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LOWER TRIASSIC CEPHALOPODA FROM SPITI, MALLA JOHAR, AND BYANS.

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LOWER TRIASSIC CEPHALOPODA FROM SPITI, MALLA JOHAR, AND BYANS.

HIMALAYAN FOSSILS.

VOLUME VI, MEMOIR No. I.

LOWER TRIASSIC CEPHALOPODA FROM SPITI, MALLA JOHAR, AND BYANS.

BY

A. v. KRAFFT, PH.D., AND C. DIENER, PH.D.

INTRODUCTION.

BY

C. DIENER.

DURING the years 1899, 1900 and 1901 Dr. A. von Krafft was working on the lower Triassic faunæ of the Himálayas both in the field and in the museum. The description of the fossils from the Meekoceras and Hedenstrœmia beds of Spiti and Byans engaged him up to the day of his premature death (22nd September, 1901).

Among his papers was found a manuscript containing more or less complete descriptions of species belonging to the genera *Meekoceras*, *Hedenstrœmia*, *Xenodiscus*, *Ceratites*, *Sibirites*, *Proptychites*, *Tirolites*, *Flemingites*, *Nannites* and *Pleuronautilus*.

The late Mr. C. L. Griesbach, then Director of the Geological Survey of India, considered the work left by Dr. A. v. Krafft to be a very valuable contribution to Triassic palæontology, although a careful revision of the somewhat fragmentary notes, and the selection of suitable figures for illustrating the type-specimens, were found necessary for a publication of the final memoir. This task Griesbach reserved for himself for the time of his retirement from service, but his long and serious illness prevented his taking the active part that he had hoped in the completion of the memoir.

The duty of editing A. v. Krafft's memoir has fallen to my lot. Among his original descriptions only those of the species belonging to the genera *Meekoceras* and *Hedenstrœmia* had been partly revised by Griesbach. These were also illustrated by ten plates, and in addition unarranged material for eleven more plates was available. The work of comparing the type-specimens with the respective illustrations and of selecting the figures for ten more plates had still to be done. Nor did I find A. v. Krafft's descriptions of new species ready for publication. Since they were written our knowledge of lower Triassic Cephalopoda has increased considerably. I only need mention the beautiful monograph on the Triassic

E. v. Mojsisovics and by myself, but referred to the Permian by Frech, Noetling, and A. v. Krafft. The reasons for placing it in the Triassic system will be stated in the summary concluding this memoir.

In the series of thin-bedded limestones and shales between the layer with *Otoceras* and an earthy limestone with brachiopods (*Rhynchonella Griesbachi* Bittn.) 59 feet above the top of the Productus shales, a few fossils were found by Griesbach, but were in most cases too badly preserved to admit of determination. They were, however, sufficient to prove the lower Triassic age of the entire series up to the limestone with brachiopods, which was correlated with the lower Muschelkalk by Griesbach.

In 1883 the fauna with *Otoceras* was also obtained by Griesbach from Khar in Spiti, from the beds immediately overlying the Kuling shales. A second fauna, rich in cephalopoda, was discovered by the same author to the south-east of the village of Muth.

The expedition of 1892, in which C. L. Griesbach, C. S. Middlemiss and myself took part, led to the conclusion that at least two different cephalopod-faunæ were contained in the series between the top of the Productus shales, and the brachiopod-bearing limestone, with *Rhynchonella Griesbachi*, of the lower Muschelkalk. The *Otoceras* fauna was found to be the lowest, and restricted to the beds, less than three feet in thickness, overlying the Productus shales. The younger fauna, corresponding to the fauna of Muth in Spiti, was discovered in the upper division of the series, reaching 24 feet in thickness. For this upper division the term "Subrobustus beds" was proposed by myself in 1895, but the later discovery of the true layer of *Ceratites subrobustus* (= *Keyserlingites Dieneri* Mojs.), in the Muschelkalk, has induced A. v. Krafft to substitute the name "Hedenstrœmia beds," which has since been unanimously accepted.

In 1900 F. Noetling discovered a third cephalopod-bearing horizon of lower Triassic age in the same region. In the section of the Shalshal cliff this horizon is situated about 20 feet above the top of the Kuling shales, and is separated from the Otoceras beds by a band of green shales and dark blue limestone, of 18 feet in thickness. *Meekoceras Markhami* Diener was found to be its chief leading fossil.

The horizon of *Meekoceras Markhami*, for which the term "Meekoceras beds" has been proposed, is also known from Spiti, where it has been studied by A. v. Krafft and H. H. Hayden. *Meekoceras lilangense* Krafft and *Meekoceras Varaha* Dien. are its leading fossils in the section of Lilang. It is only three feet in thickness, and is overlaid by a thin-bedded nodular limestone with *Hedenstrœmia Mojsisovicsi* Dien.

The section of the Shalshal cliff in Painkhánda was studied in detail by C. L. Griesbach and myself in 1892 and by F. Noetling in 1900. I wish to call the special attention of the reader to the fact, that there is a complete agreement between our observations regarding the actual sequence of the beds, and that we differ only in their correlation.

In the section of the Shalshal cliff the sequence of lower Triassic beds, according to Noetling's [1] last reports, is as follows:—

10. Hard, splintery, nodular limestone, grey, thick bedded, with very thin layers of dark shale intercalated, 60 feet (*Niti limestone*).
9. Thin bedded, grey limestone, with regular partings of shale, having a total thickness of 25 feet.
8. Grey limestone divided into two bands by a shaly parting, very poor in fossils, 5 feet.
7. Dark olive-green shales, with partings of concretionary limestone near base, containing the main layer of *Meekoceras Markhami* Dien., having a total thickness of 6 feet.
6. Dark blue hard limestone, unfossiliferous,
5. Dark olive-green shales, unfossiliferous, } 12 feet.
4. Dark blue limestone, rich in *Ophiceras tibeticum* Griesb., 1 foot.
3. Dark, hard clay, thick-bedded, with a few fossils in limestone concretions (*Episageceras dalailamæ* Dien.), 2 feet.
2. Dark blue, hard limestone, with *Otoceras* and numerous Lamellibranchiata, 1½ feet.
1. Dark thin bedded shales, with partings of concretionary limestone (*Productus shales*).

Nos. 2, 3 and 4 correspond to the Otoceras beds with the main layer of *Otoceras Woodwardi* at their base; no. 7 corresponds to the Meekoceras beds. The horizon of *Rhynchonella Griesbachi* has been included in the Hedenstrœmia beds (nos. 8, 9) by Noetling, who draws the boundary between the lower Trias and the Muschelkalk at the base of the Niti limestone and that between the Triassic and Permian systems above the limestone band with *Ophiceras tibeticum* (no. 4).

In Spiti the marine lower Triassic section is not less complete than in Painkhánda, nearly all the beds having yielded determinable fