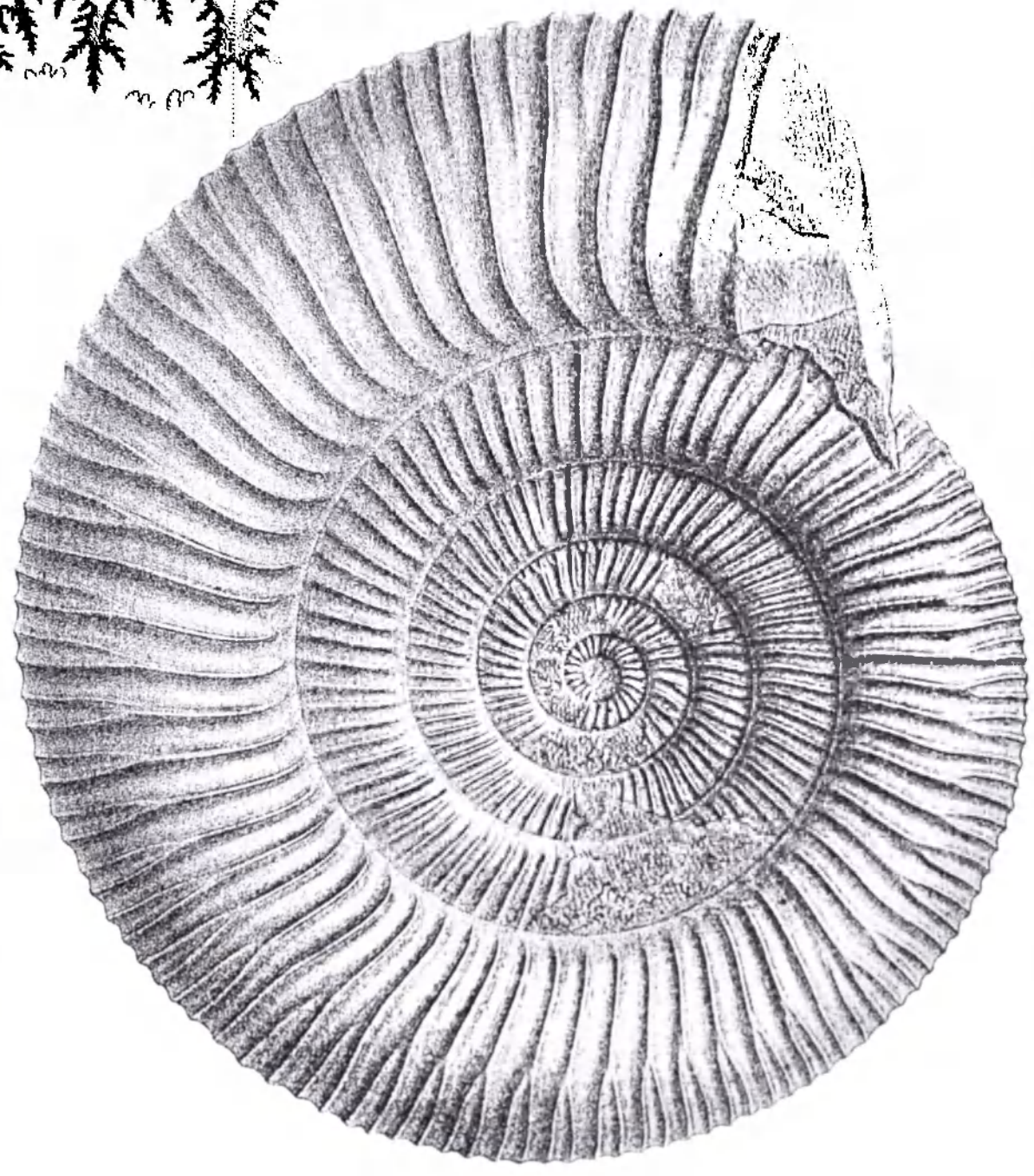
1c



1d



1a



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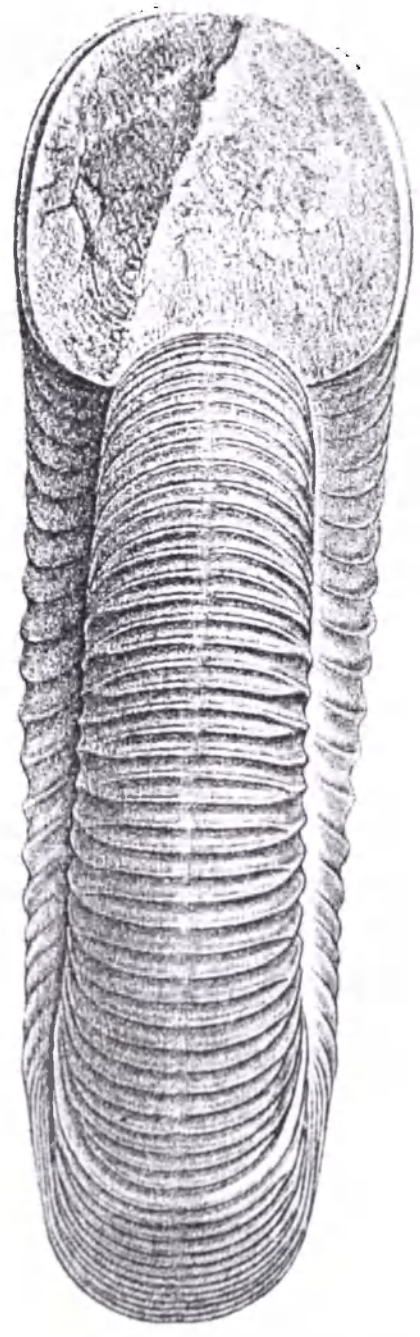


R. Mayer del. et. lith.

Albert Berger print.

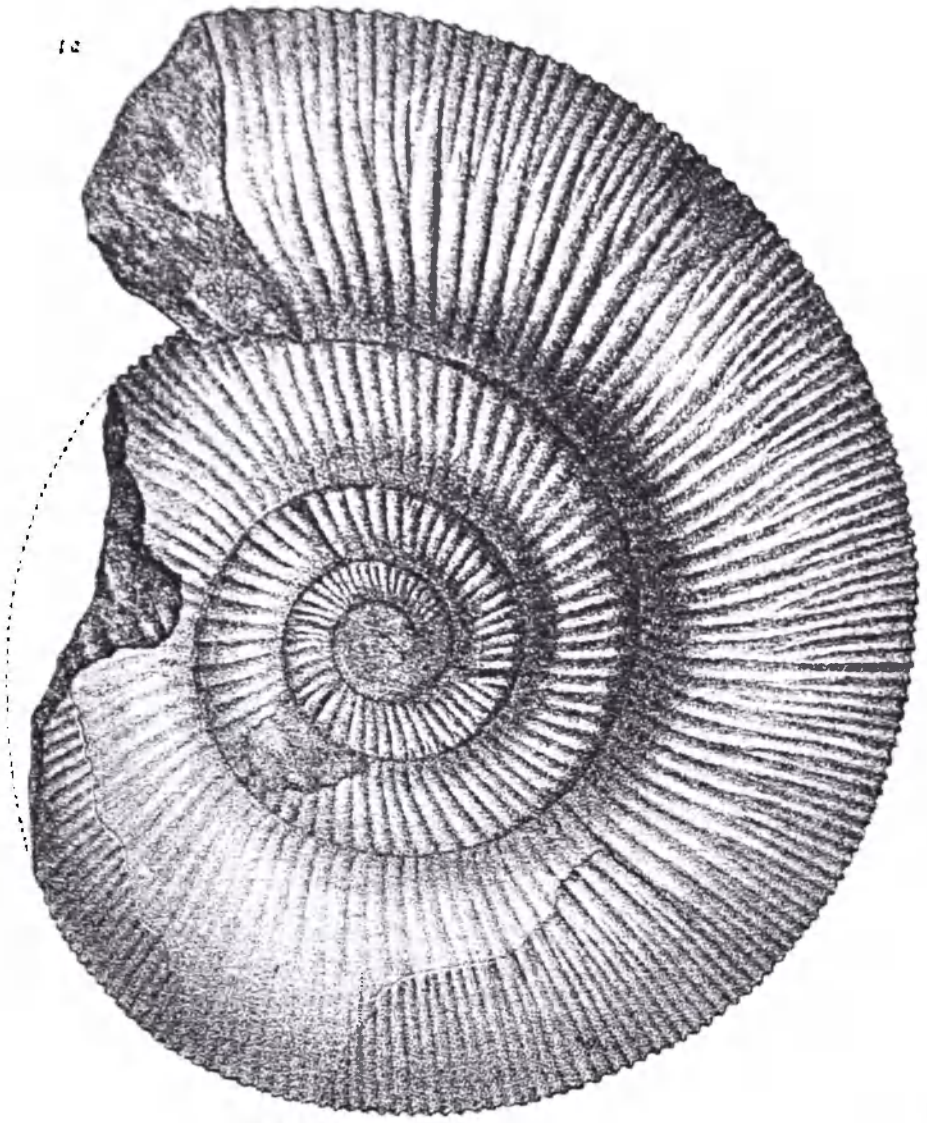
PLATE LII.

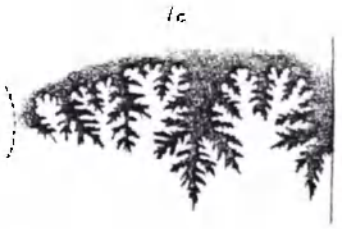
Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) ROTUNDIDOMA n. sp.

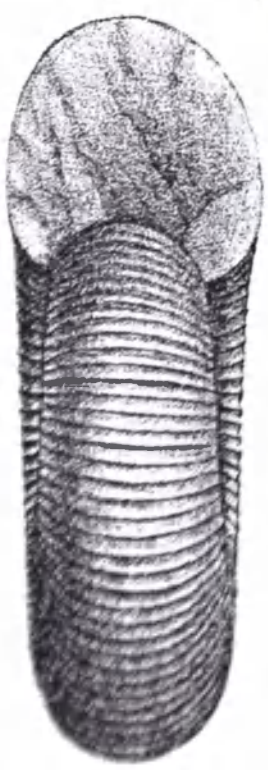
Page 318. Internal cast. Natural size. 1*a*. Lateral view. Two-thirds of the last whorl belong to the body-chamber. It is not quite certain whether the anterior margin represents the aperture. 1*b*. Apertural view. 1*c*, Suture. The external periphery of this specimen is represented in pl. LIII, fig. 1. Chidamu, Chidamu-beds.

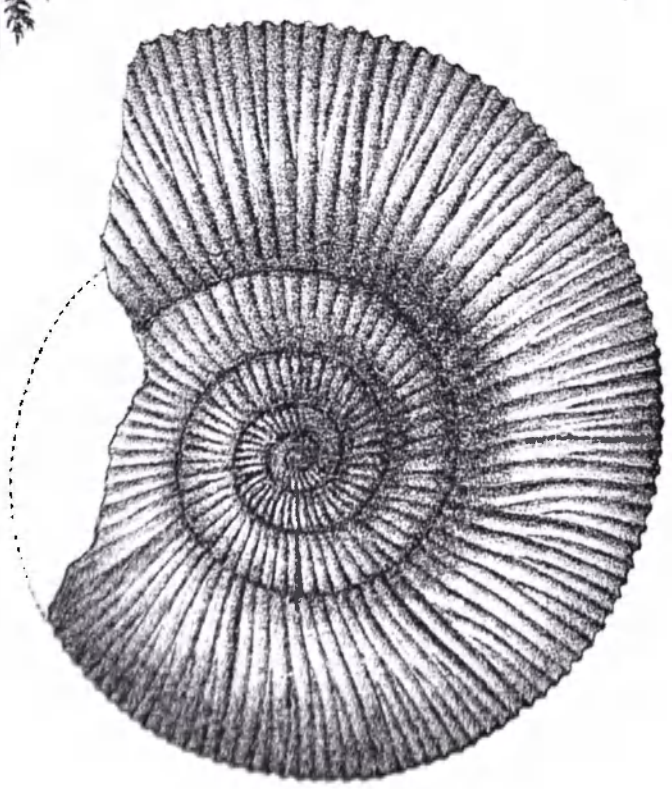
Fig. 2 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) SERPENTINUS n. sp.

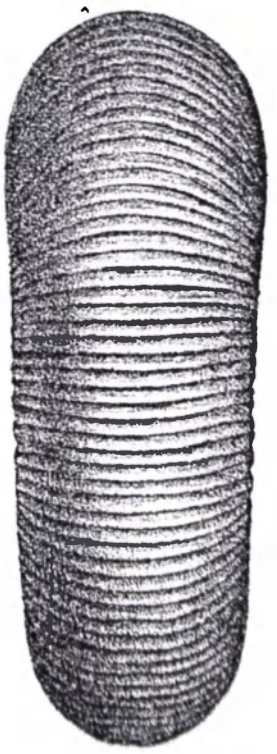
Page 322. Internal cast. Natural size. 2*a*. Lateral view. Two-thirds of the last whorl belong to the body-chamber. 2*b*. Apertural view. The breadth of the aperture as shown by the artist is 3·5 mm. too narrow. 2*c*, View of the external periphery. 2*d*. Suture. Spiti Valley.











Albert Berger print.

PLATE LIII.

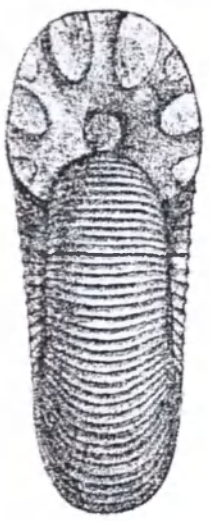
Fig. 1. PERISPHINCTES (VIRGATOSPHINCTES?) ROTUNDIDOMA n. sp.
Page 318. View of the external periphery of the specimen figured on pl. LII, fig. 1 *a—c*. From Chidamu, Chidamu-beds.

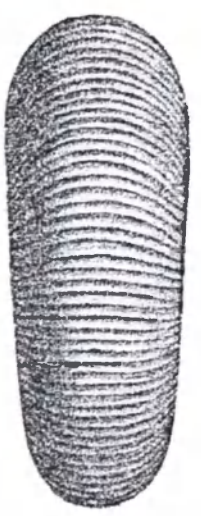
Fig. 2. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. View of the external periphery of the specimen figured on pl. LIV, fig. 1. Shalshal, 2nd Stage (Chidamu-beds).

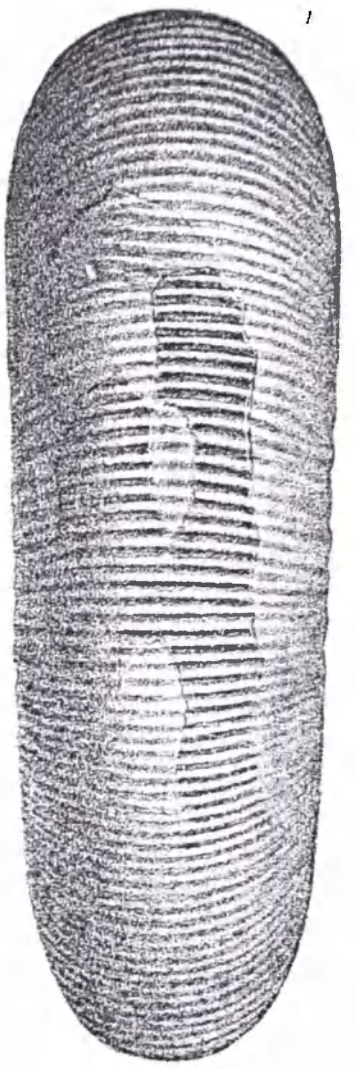
Fig. 3 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. Internal cast. Natural size. 3*a*, Lateral view. 3*b*. Apertural view. 3*c*, View of the external periphery. 3*d*, Suture. Compare with plates LIV, LV and LVI. From Spiti.

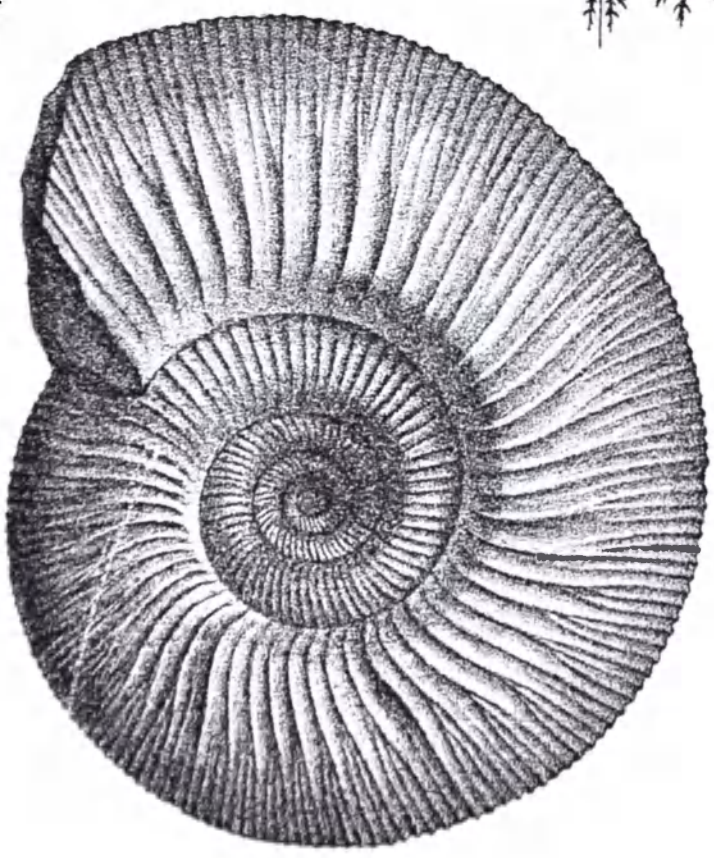
Fig. 4 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) KRAFFTI n. sp.
Page 335. Internal cast. Natural size. Variety with narrow umbilicus. 4*a*, Lateral view. The body-chamber takes up nearly the whole of the last whorl. 4*b*, Apertural view. 4*c*, View of the external periphery. 4*d*, Suture. The representation of the suture line is not quite correct. Compare with pl. LXII, figs. 1 *a*, *b*, 2 *a—c*. From Chidamu (Chidamu-beds).

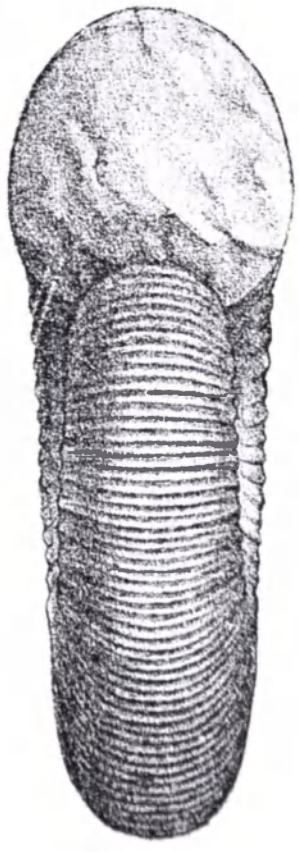
JURASSIC FOSSILS (HIMALAYA).











Albert Berger print

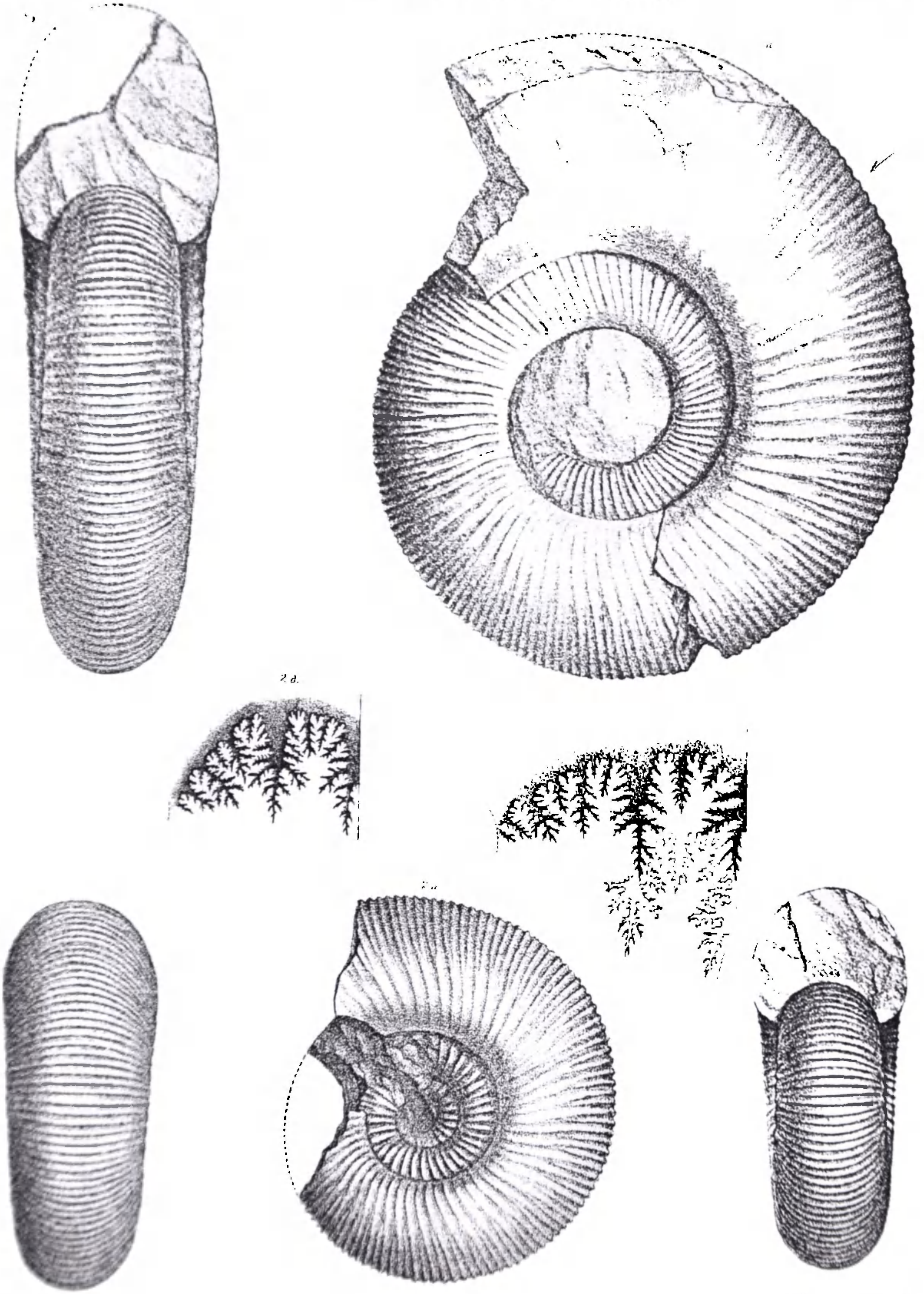
PLATE LIV.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.

Page 313. Internal cast. Natural size. 1*a*, Lateral view. The anterior quarter of the last whorl belongs to the body-chamber. 1*b*, Apertural view. 1*c*, Suture. A view of the external periphery is shown on pl. LIII, fig. 1. Compare also pl. LV, fig. 1, and pl. LVI, fig. 1. From Shalshal, 2nd Stage (Chidamu-beds).

Fig. 2 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) SIMILIS n. sp.

Page 322. Internal cast, chambered up to the end. Natural size. 2*a*, Lateral view. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. From Spiti.



Albert Berger print.

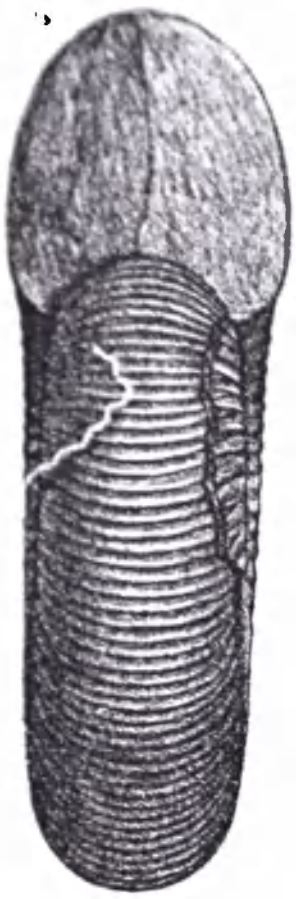
PLATE LV.

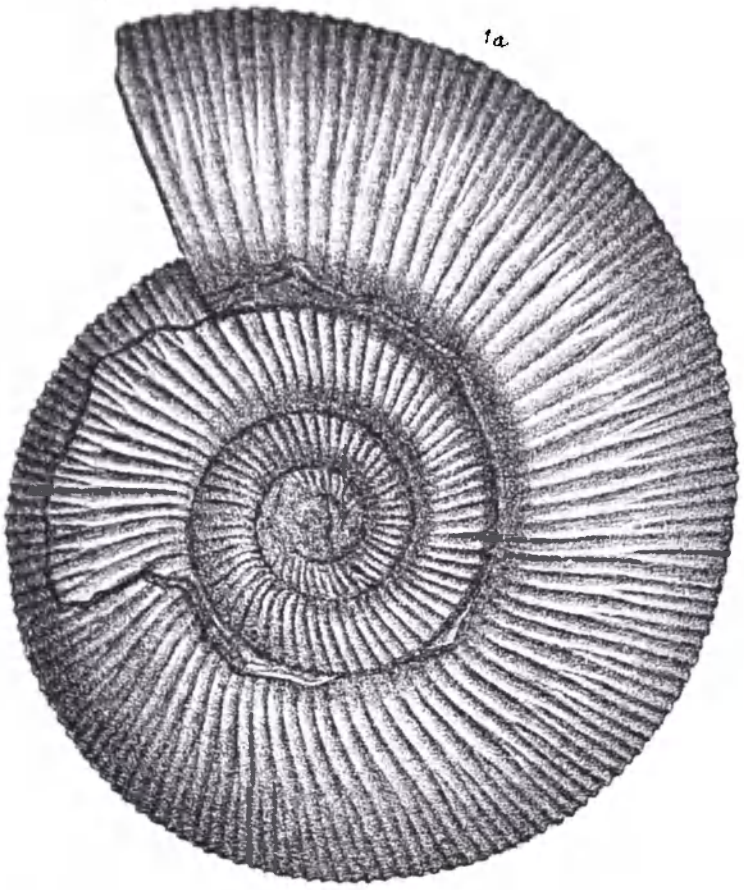
Fig. 1 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. Internal cast. Natural size. 1*a*, Lateral view. The body-chamber begins at the end of the last whorl. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. (See pl. LIII, fig. 1, pl. LIV, fig. 1, and pl. LVI, fig. 1.) From Shalshal, Chidamu-beds.

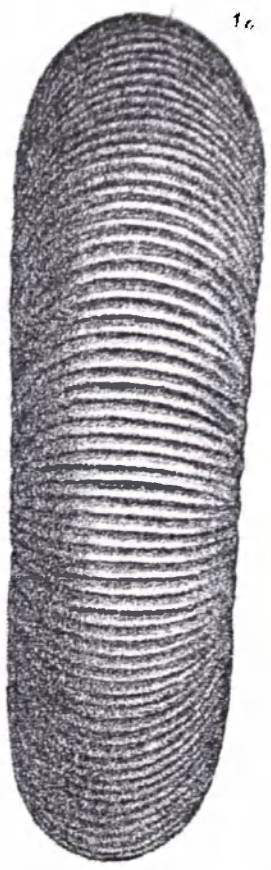
Fig. 2 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. Specimen with the shell partly adhering. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Apertural view. 2*d*, Sutures. The stem of the first lateral lobe as represented is somewhat too broad. From Laptal, Hundes.

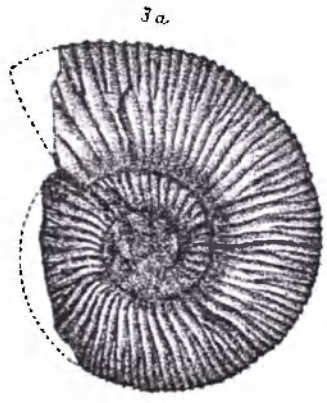
Fig. 3 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. Internal whorls, with deep constrictions. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Apertural view. 3*d*, Suture. From Shalshal, Chidamu-beds.

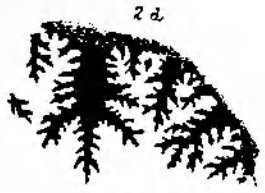
JURASSIC FOSSILS (HIMALAYA).

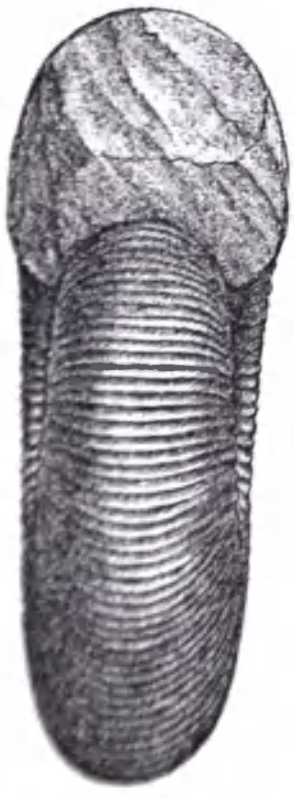


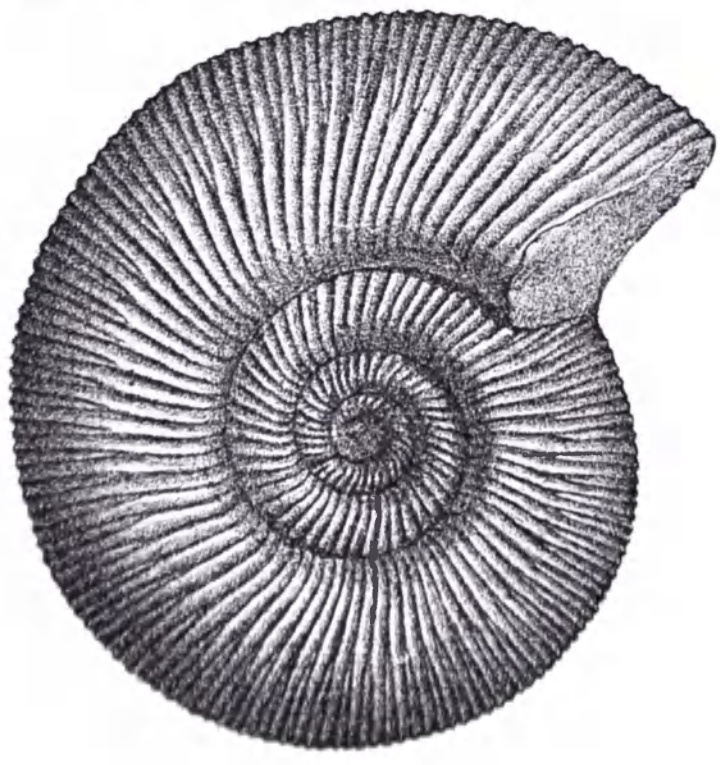












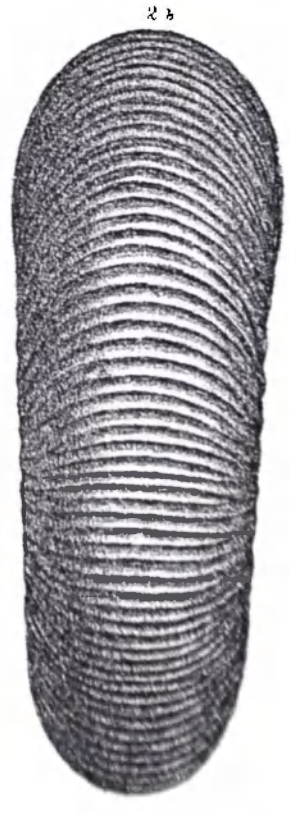
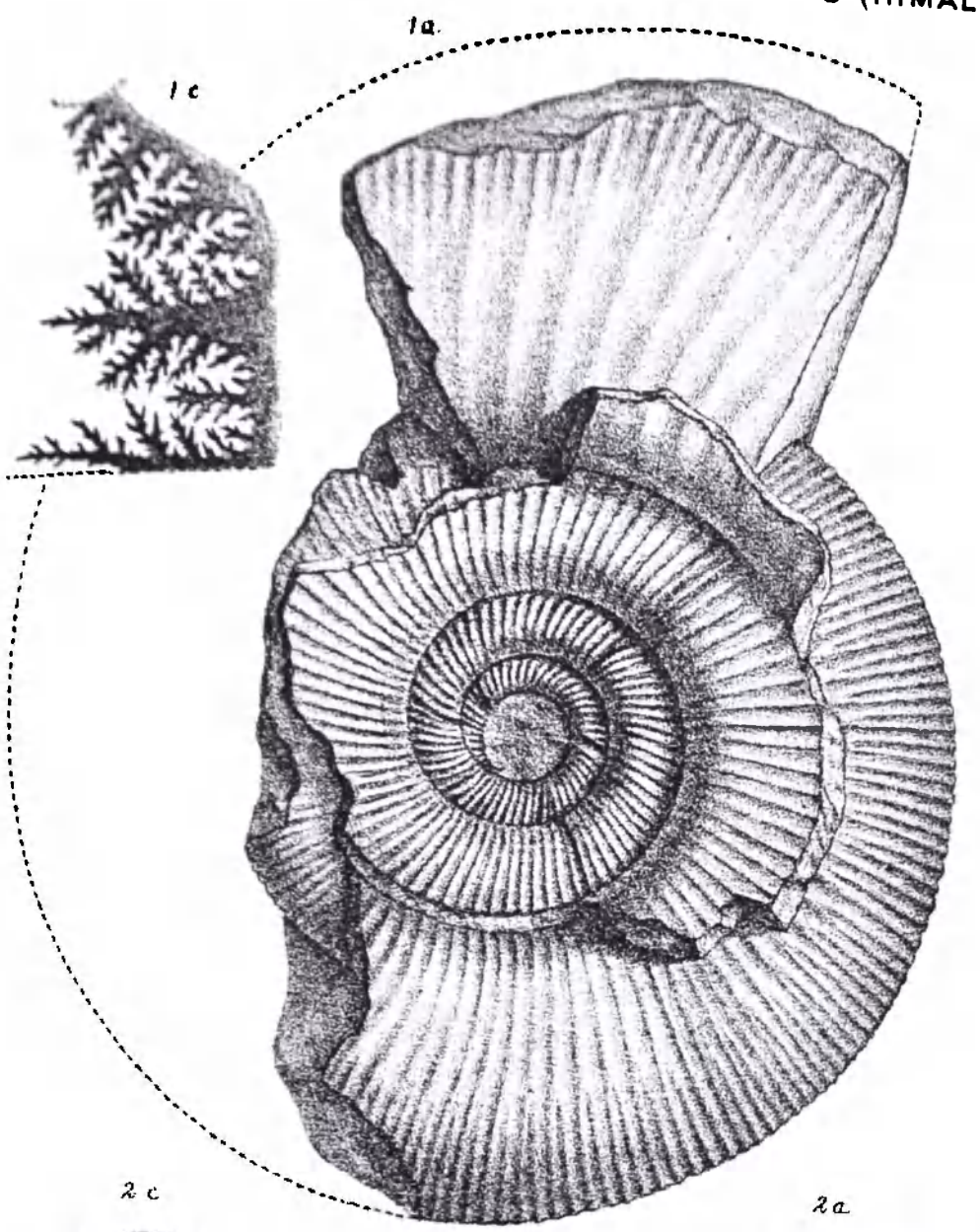


PLATE LVI.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) DENSEPLICATUS Waagen.
Page 313. Internal cast. Natural size. 1*a*, Lateral view. The greater part of the last whorl belongs to the body-chamber. 1*b*, Apertural view. 1*c*, Suture. See pl. LIV, fig. 1, and pl. LV, fig. 1. From Sirkia, South Hundes.

Fig. 2 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) MINUSCULUS n. sp.
Page 317. Internal cast. Natural size. 2*a*, Lateral view. The last whorl belongs to the body-chamber. 2*b*, Apertural view. 2*c*, View of the external periphery. Spiti Shales.

JURASSIC FOSSILS (HIMALAYA).



Lith. Swoboda del. et lith.

Albert Berger print.

PLATE LVII.

Fig. 1 *a*—*c*. PERISPHINCTES BIPLICATUS n. sp.

Page 379. Internal cast. Natural size. 1*a*, Lateral view. The last whorl belongs to the body-chamber. 1*b*, Cross-section. 1*c*, View of the external periphery. See also pl. LIX, fig. 1 *a*—*c*. Spiti shales, Kibber.

Fig. 2 *a*—*d*. PERISPHINCTES BIPLICATUS n. sp.

Page 379. Internal cast. Natural size. 2*a*, Lateral view. Two-thirds of the last whorl belong to the body-chamber. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. Spiti shales, Kibber.

Fig. 3. PERISPHINCTES *cf.* BIPLICATUS n. sp.

Page 380. Suture of a badly preserved specimen. Natural size. Spiti shales.

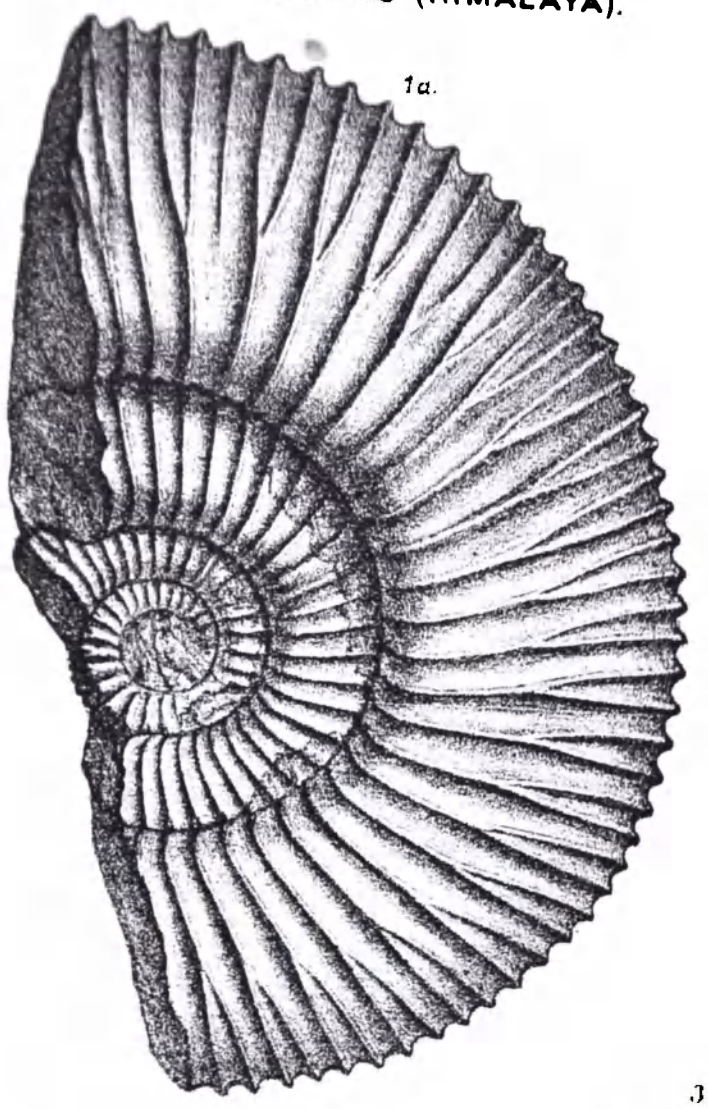
Geol. Surv. of India.

JURASSIC FOSSILS (HIMALAYA).

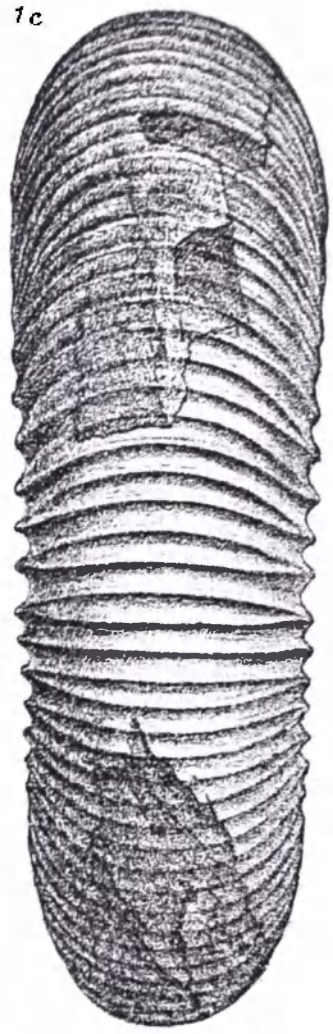
Pl. LVII.

1b

1a.



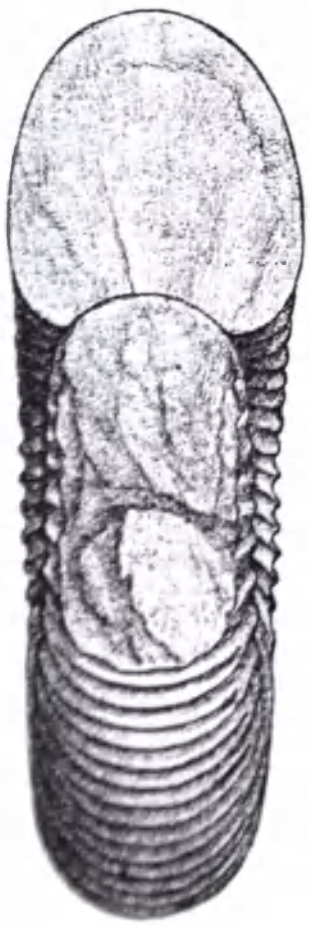
1c



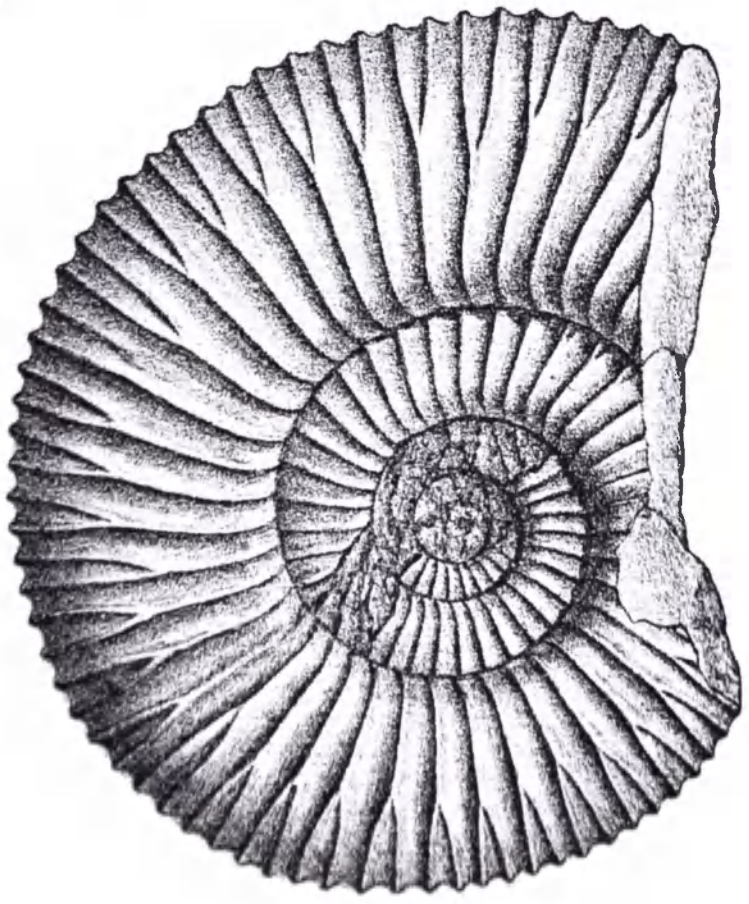
3

2d

2b



2a.



2c

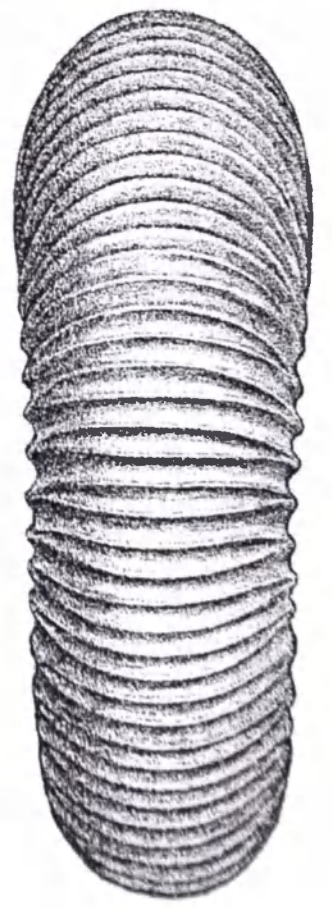


PLATE LVIII.

Fig. 1 *a*—*c*. HOLCOSTEPHANUS (SPITICERAS) OPPELI n. sp.
Page 121. Chambered nucleus. 1*a*, Side view. 1*b*, Apertural view. 1*c*, Suture. Spiti shales, exact locality not known. Schlagintweit Collection, Munich.

Fig. 2 *a*—*c*. HOLCOSTEPHANUS (SPITICERAS) SCRIPTUS Strachey-Blanford.
Page 112. 2*a*, Lateral view. 2*b*, Cross-section. 2*c*, Sture. The figures are drawn after a plaster-cast of Blandford's type specimen, illustrated in the Palæontology of Niti, pl. 16, fig. 2 *a*—*c*. Spiti shales of Niti, exact locality not known.

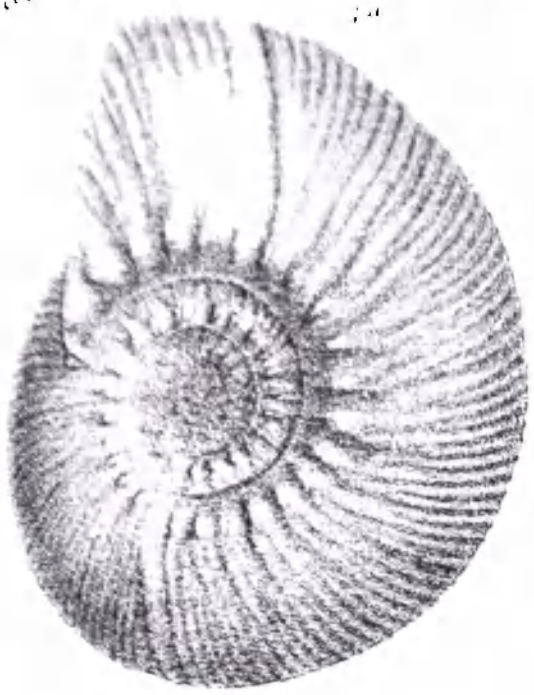
Fig. 3 *a*, *b*. HECTICOCERAS KOBELLI Oppel sp.
Page 25. 3*a*, Lateral view. 3*b*, View of the external periphery. Drawn after a plaster cast of Oppel's type specimen, illustrated in "Palaeontologische Mitteilungen," Vol. II, pl. 76, fig. 1*a*, 1*c*. From Shangra, Gnari Khorsum. Schlagintweit Collection, Munich.

Fig. 4 *a*—*d*. HECTICOCERAS KOBELLI Oppel sp.
Page 25. Chambered nucleus. Natural size. 4*a*, Lateral view. 4*b*, Apertural view. 4*c*, View of the external periphery. 4*d*, Suture. This is Oppel's type specimen, illustrated in the "Palæontologische Mitteilungen," Vol. II, pl. 76, fig. 2 *a*, *b*. From Spiti shales. Schlagintweit Collection. Munich.

Fig. 5 *a*—*d*. HECTICOCERAS sp. nov. ind.
Page 29. Fragment of the internal volution. Natural size. 5*a*, Lateral view. 5*b*, Cross-section 5*c*, View of the external periphery. 5*d*, Suture. From Sirkia, S. Hundes.

Fig. 6 *a*, *b*. HOPLITES (NEOCOMITES) NIKITINI n. sp.
Page 255. Body-chamber showing the upper portion of the apertural margin. Natural size. 6*a*, Lateral view. 6*b*, View of the external periphery. From Lochambelkichak, Lochambel-beds.

1a



1b

3a

3b

2a

2b

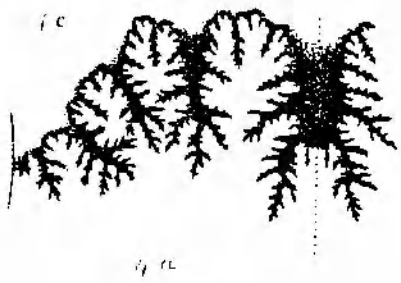
2c

5a

5b

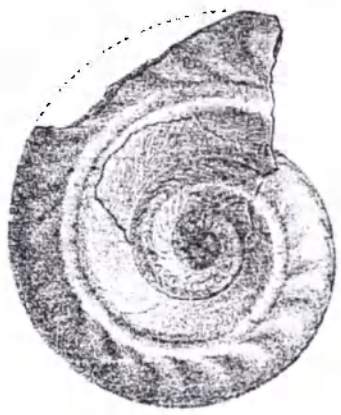
5c

4c



4d

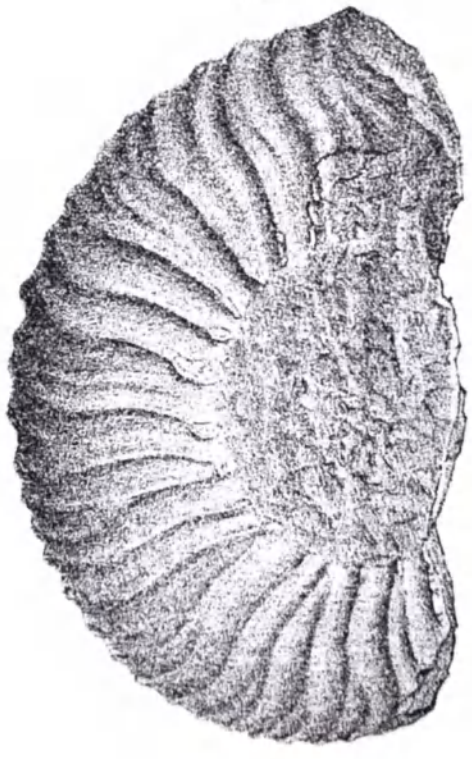
4a



4b

4e

6a



6b

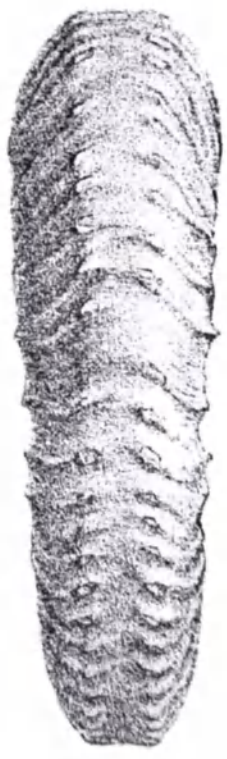


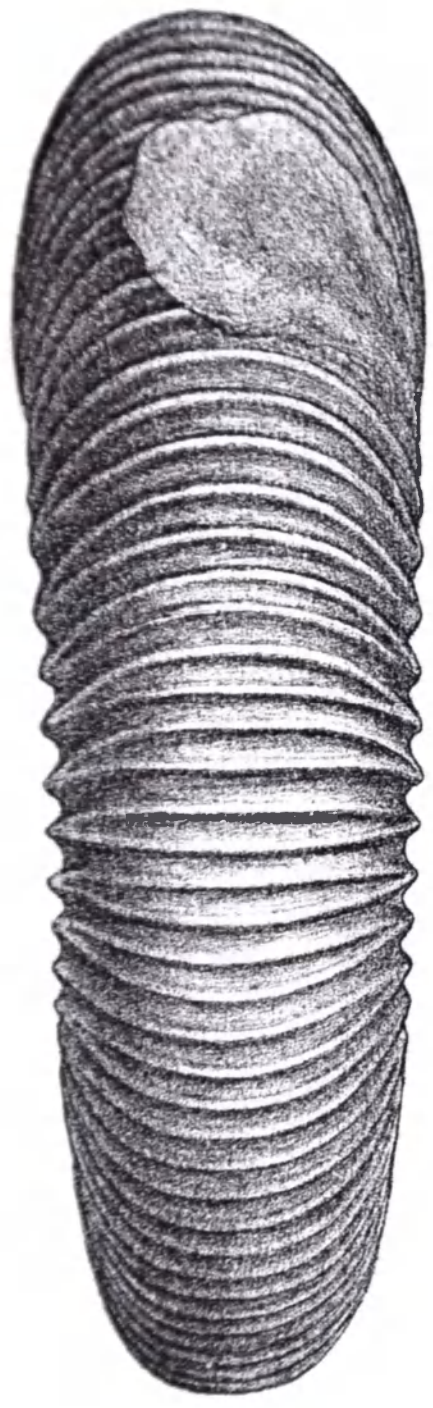
PLATE LIX.

a—*c*. PERISPHINCTES BIPLICATUS n. sp.

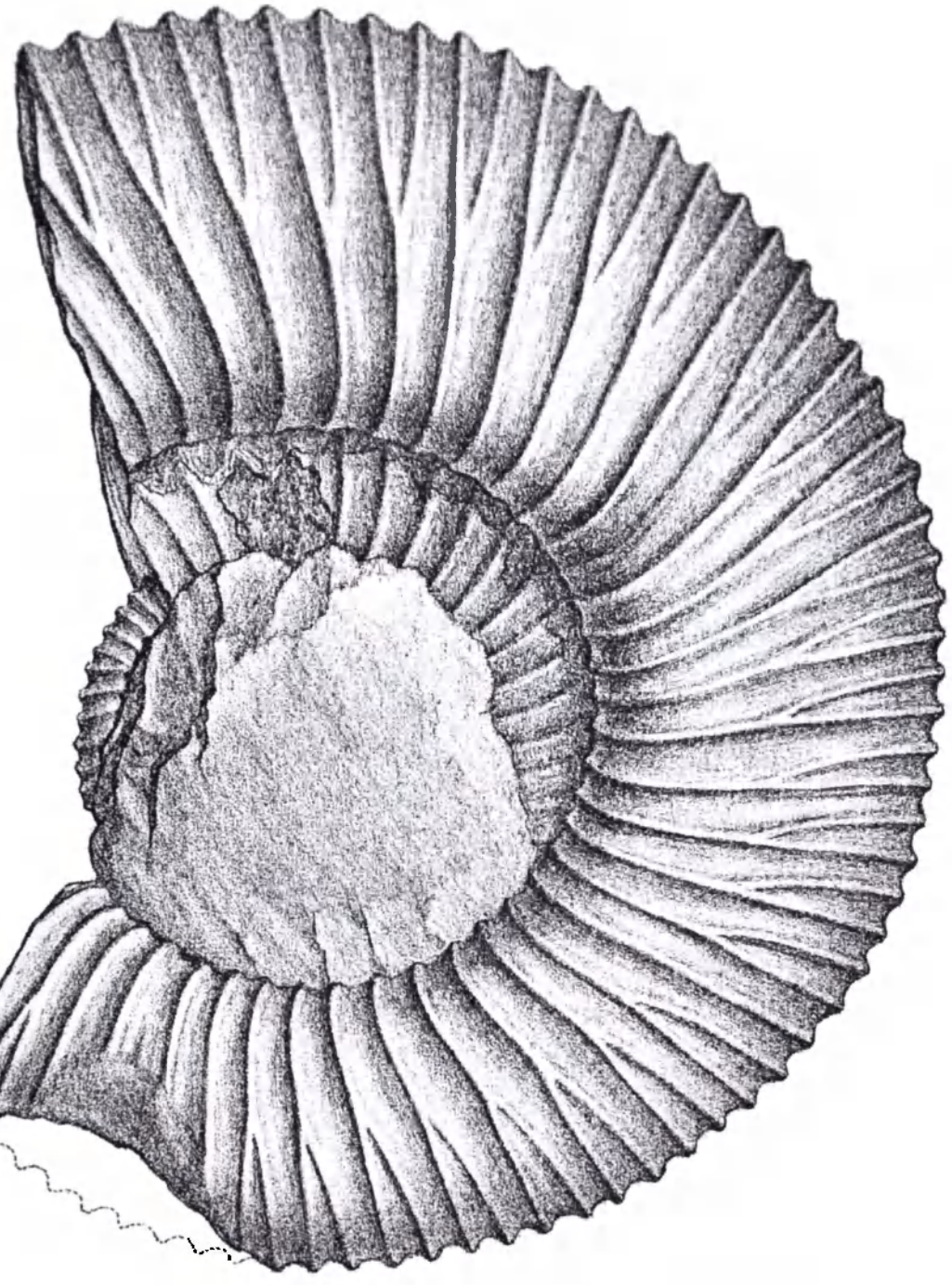
Page 379. Internal cast. Natural size. Half of the last whorl belongs to the body-chamber. 1*a*, Lateral view. 1*b*, Front view. 1*c*, View of the external periphery. See also pl. LVII, figs. 1—3. From Kibber.

JURASSIC FOSSILS (HIMALAYA).

1c



1a



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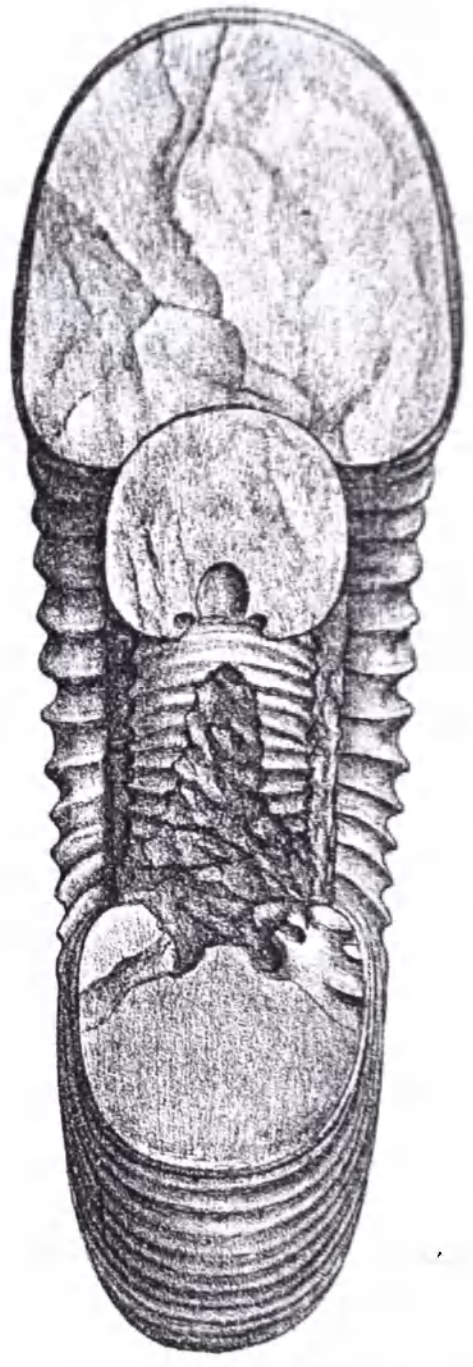


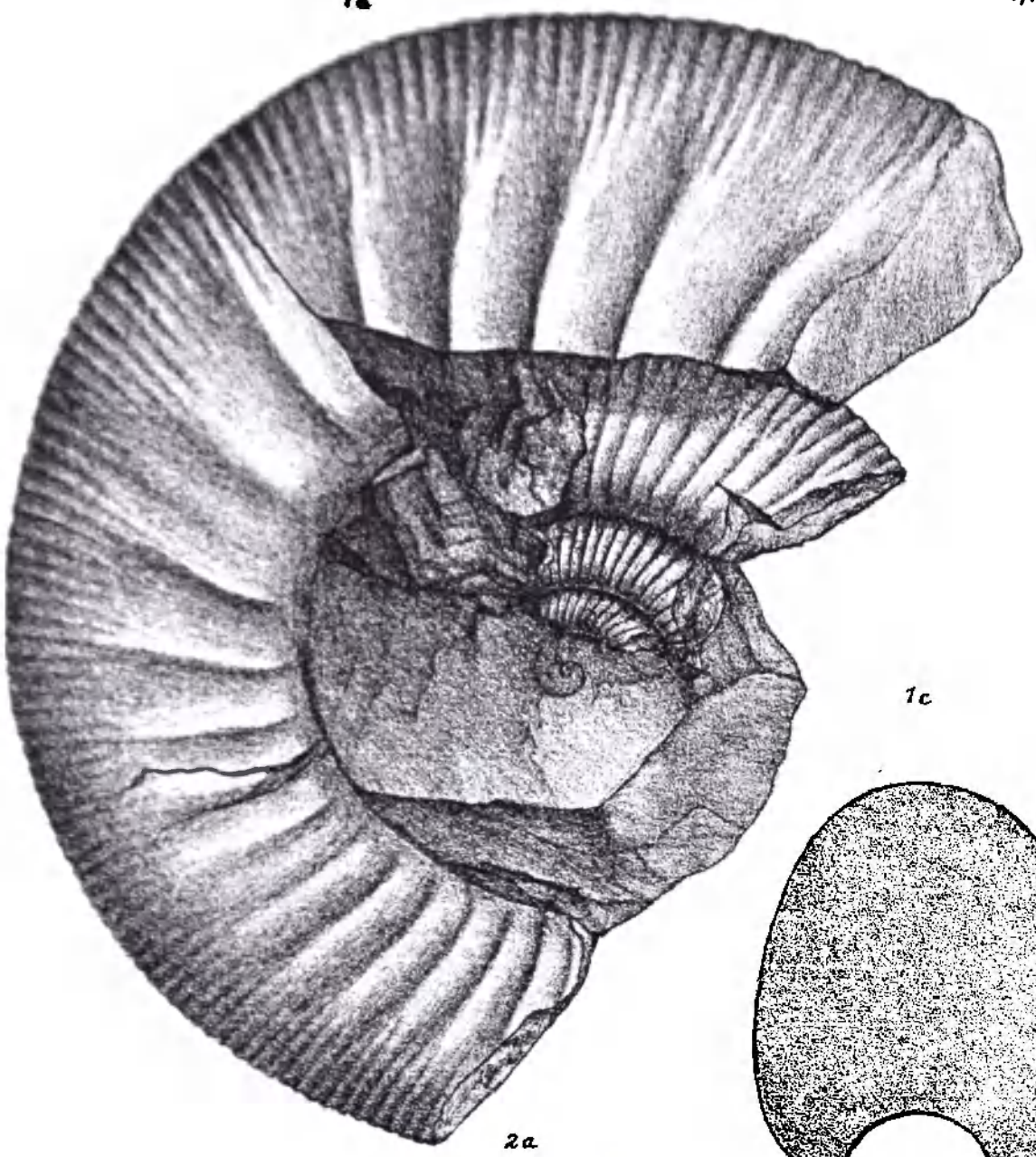
A. Swoboda del. et lith.

Albert Berger print.

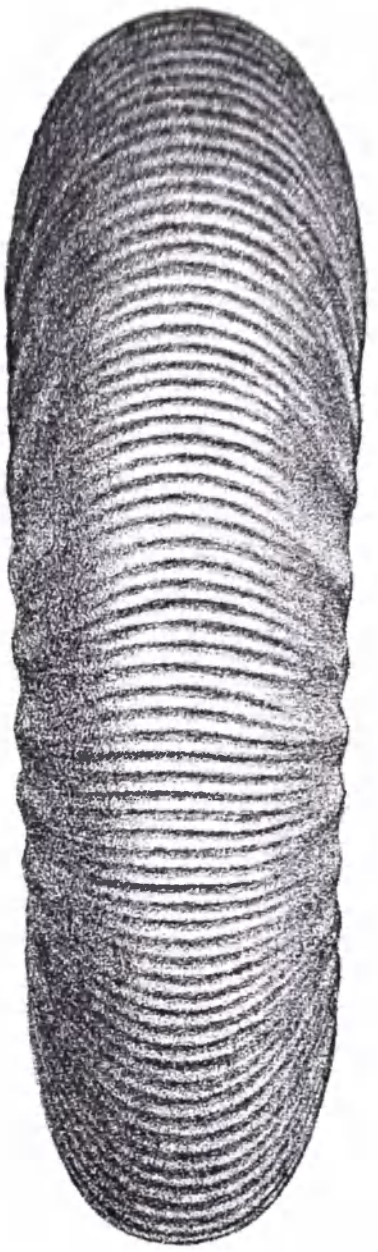
Fig. 1 *a—c*. PERISPHINCTES (VIRGATOSPHINCTES) MULTIFASCIATUS n. sp.
Page 333. Internal cast. Natural size. 1*a*, Lateral view. The last whorl as far as preserved, belongs to the body-chamber. 1*b*, View of the external periphery. 1*c*, Section of the body-chamber in outline. From Jandu, Sherik river, Hundes.

Fig. 2 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) KUTIANUS n. sp.
Page 329. Fragment of the body-chamber, with apertural margin. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, 2*d*, Sections of the body-chamber in outline. See also pl. LXXVI, fig. 1. From Laptal, Hundes.

1a



1b



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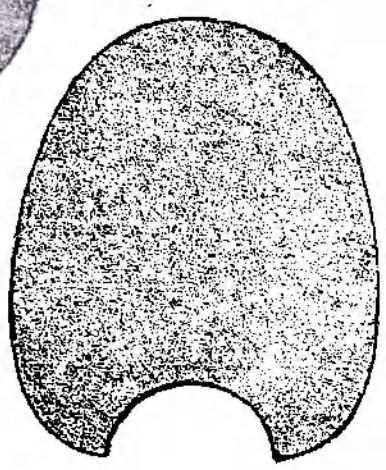

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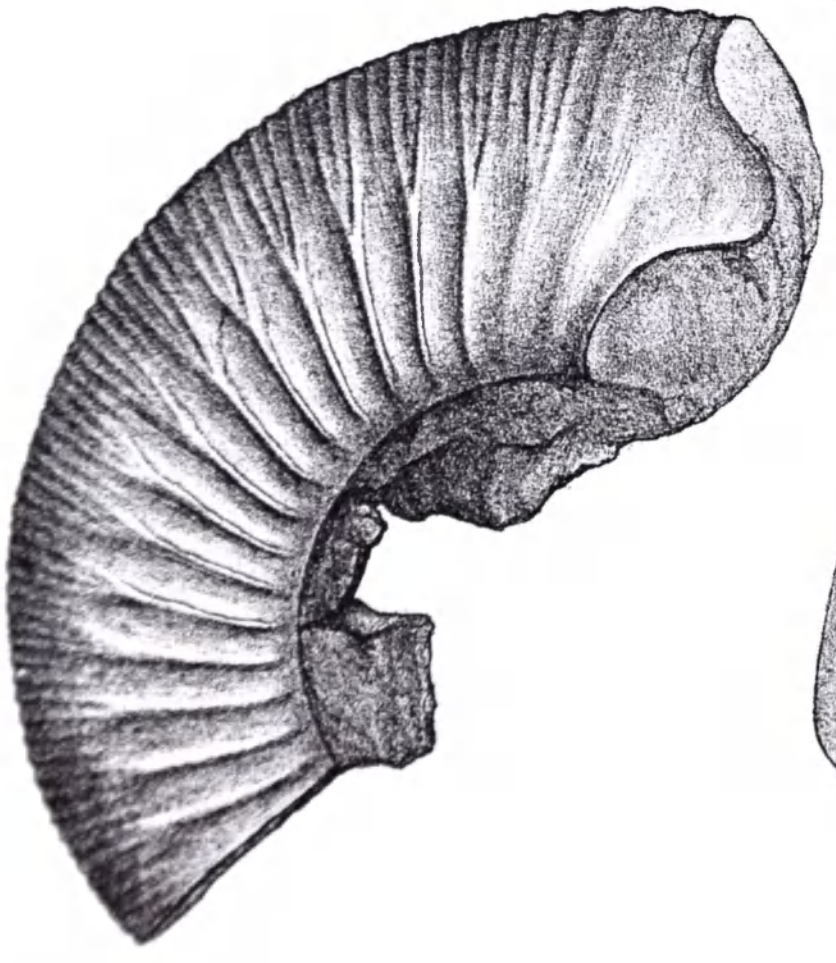
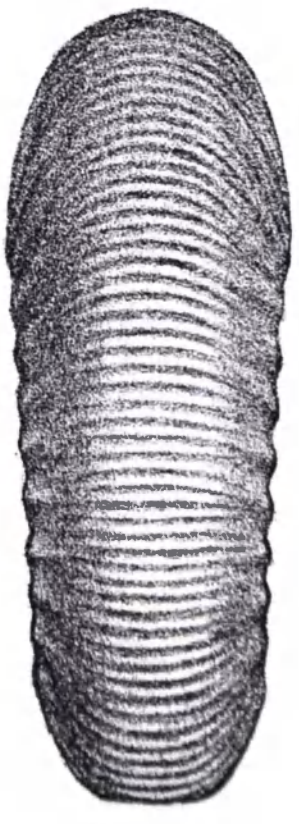


2d

2b



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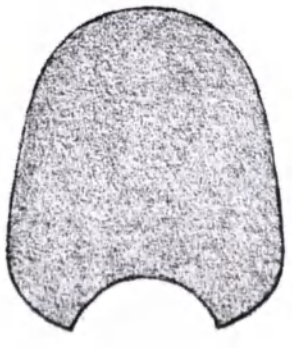


Swoboda del. et lith.

Albert Berger print.

PLATE LXI.

Fig. 1 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) SUBFREQUENS n. sp.
Page 327. Chambered nucleus. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Sutures. Compare with pl. XLIX, fig. 1 *a*—*d*. From Sirkia, Southern Hundes.

Fig. 2 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) HAYDENI n. sp.
Page 334. Internal cast. Natural size. 2*a*, Lateral view. About three-quarters of the last whorl belong to the body-chamber 2*b*, View of the external periphery. 2*c*, Cross-section of the posterior portion of the body-chamber. 2*d*, Cross-section of the anterior portion of the body-chamber. From Jandu, Sherik river, Hundes.

JURASSIC FOSSILS (HIMALAYA).

1b

1a

1c

1d

2a

2d

2b

2c

A Swynnerton del et lith.

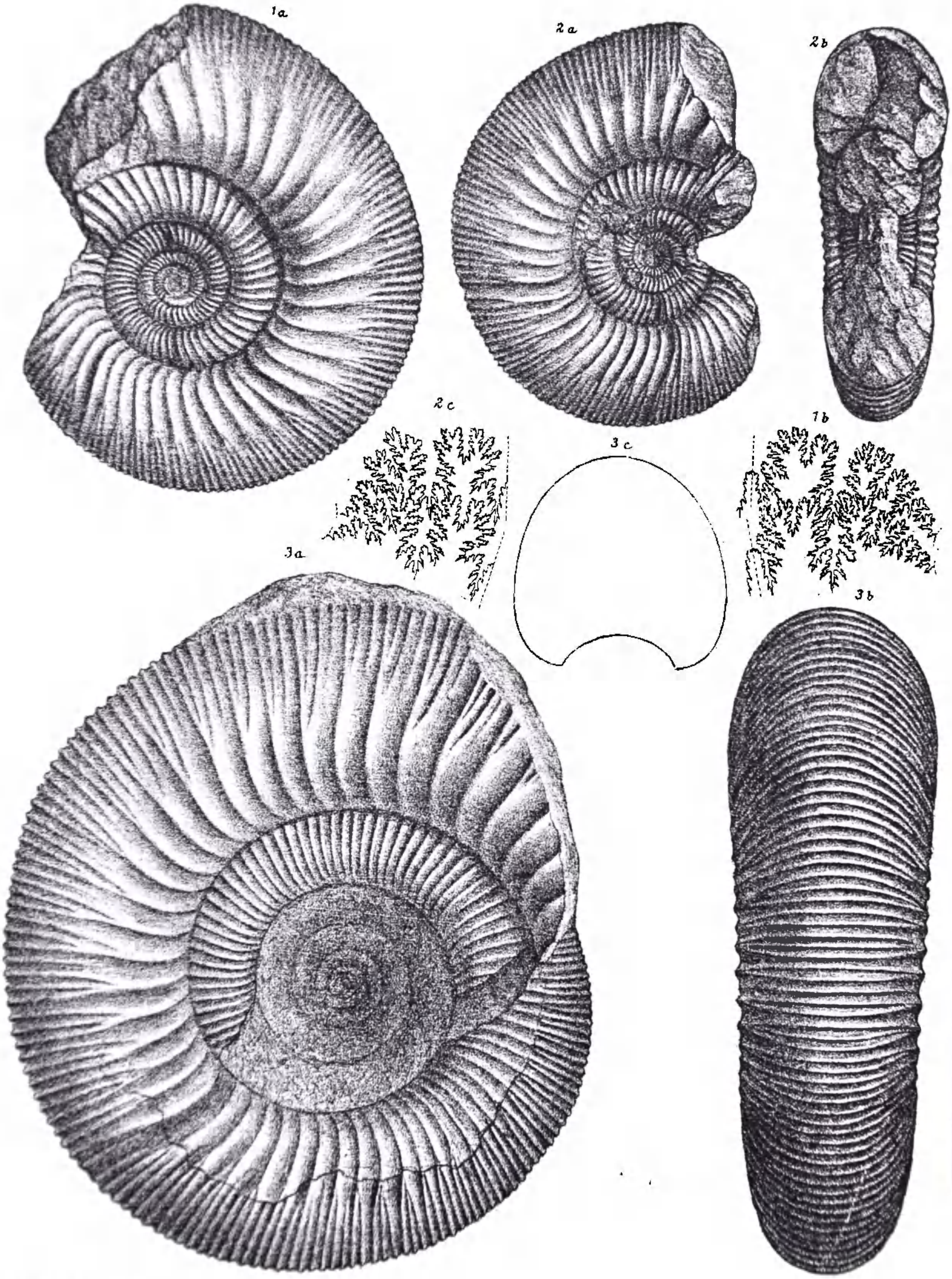
Albert Berger print.

PLATE LXII.

Fig. 1 *a*, *b*. PERISPHINCTES (VIRGATOSPHINCTES) KRAFFTI n. sp.
Page 335. Internal cast. Natural size. 1*a*, Lateral view. The body-chamber begins at the anterior portion of the last whorl. 1*b*, Suture. See also pl. LIII, fig. 4. From Sirkia, Southern Hundes.

Fig. 2 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) KRAFFTI n. sp.
Page 335. Internal cast. Natural size. 2*a*, Lateral view. The body-chamber begins at the anterior portion of the last whorl. 2*b*, Apertural view. 2*c*, Suture. From the Spiti Valley (?)

Fig. 3 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) BURCKHARDTI n. sp.
Page 332. Specimen with the shell partly adhering. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Cross-section of the anterior portion of the last whorl. From Tongtak.



A. Swoboda del et lith

Albert Berger print.

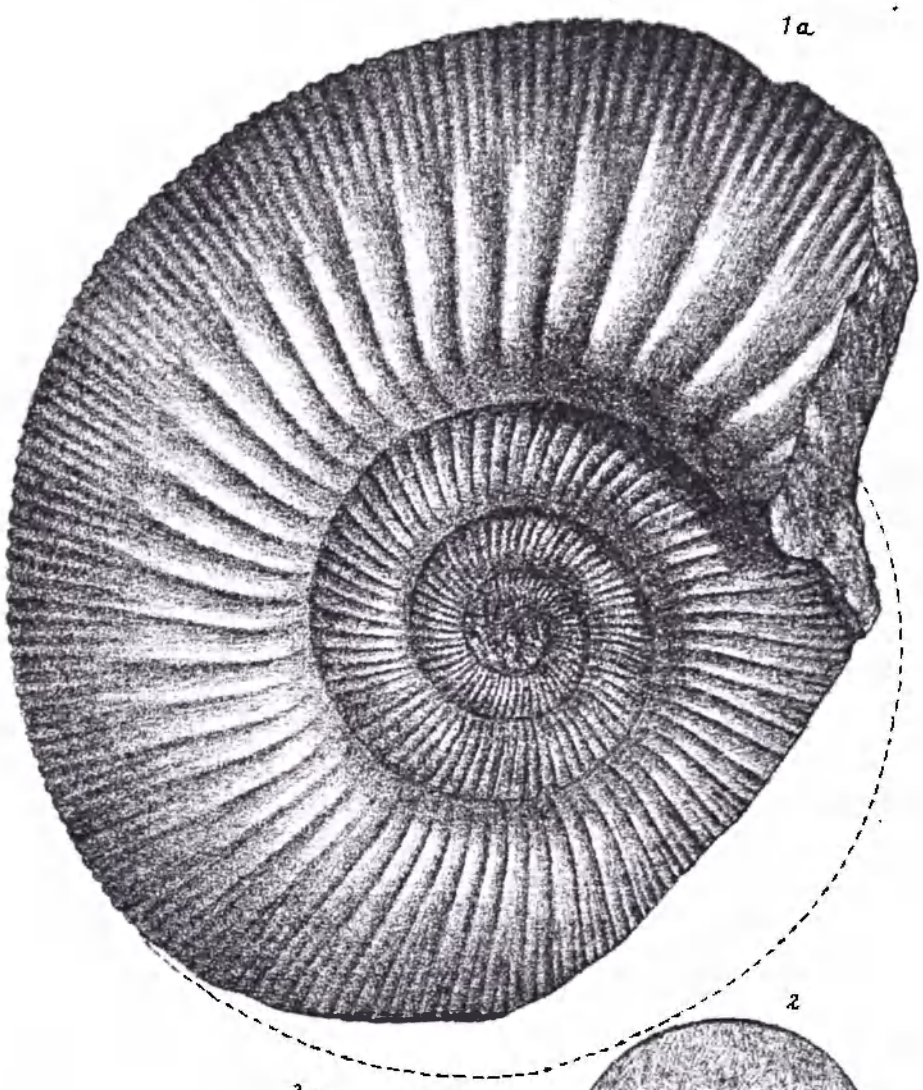
PLATE LXIII.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) FREQUENS Oppel sp.
Page 325. Chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 1*c*, Suture. See also pl. LXXV, fig. 1 *a*—*c* and pl. LXXV A, fig. 1. Spiti Valley.

Fig. 2. PERISPHINCTES (VIRGATOSPHINCTES) FREQUENS Oppel sp.
Page 325. Chambered nucleus. Natural size. Apertural view. Spiti Valley.

Fig. 3 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) FREQUENS Oppel sp., var. ANGUSTUMBILICATA.
Page 325. Internal cast. Natural size. 3*a*, Lateral view. The body-chamber commences at the anterior end of the whorl. 3*b*, View of the external periphery. 3*c*, Suture. From Chidamu, Chidamu-beds.


1b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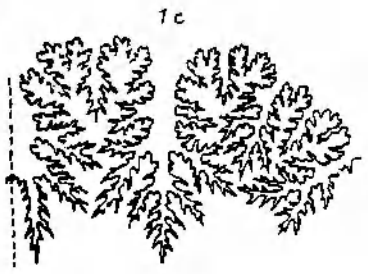
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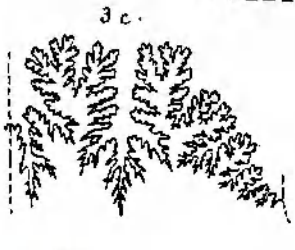
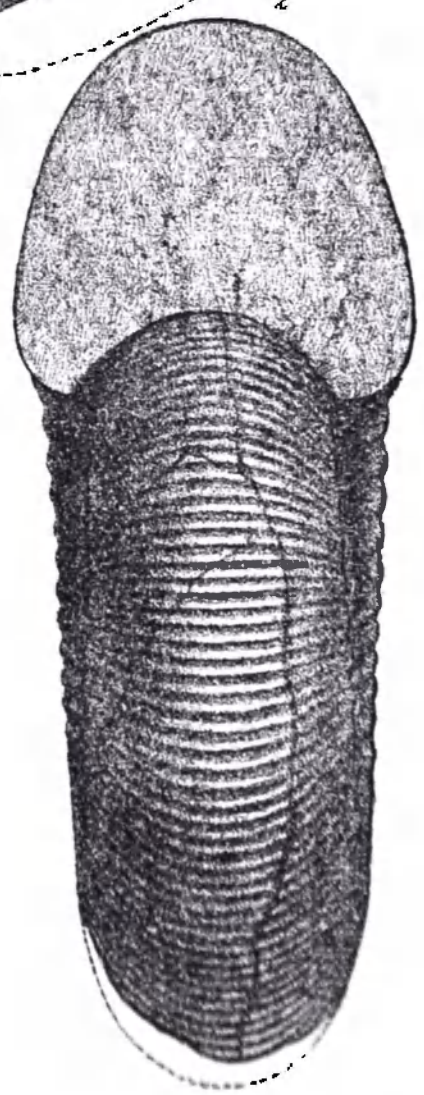
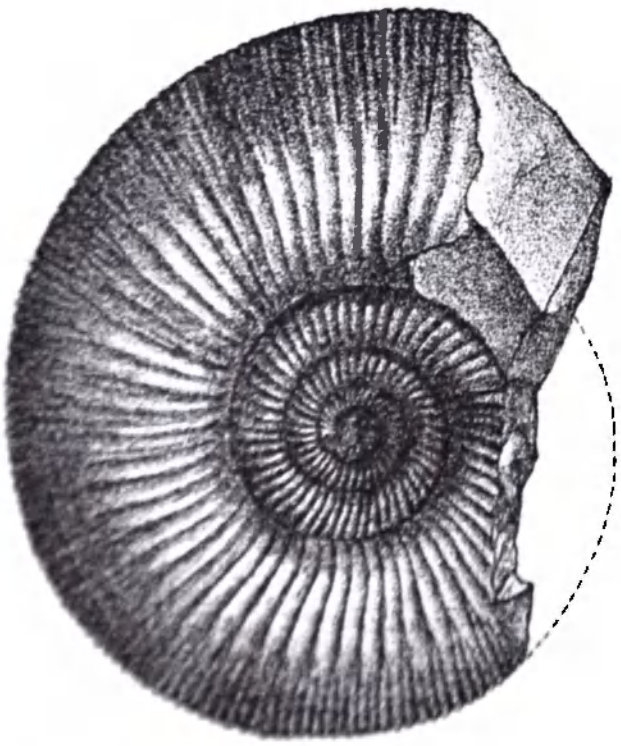

3c


2

3a



3b

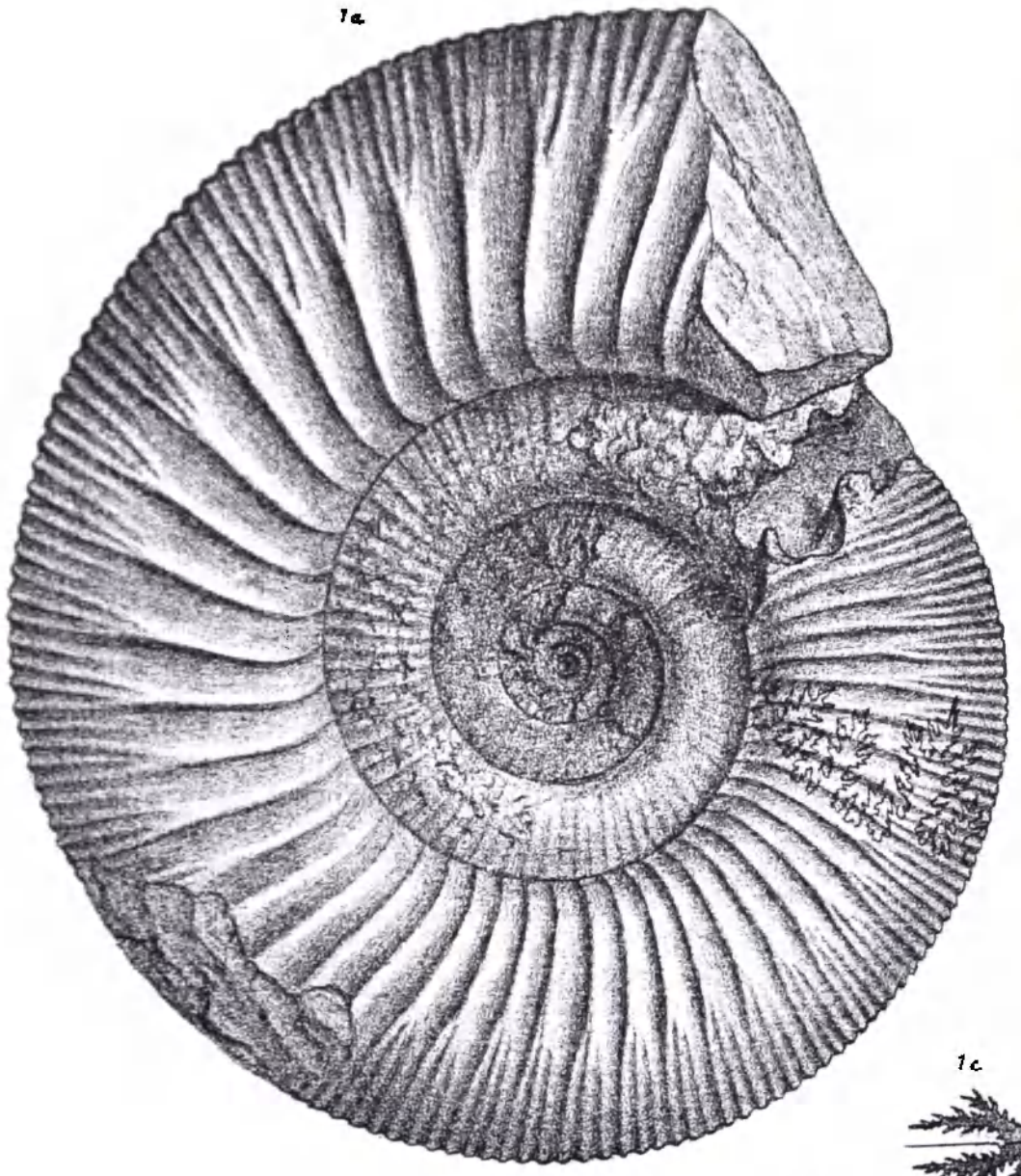
Albert Berger print

PLATE LXIV.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) HIMALAYANUS n. sp.
Page 330. Internal cast. Natural size. 1*a*, Lateral view. The ultimate whorl belongs mostly to the body-chamber. The figured suture indicates the position of the last septum. 1*b*, View of the external periphery. 1*c*, Suture. From Chidamu, Chidamu-beds.

Fig. 2 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) HOLDHAUSI n. sp.
Page 323. Internal cast. Natural size. The specimen has suffered somewhat from compression along its external margin. 2*a*, Lateral view. The last whorl belongs mostly to the body-chamber. 2*b*, View of the external periphery, the lower part of which is somewhat restored. 2*c*, Apertural view. From Laptal, Hundes.

JURASSIC FOSSILS (HIMALAYA).



A Swoboda del et lith.

Albert Berger print.

PLATE LXV.

Fig. 1 *a—c*. PERISPHINCTES (VIRGATOSPHINCTES) POMPECKJI n. sp.
Page 320. Specimen with part of the body-chamber preserved. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, Suture. The first lateral lobe, as represented, is too short. North of Jandu, Sherik river, Hundes.

Fig. 2 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) sp. ind. aff. DENSEPLICATUS Waagen.
Page 324. Internal cast. Natural size. 1*a*, Lateral view. The body-chamber begins at the anterior part of the last whorl. 2*b*, Apertural view. 2*c*, View of the external periphery. 2*d*, Suture. From Spiti.

Fig. 3 *a—d*. PERISPHINCTES (AULACOSPHINCTES) WILLISI n. sp.
Page 373. Fragment of interior volution. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Apertural view. 3*d*, Suture. Compare with pl. LXXIII, fig. 1 *a—c*. From Gieumal.

JURASSIC FOSSILS (HIMALAYA).

1b

1a

1c

2d

2a

2b

2c

3d

3a

3b

3c

Albert Berger print

PLATE LXVI.

Fig. 1 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) INTERMEDIUS n. sp.
Page 319. Internal cast, with the shell partly adhering. Natural size. 1*a*, Lateral view. Two-thirds of the last whorl belong to the body-chamber. 1*b*, Front view. 1*e*, View of the external periphery. 1*d*, Suture. The first lateral lobe is drawn too short, it should be almost as long as the external lobe. From Chidamu, Chidamu-beds.

Fig. 2 *a*, *b*. PERISPHINCTES (VIRGATOSPHINCTES) INDISTINCTUS n. sp.
Page 340. Internal cast. Natural size. 2*a*, Lateral view. The last whorl belongs for the most part to the body-chamber. 2*b*, View of the external periphery. From Laptal, Hundes.

Fig. 3 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM n. sp.
Page 371. Young specimen. Natural size. 3*a*, Lateral view. 3*b*, Apertural view. The height of the aperture as drawn is 1 mm. too great. 3*c*, Sutures. See also pl. LXXII, figs. 1—4. Spiti shales. Exact locality not known.

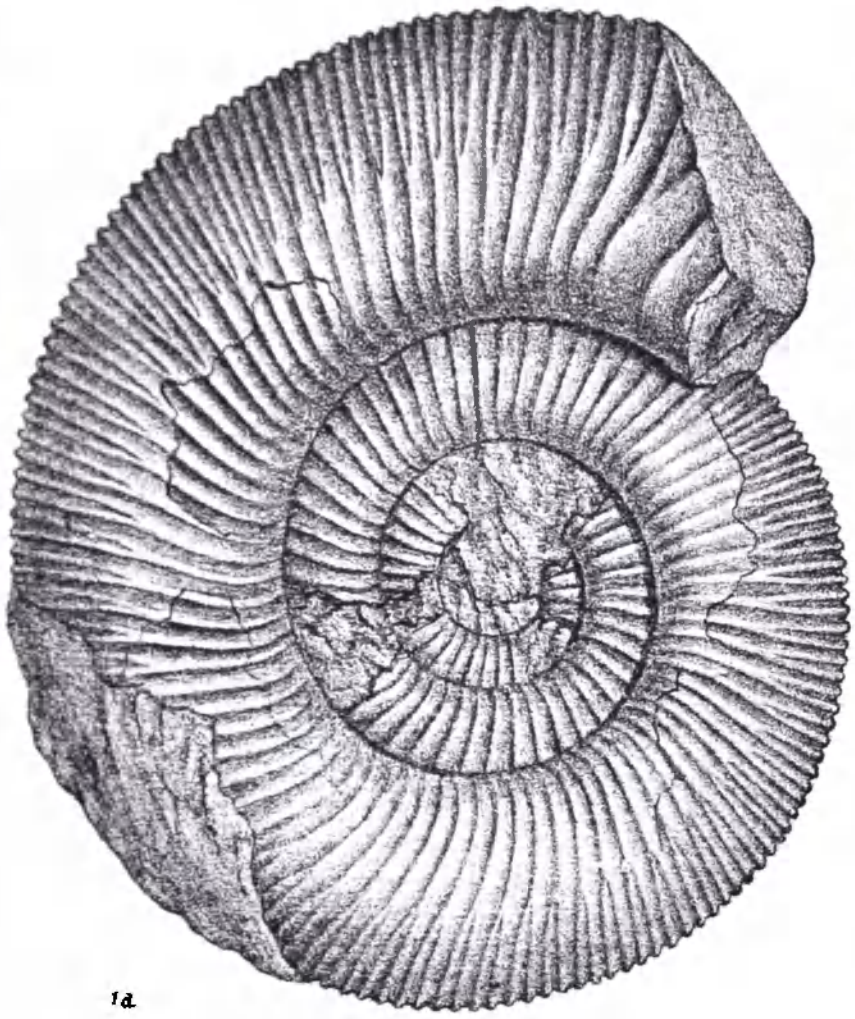
Fig. 4 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) *cf.* HUNDESIANUS n. sp.
Page 374. Internal cast. Natural size. 4*a*, Lateral view. 4*b*, Apertural view. 4*c*, Suture. See also pl. LXXI, fig. 3, and pl. LXXIII, fig. 2. Chidamu, Chidamu-beds.

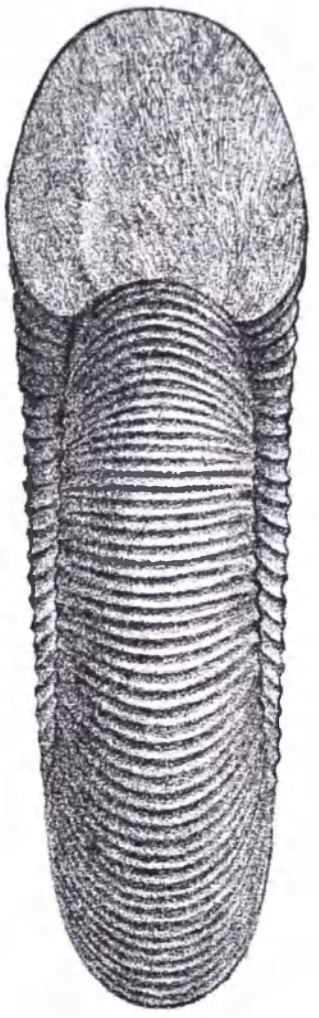
JURASSIC FOSSILS (HIMALAYA).

1c

1a

1b



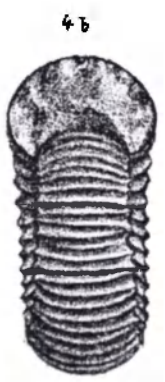


1d

3c

4c

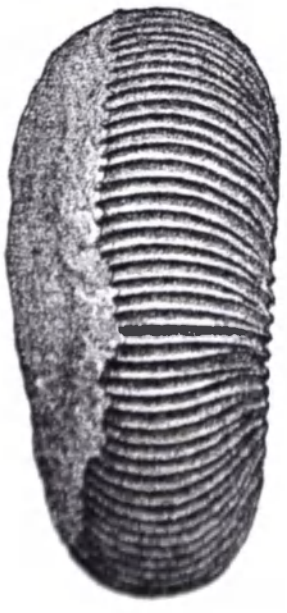
4b



4a

2a

2b



3a

3b

Albert Berger prim.

PLATE LXVII.

Fig. 1 *a—c*. PERISPHINCTES (~~AULACOSPHINCTES~~) *cf.* ADELUS Gemmellaro.

Page 375. Internal cast. Natural size. 1*a*, Lateral view. About half the last whorl belongs to the body-chamber. 1*b*, View of the external periphery. 1*c*, Apertural view. The trace of the median furrow at the origin of the last whorl has been overlooked by the artist. From Chidamu, Chidamu-beds.

Fig. 2 *a—d*. PERISPHINCTES (VIRGATOSPHINCTES) INCERTUS n. sp.

Page 342. Specimen with the shell partly adhering. Natural size. 2*a*, Lateral view. Three-quarters of the last whorl belong to the body-chamber. 2*b*, View of the external periphery. 2*c*, Apertural view. 2*d*, Cross-section. Between Ting Jung La and Chota Hoti.

JURASSIC FOSSILS (HIMALAYA).

1b

1a

1c

2d

2b

2a

2c

Swebeda del et lith.

Albert Berger print.

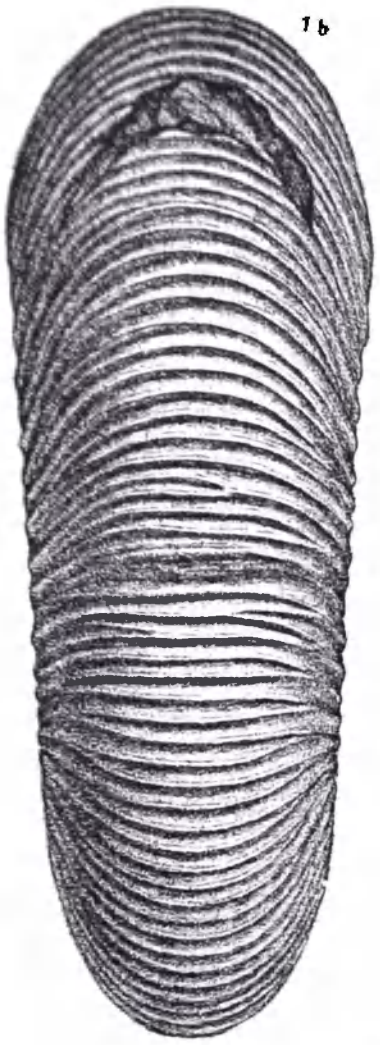
PLATE LXVIII.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) SUBQUADRATUS n. sp.
Page 338. Internal cast. Natural size. 1*a*, Lateral view. The ultimate whorl so far as preserved, belongs to the body-chamber. 1*b*, View of the external periphery. 1*c*, Cross-section of the body-chamber. From Spiti.

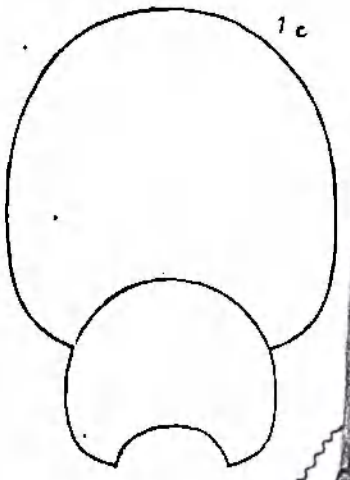
Fig. 2 *a*—*d*. PERISPHINCTES (VIRGATOSPHINCTES) CONTIGUUS Zittel.
Page 339. Internal cast. Natural size. 2*a*, Lateral view. More than three-quarters of the last whorl belong to the body-chamber. 2*b*, Apertural view. The aperture is drawn too high by 1·3 mm. 2*c*, View of the external periphery. 2*d*, Suture. From Laptal, Chidamu-beds.

JURASSIC FOSSILS (HIMALAYA).

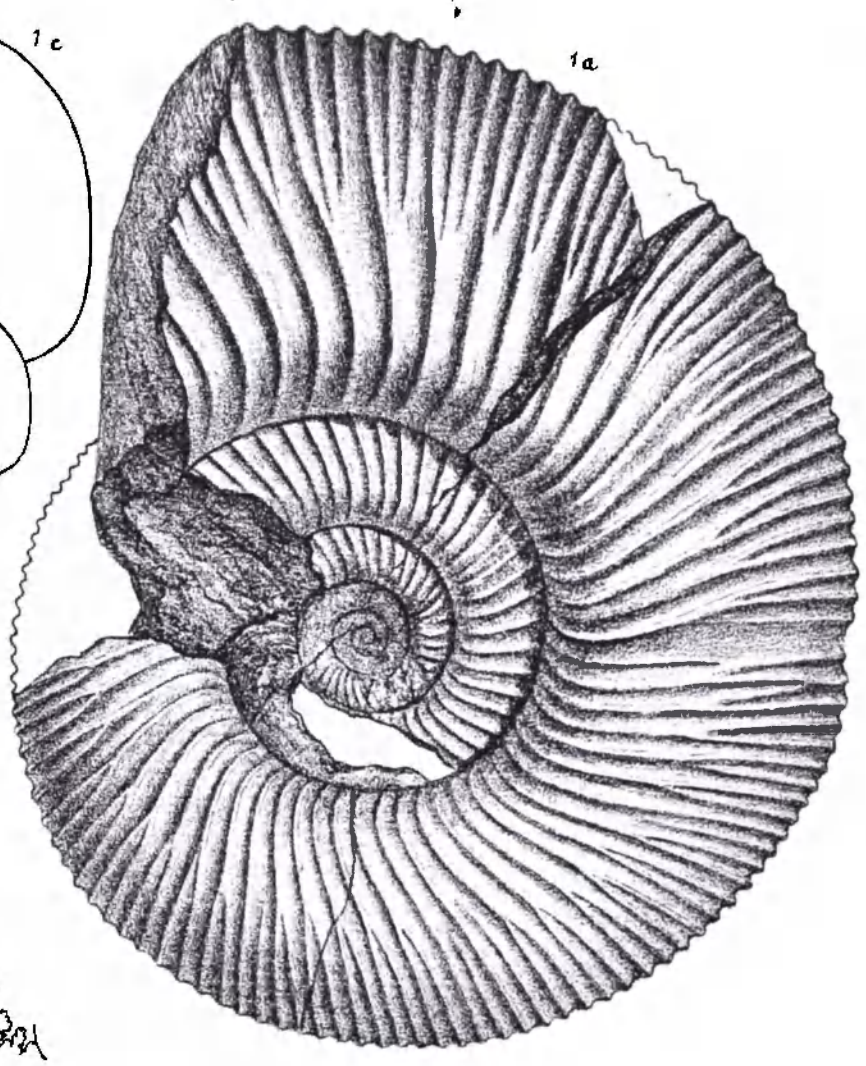
1b



1c

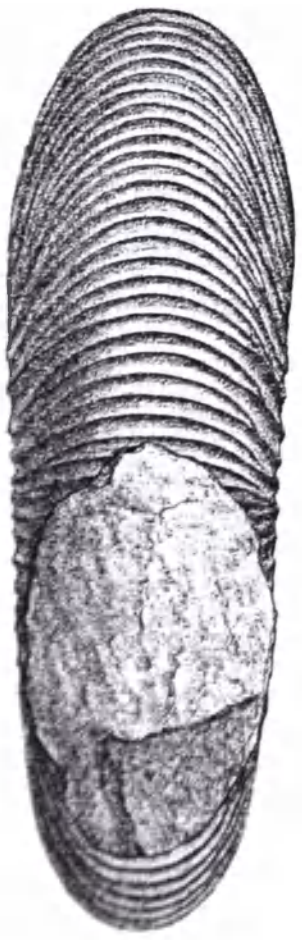


1a

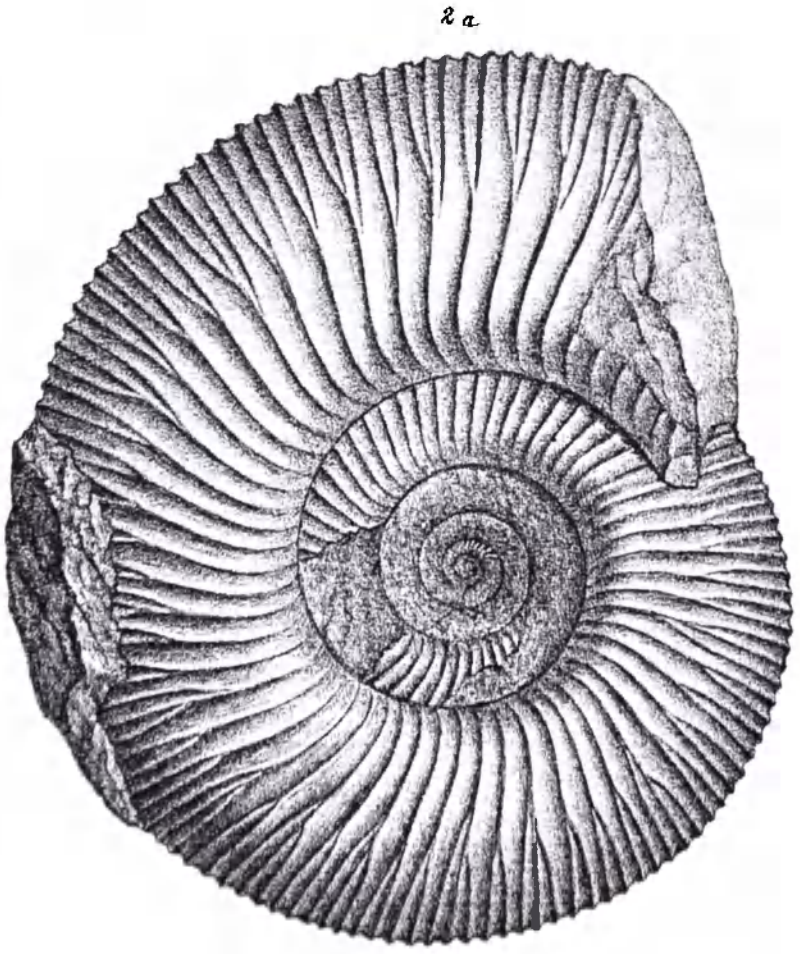


2d

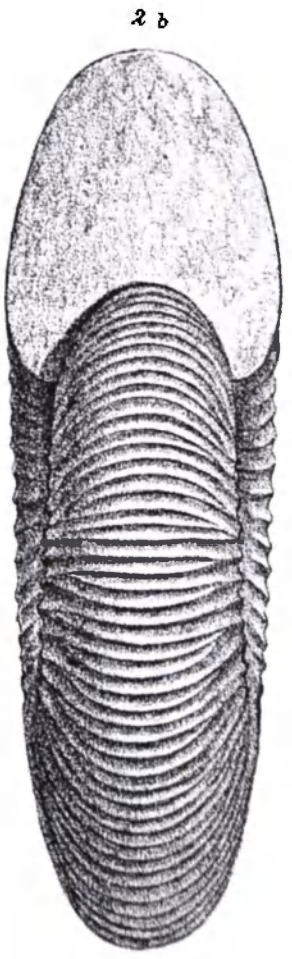
2c



2a



2b



L. Svoboda del. et lith.

Albert Berger print.

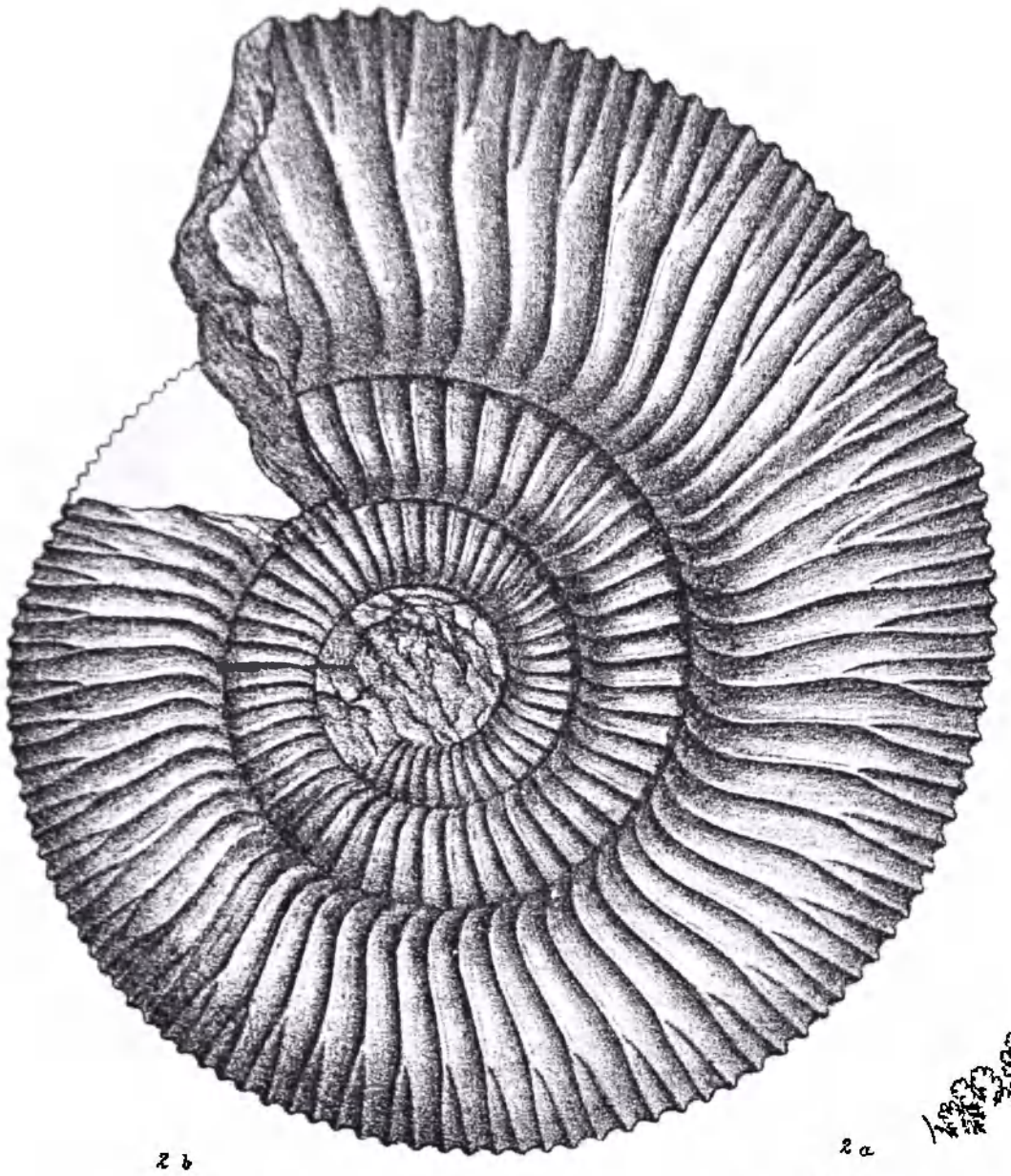
PLATE LXIX.

Fig. 1 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) SMITH-WOODWARDI n. sp.
Page 372. Specimen with the shell partly adhering. Natural size. 1*a*, Lateral view. Nearly the whole of the last whorl belongs to the body-chamber. 1*b*, View of the external periphery. 1*c*, Cross-section in outline. From Spiti shales. Exact locality not known.

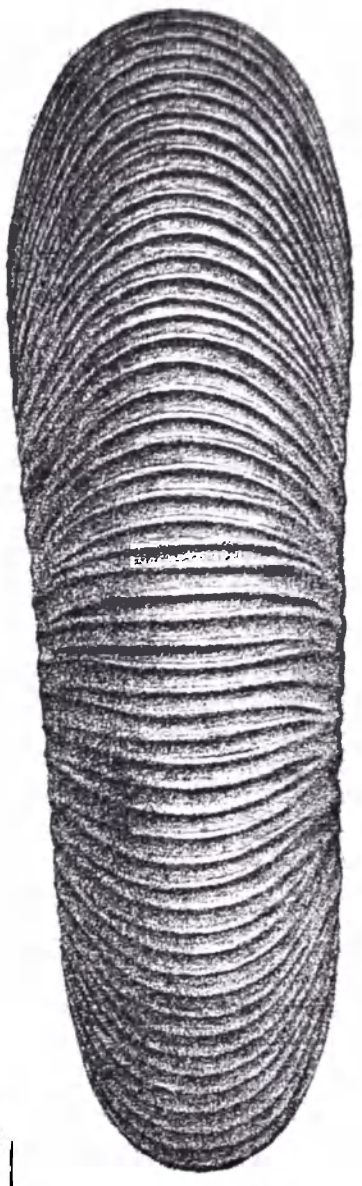
Fig. 2 *a*—*d*. PERISPHINCTES (~~AULACOSPHINCTES~~) TORQUATUS, J. ~~Sowerby~~ sp.
Page 368. Internal cast. Natural size. 2*a*, Side view. The anterior part of the last whorl belongs to the body-chamber, which is preserved only on one side up to the apertural margin. The artist has unfortunately illustrated the incomplete side of the shell. 2*b*, Apertural view. 2*c*, View from above, showing the expanded aperture. 2*d*, Suture. See also pl. LXXI, figs. 1, 2. From Laptal (?)

JURASSIC FOSSILS (HIMALAYA).

1a

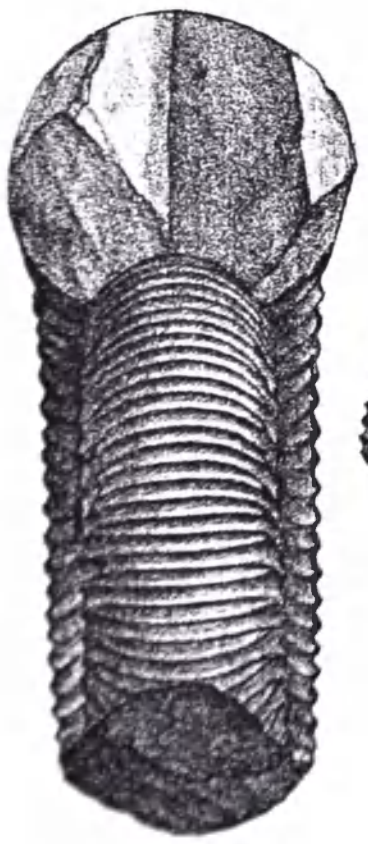


1b

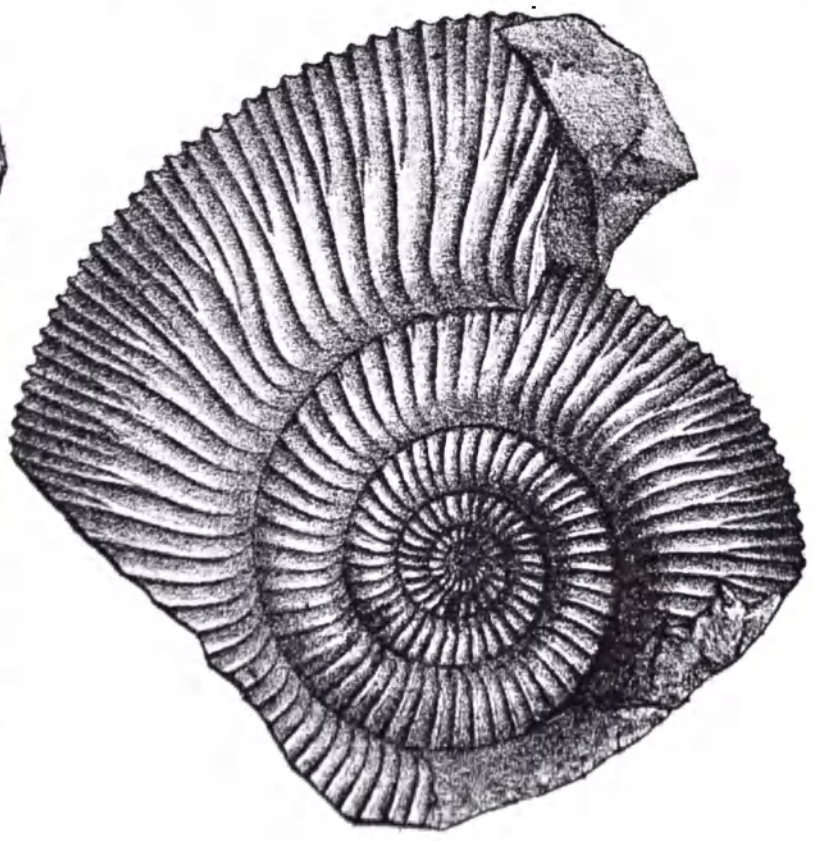


2d.

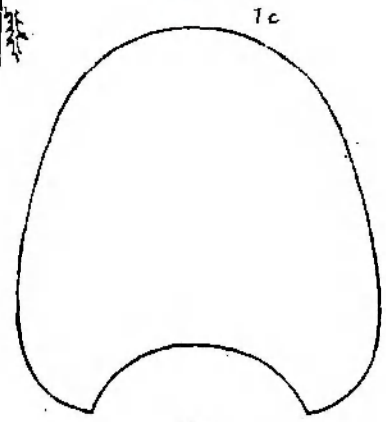
2b



2a



1c



2c

A Swoboda del. et lith.

Albert Berger print.

PLATE LXX.

Fig. 1 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) SUBTORQUATUS n. sp.
Page 367. Internal cast. Natural size. 1*a*, Lateral view. The last whorl belongs mostly to the body-chamber. 1*b*, Apertural view. 1*c*, View of the external periphery. From Laptal, Hundes.

Fig. 2 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) PERRIN-SMITHI n. sp.
Page 362. Internal cast. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section. From Chidamu, Chidamu-beds.

Fig. 3 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) TIBETANUS n. sp.
Page 361. Internal cast with the body-chamber preserved. Natural size. 3*a*, Lateral view. 3*b*, View of the external periphery. 3*c*, Cross-section. From Laptal.

Fig. 4 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) TIBETANUS n. sp.
Page 361. Internal cast. Natural size. 4*a*, Lateral view. The last whorl belongs almost entirely to the body-chamber. 4*b*, Apertural view. 4*c*, View of the external periphery. From Chidamu, Chidamu-beds.

JURASSIC FOSSILS (HIMALAYA).

1b

1a

1c

4a

4c

3b

4b

3c

2c

2b

2a.

3a.

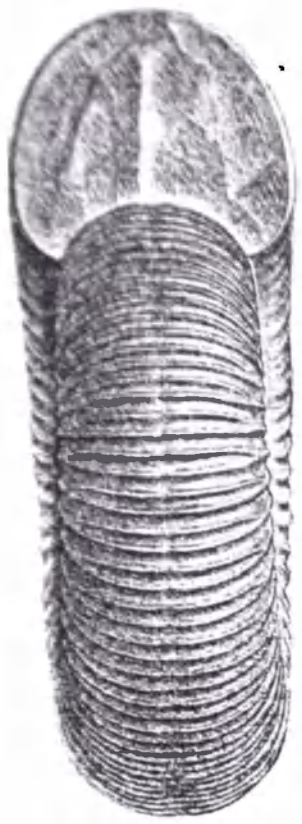
PLATE LXXI.

Fig. 1 *a—d*. PERISPHINCTES (~~AULACOSPHINCTES~~) TORQUATUS ~~J. de C. Sowerby~~ sp.
Page 368. Internal cast of a chambered nucleus. Natural size. 1a, Lateral view. 1*b*, Front view. 1*c*, View of the external periphery. 1*d*, Sutures. See also pl. LXIX, fig. 2. From Chidamu, Chidamu-beds.

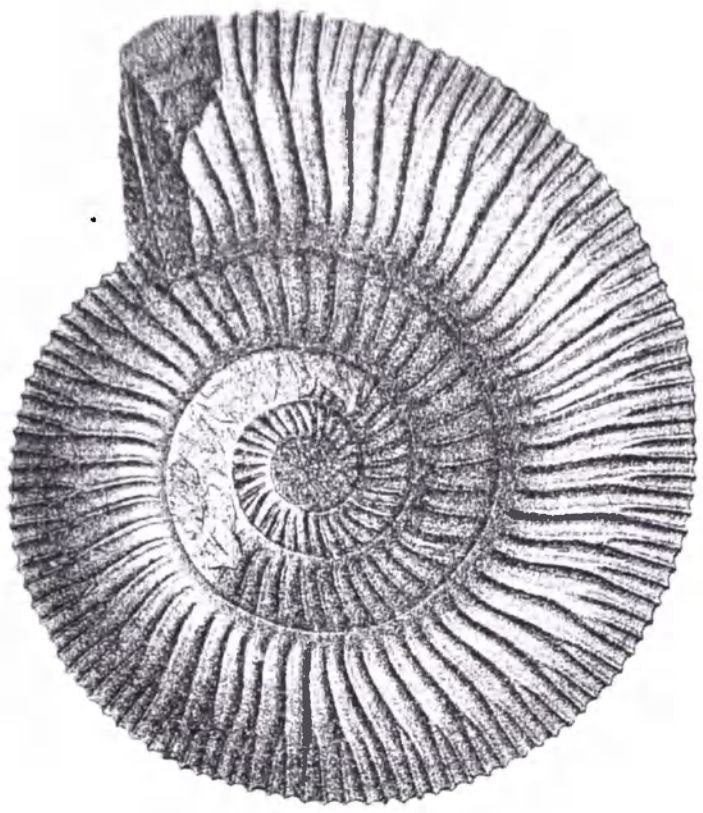
Fig. 2 *a—c*. PERISPHINCTES (~~AULACOSPHINCTES~~) TORQUATUS J. de C. Sowerby sp.
Page 368. Internal cast, almost entirely chambered. Natural size. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Sutures. From Chidamu, Chidamu-beds.

Fig. 3 *a—c*. PERISPHINCTES (~~AULACOSPHINCTES~~) HUNDESIANUS n. sp.
Page 374. Internal cast. Natural size. 3*a*, Lateral view. The last whorl belongs almost entirely to the body-chamber. 3*b*, Apertural view.3*c*, View of the external periphery. See also pl. LXXIII, fig. 2 *a—c* and pl. LXVI, fig. 4. From Chidamu, Chidamu-beds.

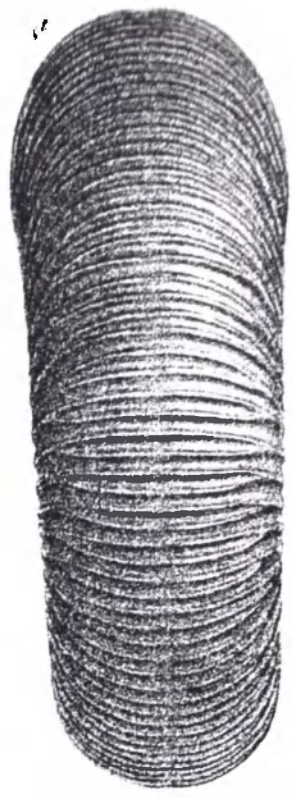
1b



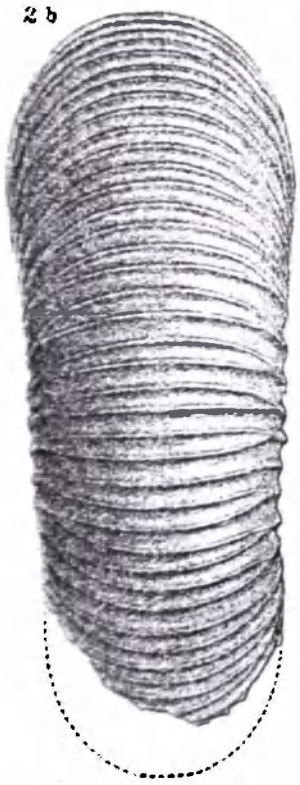
1a



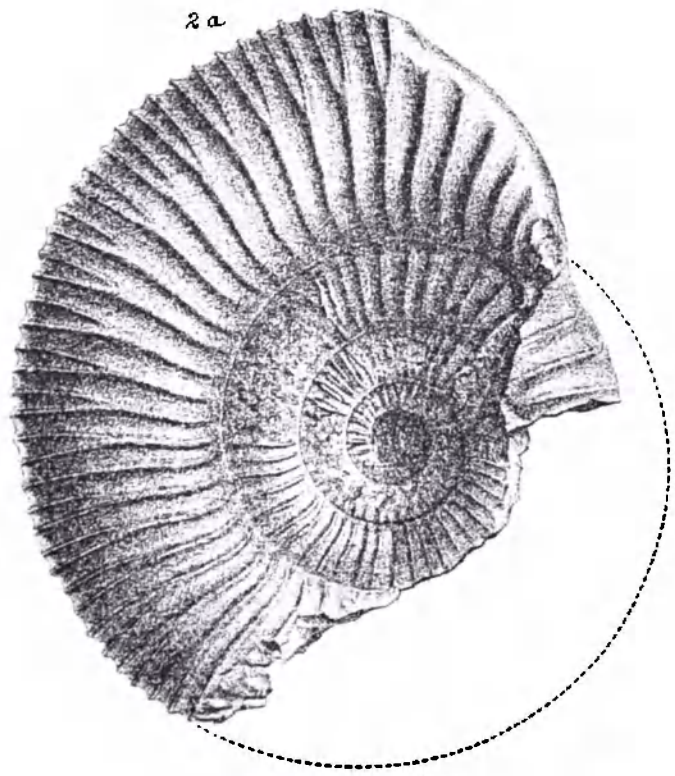
1c



2b

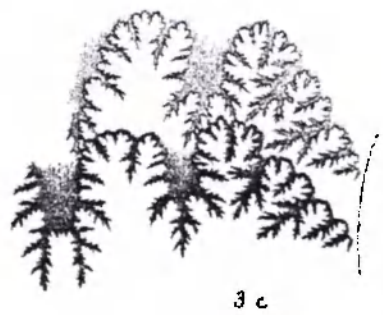


2a

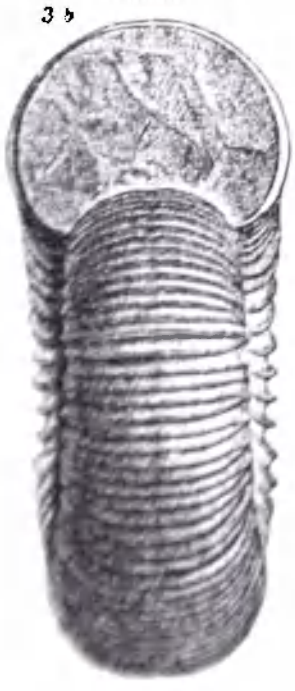


1d

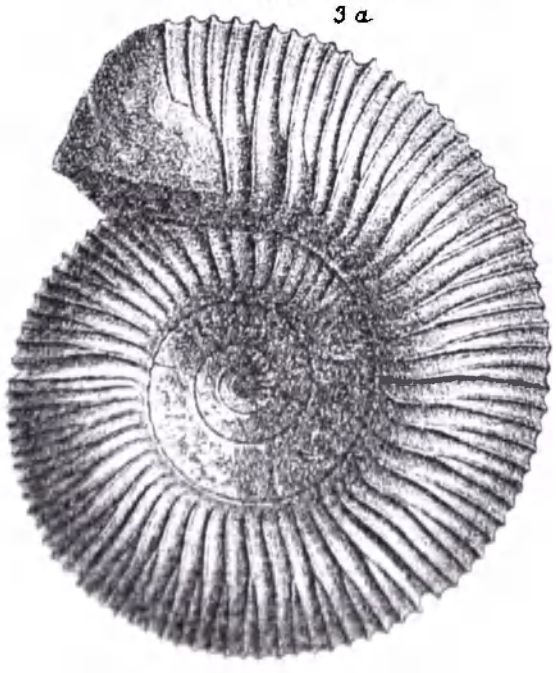
2c



3b



3a



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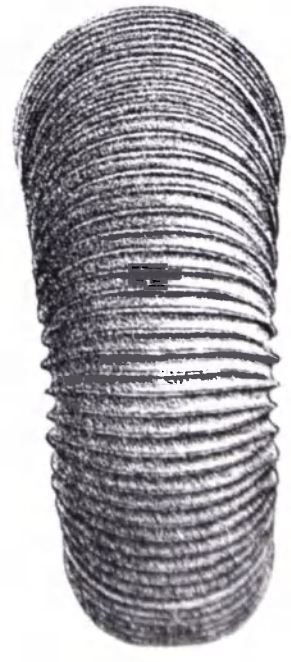


PLATE LXXII.

Fig. 1 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM n. sp.
Page 371. Internal cast. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, View of the external periphery. From Chidamu, Chidamu-beds.

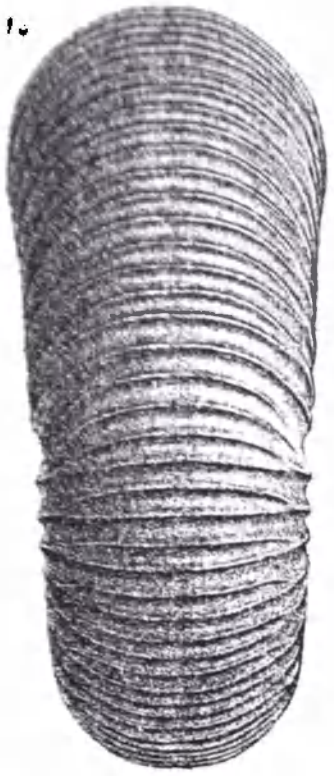
Fig. 2 *a*, *b*. PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM n. sp.
Page 371. Internal cast. Natural size. Slender variety with narrow umbilicus. 2*a*, Lateral view. The last whorl so far as preserved, belongs to the body-chamber. 2*b*, Cross-section. From Chidamu, Chidamu-beds.

Fig. 3 *a*, *b*. PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM n. sp.
Page 371. Variety with narrow umbilicus and less strongly curved ribs. 3*a*, Lateral view. Three-quarters of the last whorl belong to the body-chamber. 3*b*, View of the external periphery. Sherik river, Hundes.

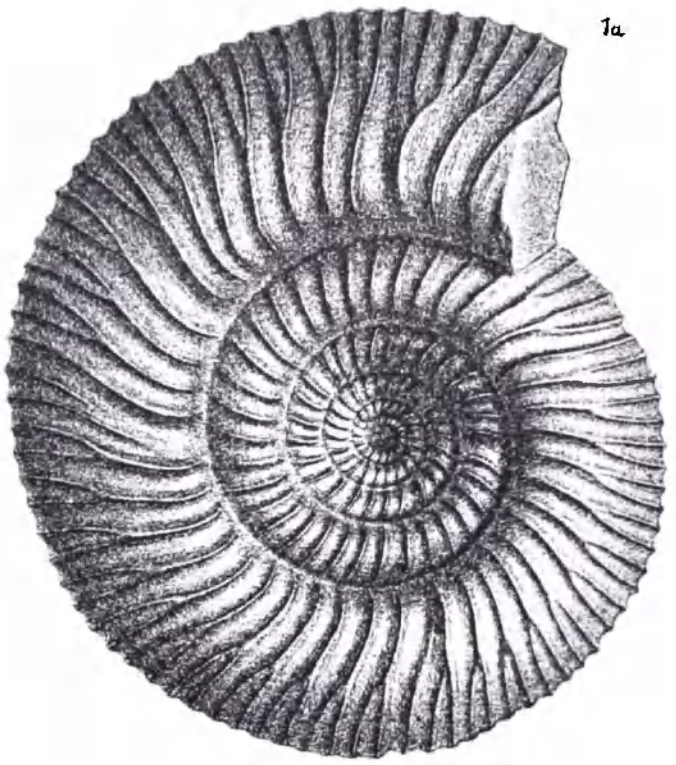
Fig. 4 *a*—*c*. PERISPHINCTES (AULACOSPHINCTES) INFUNDIBULUM n. sp.
Page 371. Variety with slightly curved ribs and broad external margin. Internal cast of a chambered nucleus. 4*a*, Lateral view. 4*b*, View of the external periphery. 4*c*, Sutures. Between Ting Jung La and Chota Hoti.

JURASSIC FOSSILS (HIMALAYA).

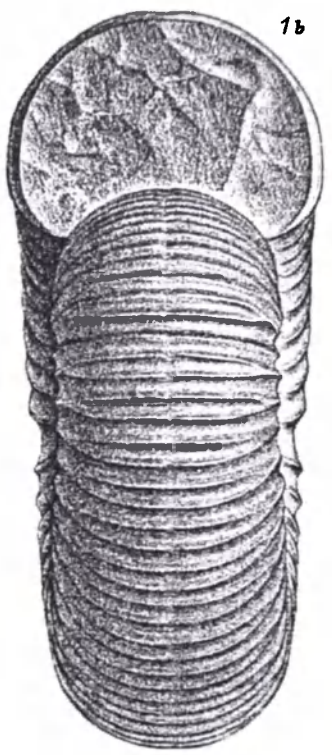
1c



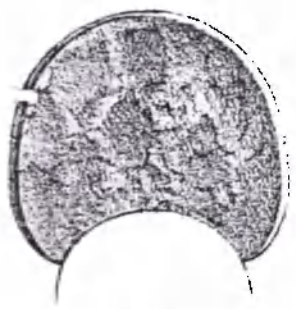
1a



1b

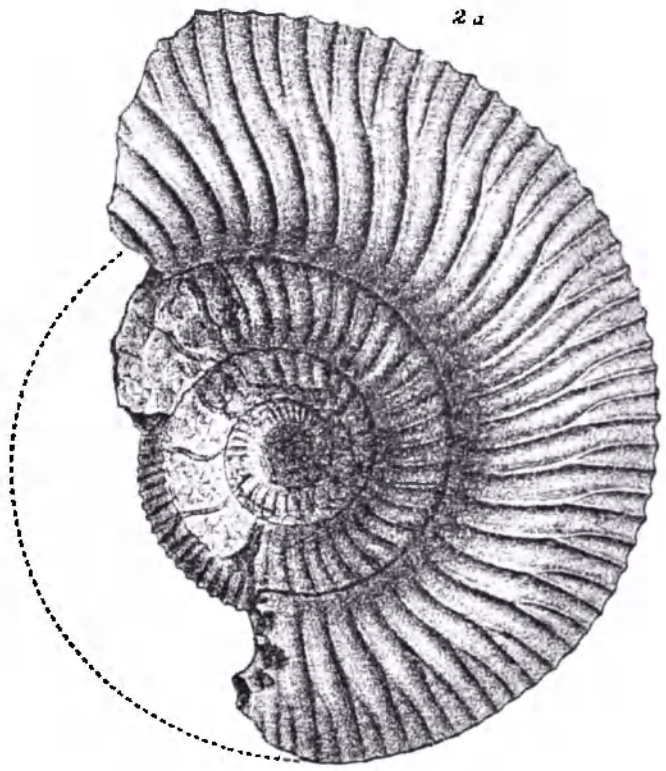


2b

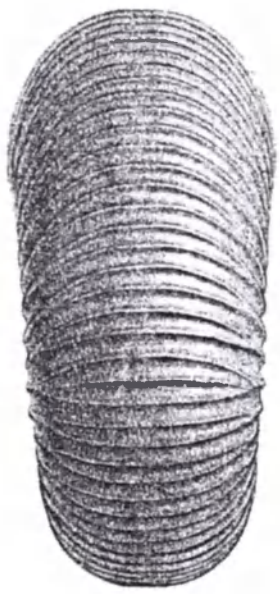


4c

2a

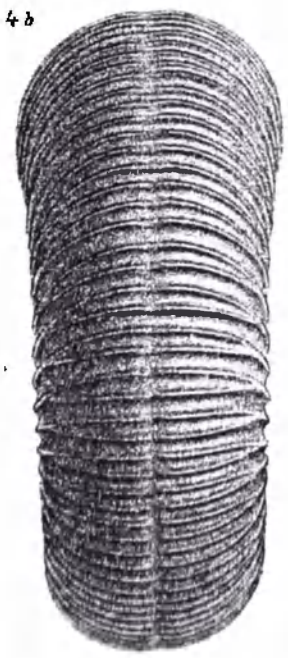


3b

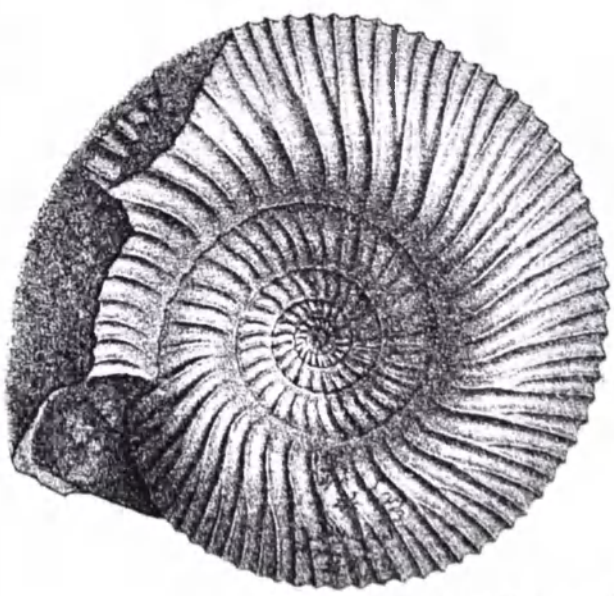


4a

4b



3a



Albert Berger print.

R. Meyer del. et lith.

PLATE LXXIII.

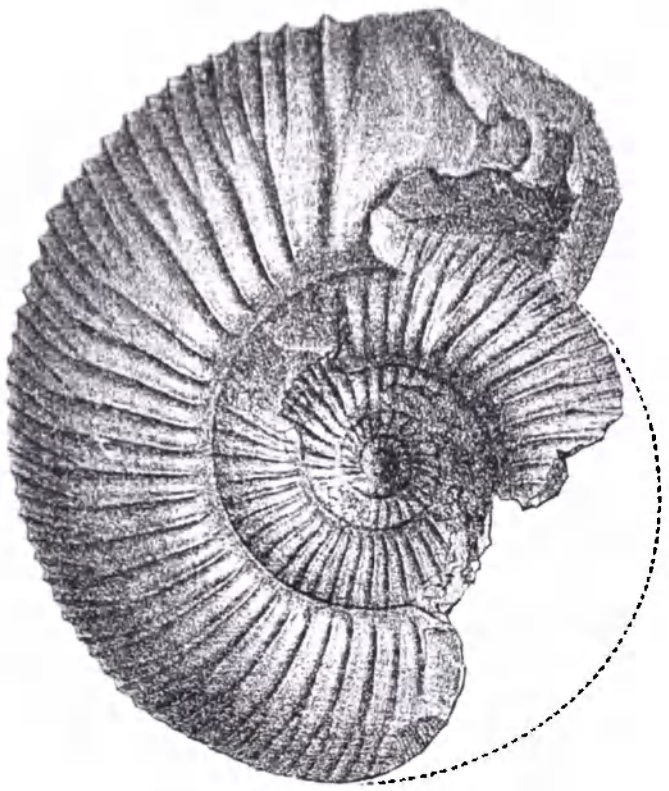
Fig. 1 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) WILLISI n. sp.
Page 373. Internal cast, with apertural margin preserved. Natural size. 1*a*, Lateral view. The inner whorls are chambered as far as the fractured surface. 1*b*, Cross-section. 1*c*, View of the external periphery. See also pl. LXV, fig. 3 *a*—*d*. Between Chota Hoti and Ting Jung La.

Fig. 2 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) HUNDESIANUS n. sp.
Page 374. Internal cast. Natural size. 2*a*, Lateral view. More than three quarters of the last whorl belong to the body-chamber. 2*b*, Apertural view. 2*c*, View of the external periphery. See also pl. LXVI, fig. 4 *a*—*c* and pl. LXXI, fig. 3 *a*—*c*. Between Laptal and Chidamu.

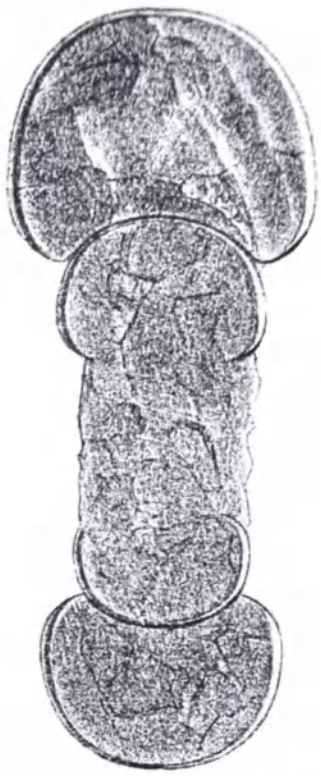
Fig. 3 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) sp. aff. EUPLOCUS Waagen.
Page 344. Specimen with the shell partly adhering. Natural size. 3*a*, Lateral view. About half the last whorl belongs to the body-chamber. 3*b*, View of the external periphery. 3*c*, Section of the body-chamber. From the Spiti shales. Exact locality not known.

1c

1a.



1b



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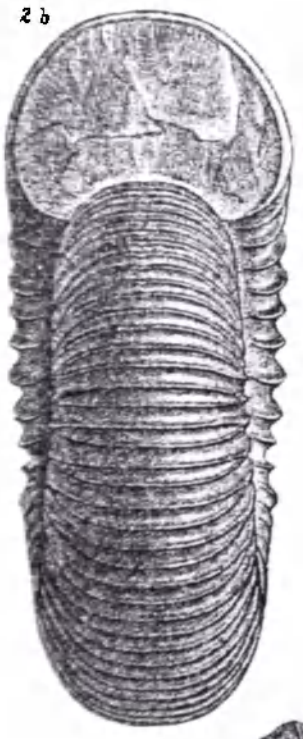
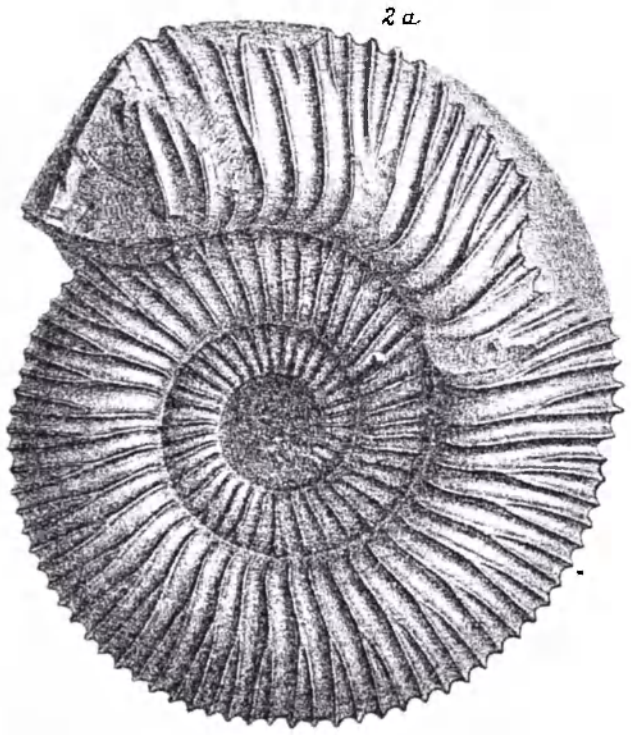
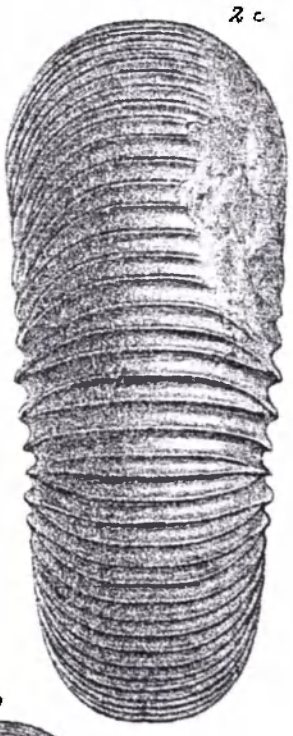


2a



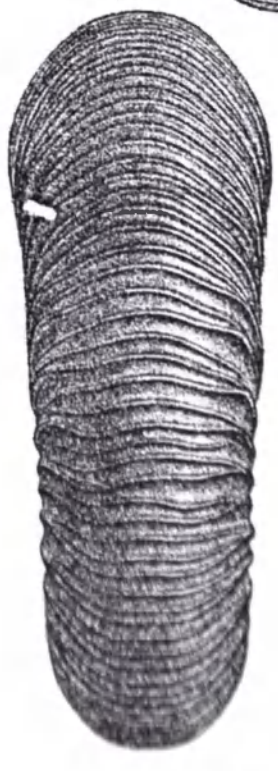
2c



3a

3c

3b



Albert Berger print

Fig. 1 *a—d*. PERISPHINCTES (~~AULACOSPHINCTES~~) CHIDAMENSIS n. sp.

Page 376. Internal cast. Natural size. 1*a*, Lateral view. The figured septum is the last one. Three-quarters of the last whorl belong to the body-chamber. 1*b*, Apertural view. 1*c*, View of the external periphery. 1*d*, Suture. From Chidamu, Chidamu-beds.

Fig. 2 *a—f*. PERISPHINCTES (~~AULACOSPHINCTES~~) SPARSICOSTA n. sp.

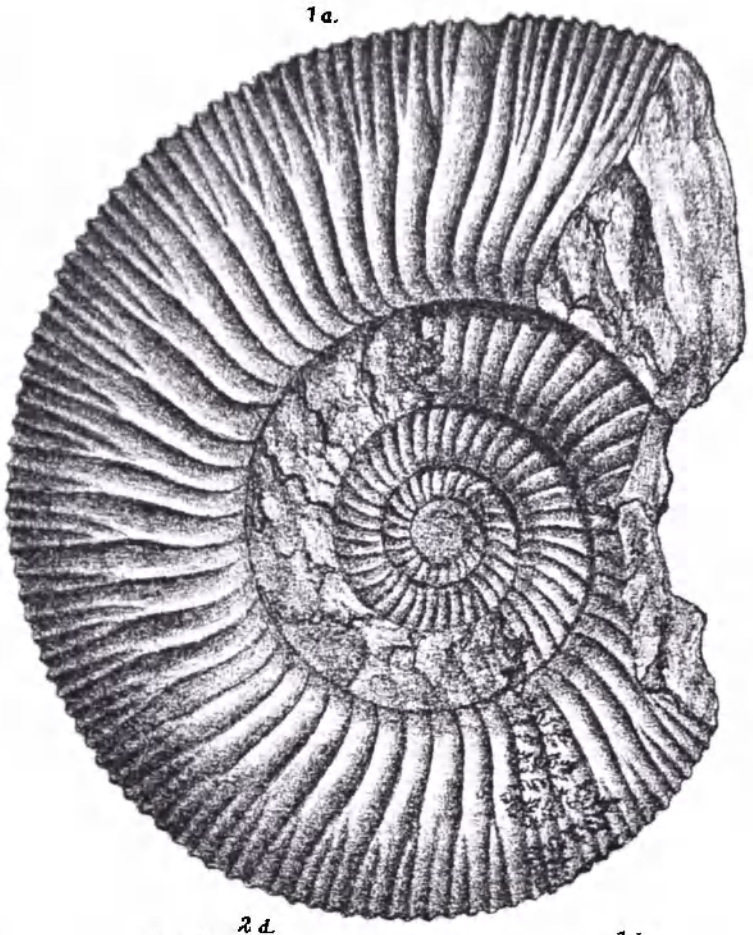
Page 377. Specimen with the shell partly adhering. Natural size. 2*a*, Lateral view. About three-quarters of the last whorl belong to the body-chamber. 2*b*, Apertural view. The great height of the aperture is caused by a slight compression of the anterior end of the shell. 2*c*, View of the external periphery. 2*d*, Suture. 2*e*, Cross-section at a diameter of 89 mm. 2*f*, Anterior part of the penultimate whorl, at the origin of the "virgatotomous" ribs. From Chidamu, Chidamu-beds.

Geol Surv of India.

JURASSIC FOSSILS (HIMALAYA).

Pl. LXXIV.


1c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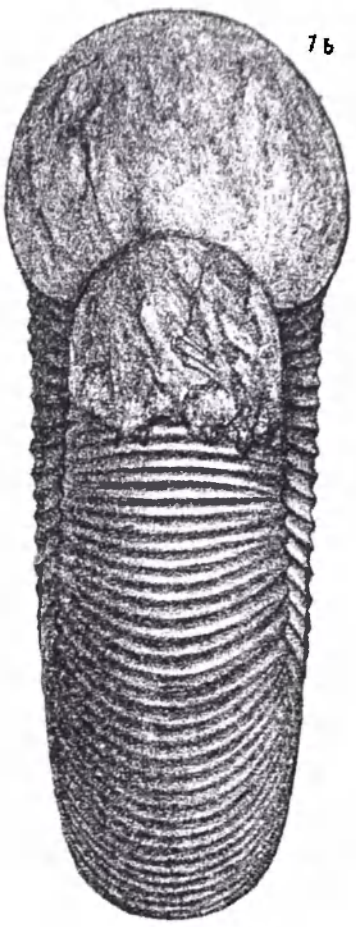
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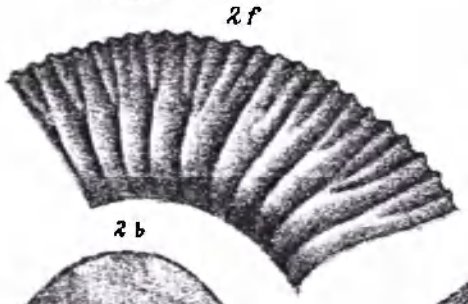
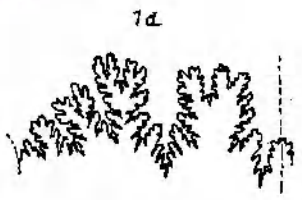
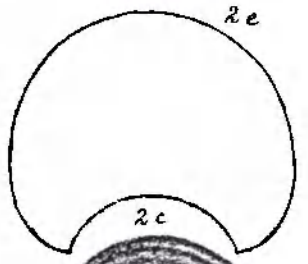
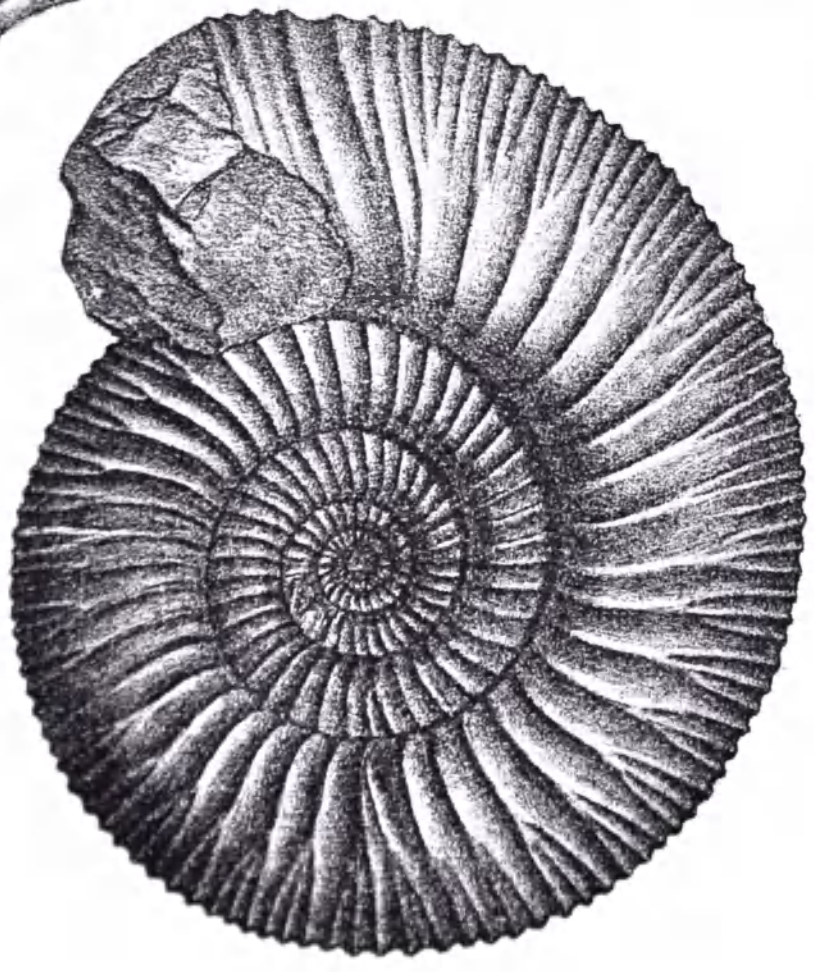

2f


2d


1d


2e


2b


2a

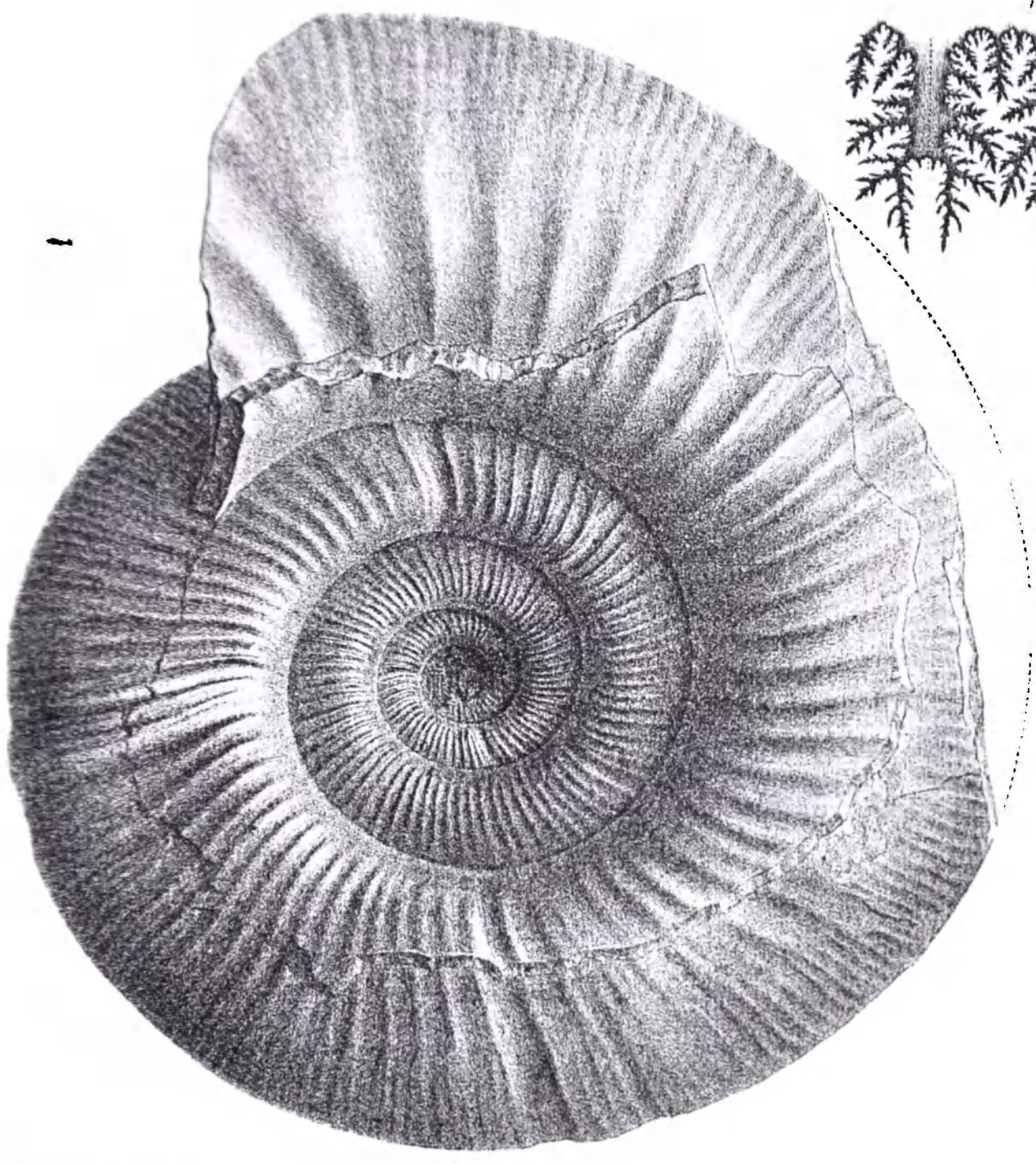

2c

Albert Berger print.

PLATE LXXV.

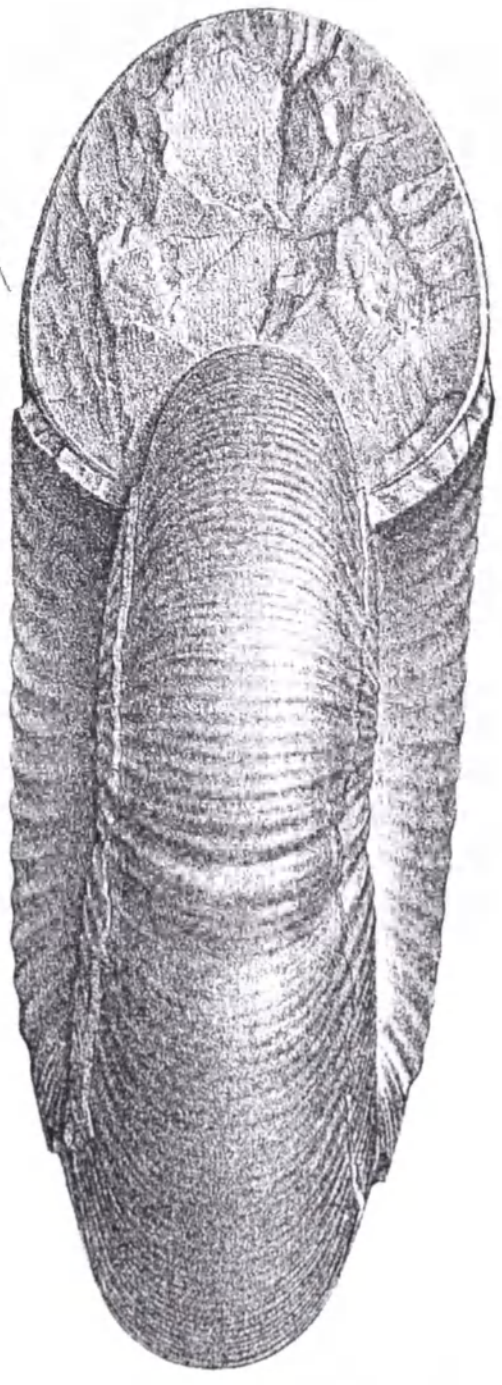
Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) FREQUENS Oppel sp.
Page 325. Specimen almost entirely chambered. Natural size. 1*a*, Lateral view. 1*b*, Apertural view. 1*c*, Suture. See also pl. LXIII, figs. 1, 2, 3 and pl. LXXV-A, fig. 1. Between Ting Jung La and Chota Hoti.

1a



1c

1b



R. Mayer del. et. lith.

Albert Berger print.

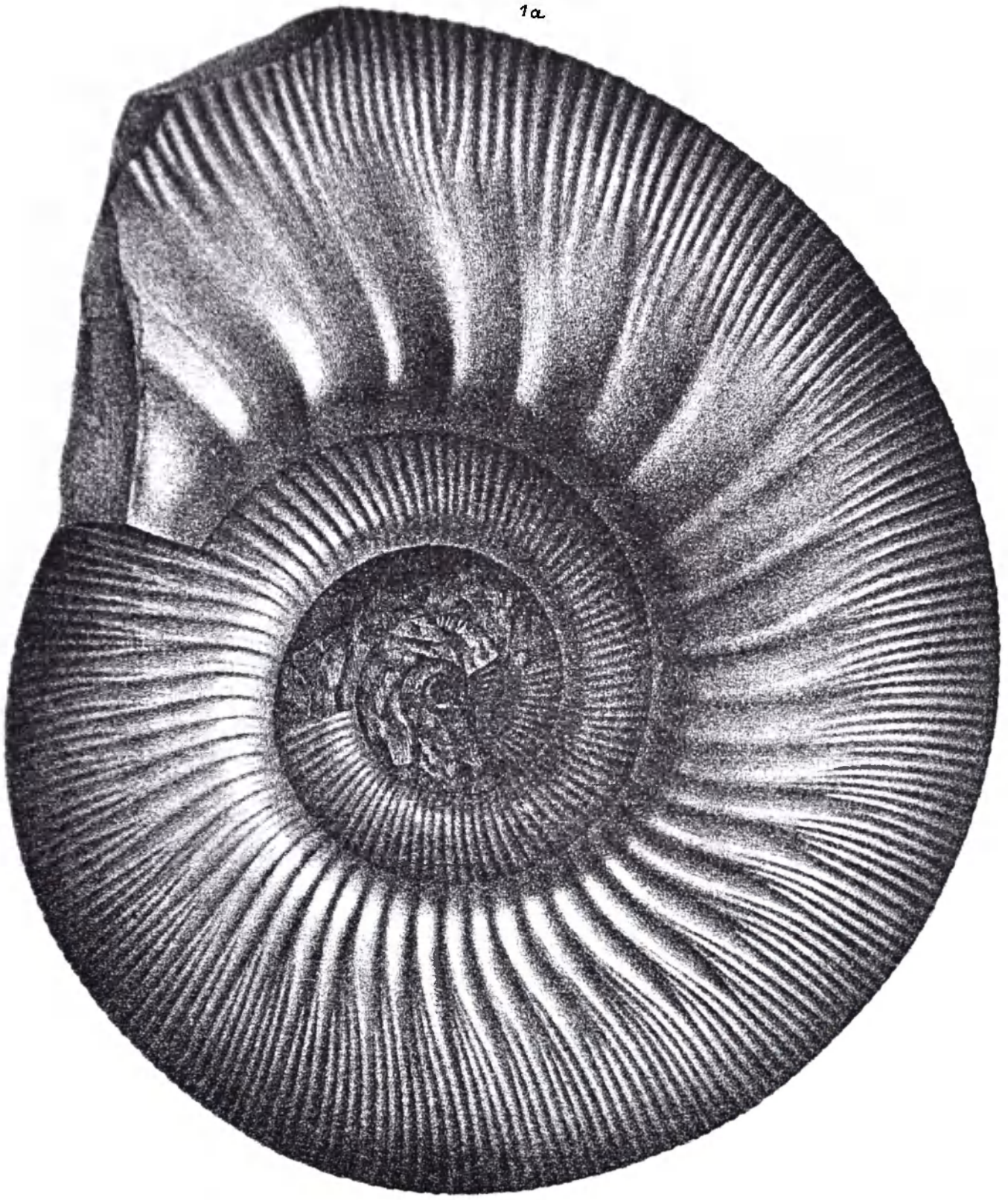
PLATE LXXV A.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) FREQUENS Oppel sp.

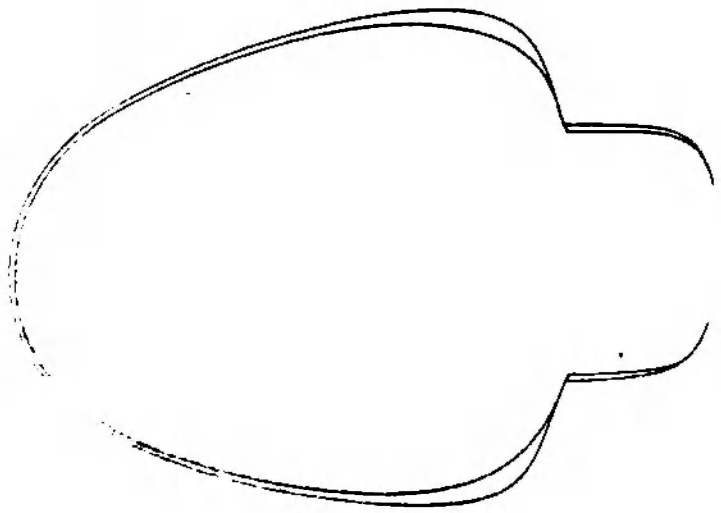
Page 325. Internal cast. Natural size. 1*a*, Lateral view. Four-fifths of the last whorl belong to the body-chamber. 1*b*, Section of the anterior part of the body-chamber. 1*c*, Section of the posterior part of the body-chamber. See also pl. LXIII, figs. 1, 2, 3 and pl. LXXV, fig. 1. From Shangra. Schlagintweit Collection, Munich.

JURASSIC FOSSILS (HIMALAYA).

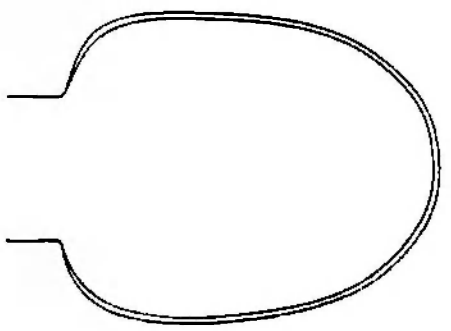
1a



1b



1c



J. F. Eichmann n. d. Nat. a. Stein gez.

Albert Berger print.

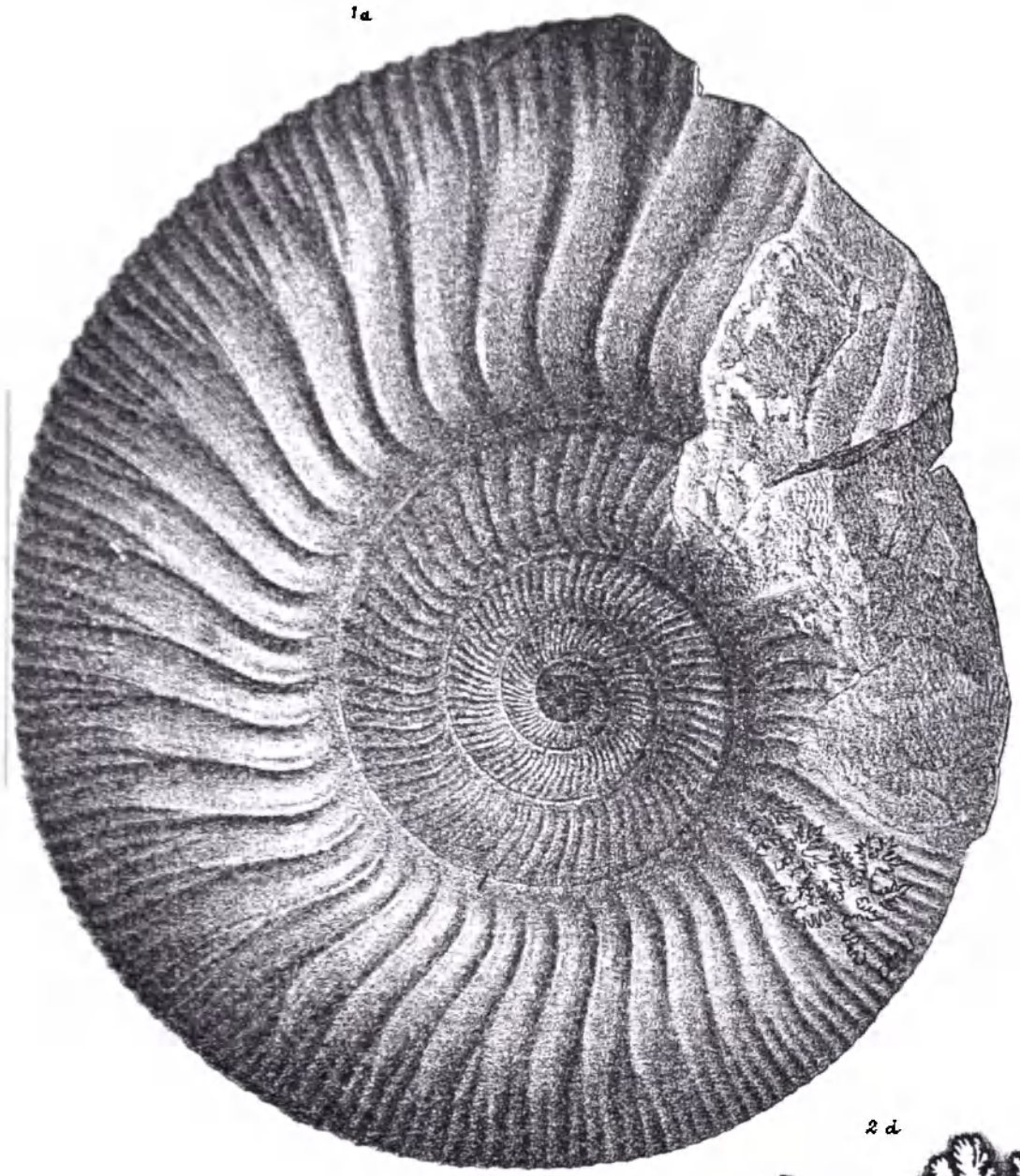
PLATE LXXVI.

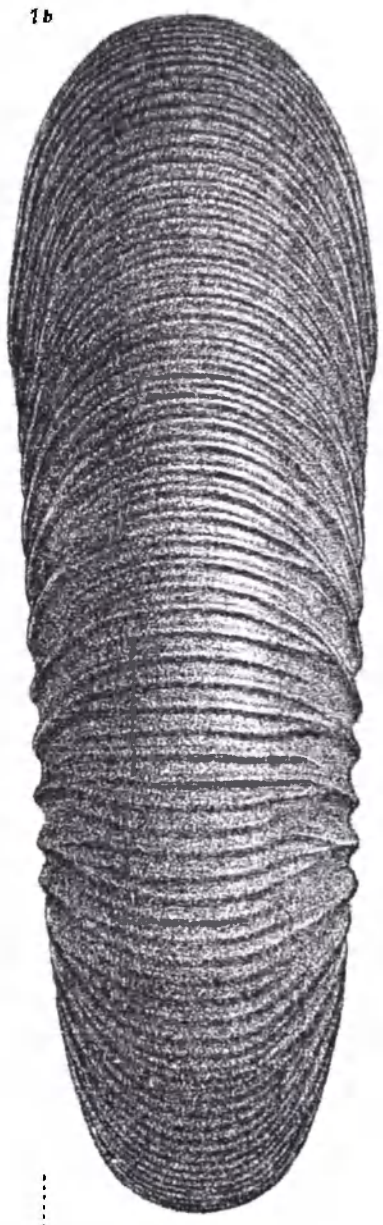
Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) KUTLANUS n. sp.

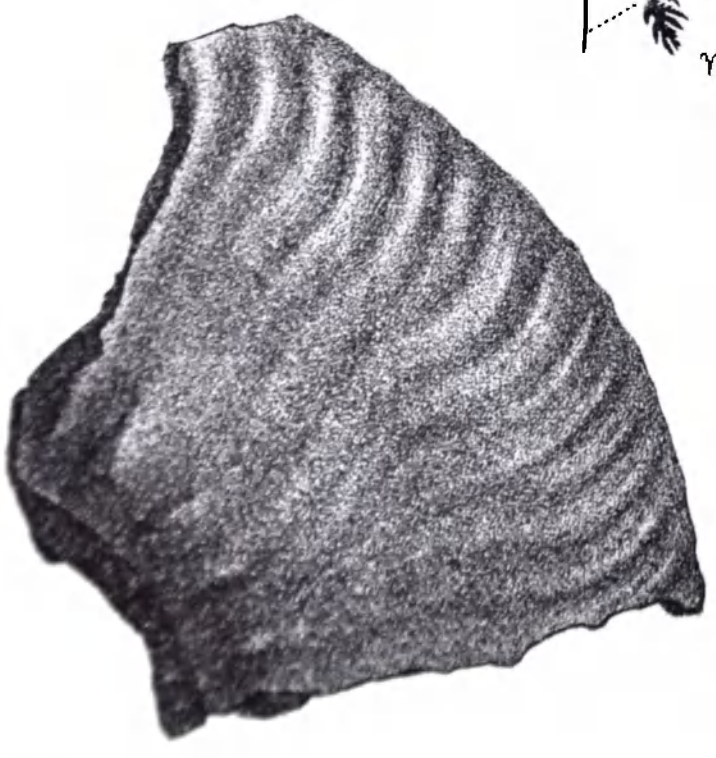
Page 329. Internal cast. Natural size. 1*a*, Lateral view. The body-chamber begins at the suture-line shown on the figure. 1*b*, View of the external periphery. 1*c*, Cross-section in outline. See also pl. LX, fig. 2. From Kuti, Byans.

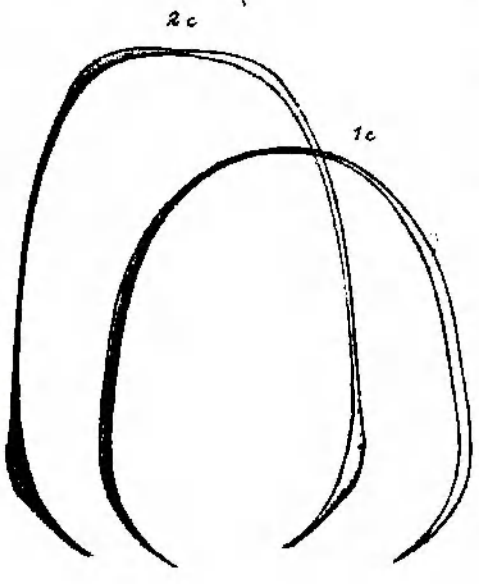
Fig. 2 *a*—*d*. HOPLITES (SARASINELLA) sp. n. ind.

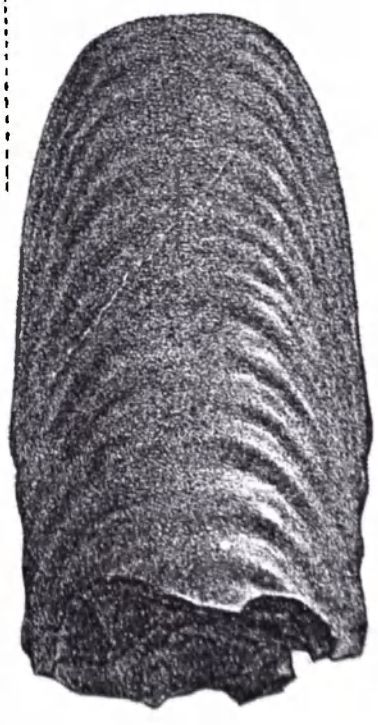
Page 242. Internal cast of chambered nucleus. 2*a*, Lateral view. 2*b*, View of the external periphery. 2*c*, Cross-section in outline. 2*d*, Sutures. Compare with *Hoplites* (*Sarasinella*) aff. *subspinosus*, pl. LXXIX, fig. 2, *a*—*d*. Lingti river. Neocomian.











Albert Berger print.

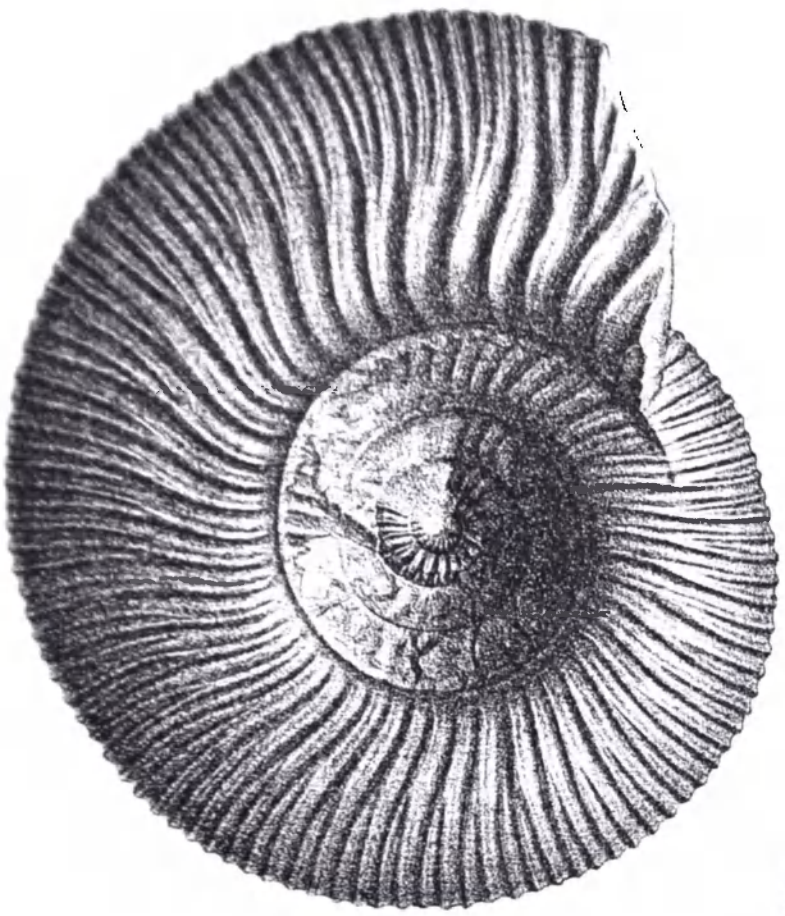
PLATE XCII.

Fig. 1 *a*—*c*. PERISPHINCTES (VIRGATOSPHINCTES) LEMOINEI n. sp.
Page 343. Internal cast of chambered nucleus. Natural size. 1*a*, Lateral view. 1*b*, View of the external periphery. 2*c*, Cross-section. From Shangra, Gnari Khorsum. Coll. Schlagintweit, Munich.

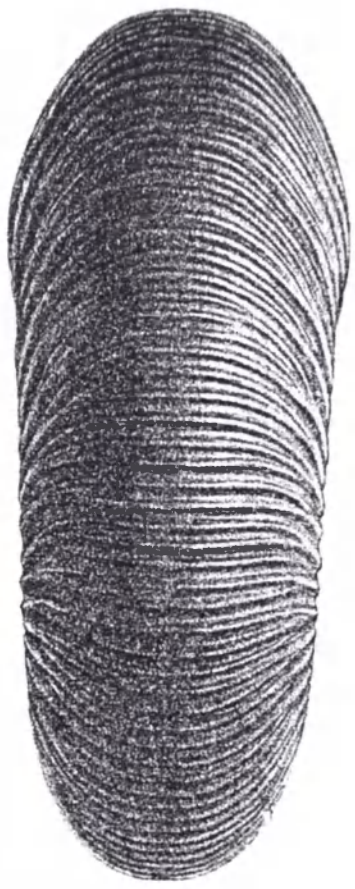
Fig. 2 *a*—*c*. PERISPHINCTES (~~AULACOSPHINCTES~~) MAYERI n. sp.
Page 358. Specimen with the shell partly adhering. Natural size. 2*a*, Lateral view. Three-quarters of the last whorl belong to the body-chamber. 2*b*, View of the external periphery. 2*c*, Outline of cross-section of the anterior part of the body-chamber. From Shangra, Gnari Khorsum, Coll. Schlagintweit, Munich.

JURASSIC FOSSILS (HIMALAYA).

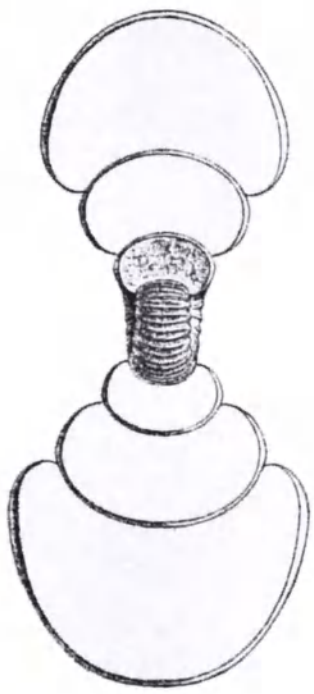
1a



1b

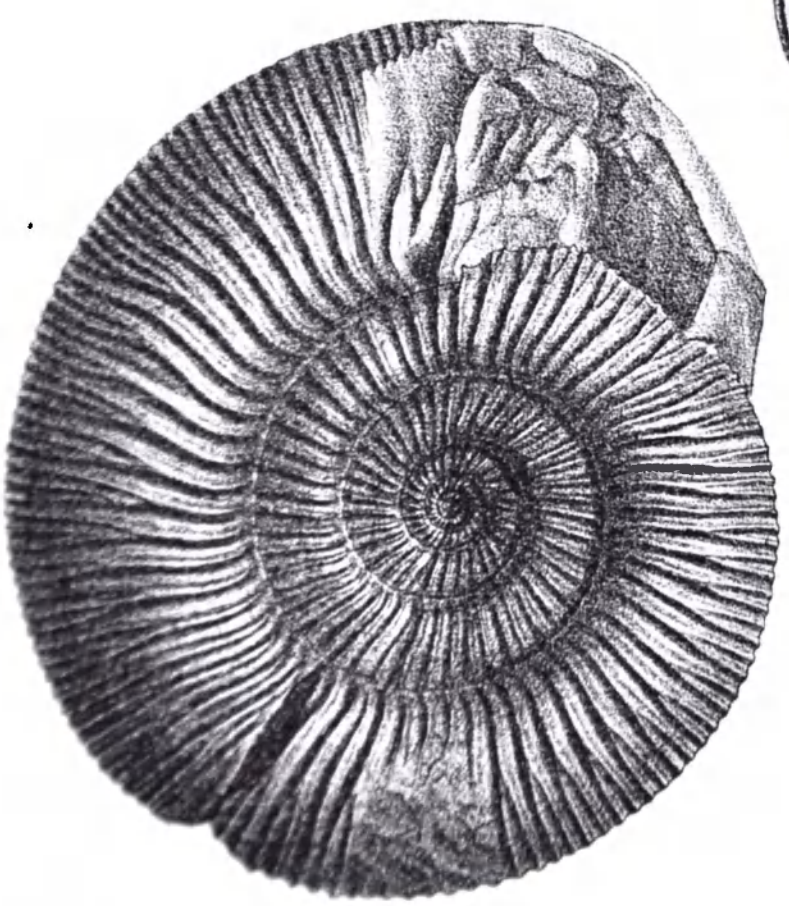


1c

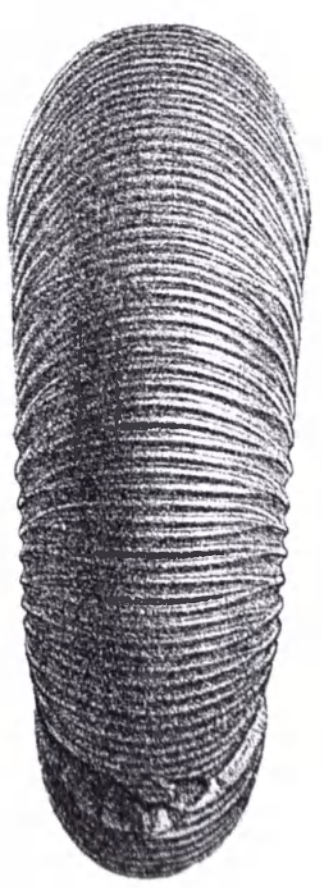


2c

2a



2b



Albert Berger

PLATE XCIII.

Fig. 1 *a—c*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Immature specimen. Natural size. 1*a*, Front view. 1*b*, *c*, Section through near the upper and lower extremities of the rostrum. From Spiti shales.

Fig. 2. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Front view of an immature specimen. Natural size. From Spiti shales.

Fig. 3 *a*, *b*. BELEMNITES (BELEMNOPSIS) ALFURICUS G. Boehm.
Page 388. 3*a*, Front view of a young specimen. 3*b*, Section through the rostrum at its lower end. Natural size. From Spiti shales.

Fig. 4. BELEMNITES (BELEMNOPSIS) ALFURICUS, G. Boehm.
Page 388. Front view. Natural size. From Spiti shales.

Fig. 5 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. 5*a*, Front view. 5*b*, Section through the rostrum at its upper end. From the Spiti shales of Niti.

Fig. 6. BELEMNITES (BELEMNOPSIS) ALFURICUS, G. Boehm.
Page 388. Front view of a specimen from the Spiti shales. Natural size.

Fig. 7 *a—c*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. 7*a*, Front view. 7*b*, Side view. 7*c*, Section through the rostrum at its upper end. Natural size. Jandu, Hundes.

Fig. 8. BELEMNITES sp. ind.
Page 389. Pathological specimen of *Belemnites Gerardi?* Natural size. From Spiti shales. (See also pl. XCIII-A, fig. 3 *a—d*.)

Fig. 9 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Specimen of normal size. 9*a*, Front view. 9*b*, Section through the rostrum at upper end. From Jandu, Hundes.

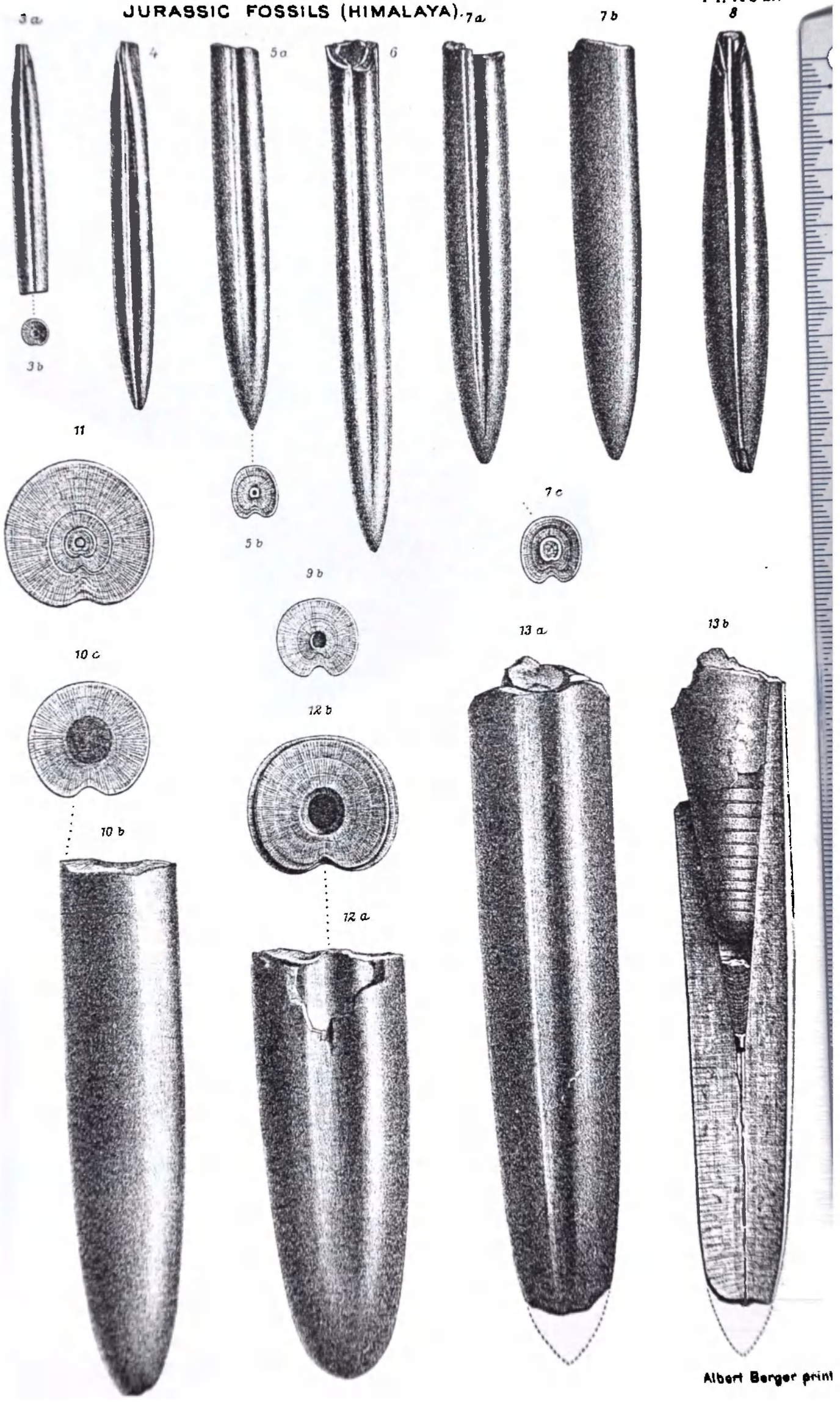
Fig. 10 *a—c*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Full-grown specimen. Natural size. 10*a*, Front view. 10*b*, Side view. 10*c*, Section through the rostrum at its upper end. From Jandu, Hundes.

Fig. 11. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Section through the rostrum of a full-grown specimen. From the Spiti shales.

Fig. 12 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Full-grown thick specimen. Natural size. 12*a*, Front view. 12*b*, Section through the rostrum at its upper end. From Jandu, Hundes.

Fig. 13 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Full-grown specimen. Natural size. 13*a*, Front view. 13*b*, Longitudinal dorso-ventral section of the rostrum, with phragmocone. From Jandu, Sherik river.

JURASSIC FOSSILS (HIMALAYA).



Albert Berger print

PLATE XCIII A.

Fig. 1 *a*—*c*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Phragmocone of a full-grown specimen. Natural size. 1*a*, Front view. 1*b*, Lateral view. 1*c*, Septum at lower end. Upper and Middle Spiti shales, Kuti.

Fig. 2 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Phragmocone of a full-grown specimen. Natural size. 2*a*, Lateral view. 2*b*, View of lower end. Between Ting Jung La and Chota Hoti.

Fig. 3 *a*—*d*. BELEMNITES sp. ind.
Page 389. Immature specimen with well marked dorso-lateral grooves. Natural size. 3*a*, Front view. 3*b*, *c*, Side view. 3*d*, Section through the rostrum at its upper end. (See pl. XCIII, fig. 8.) From Spiti shales.

Fig. 4 *a*, *b*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Phragmocone of an old specimen. Natural size. 4*a*, Lateral view. 4*b*, Septum at upper end. From Hundes.

Fig. 5 *a*—*c*. BELEMNITES (BELEMNOPSIS) GERARDI Oppel.
Page 386. Phragmocone of a young specimen. Natural size. 5*a*, Front view. 5*b*, Lateral view. 5*c*, View of lower end. From Jandu.

Fig. 6 *a*, *b*. ?DIPLOCONUS sp. ind.
Page 389. Phragmocone. Natural size. 6*a*, Lateral view. 6*b*, View of lower end, with a slight trace of the siphuncle on the right side. From Spiti shales.

1a

1b

2b

4b

3d

5c

3c

1c

3b

6a

5a

5b

4

3a

Albert Berger print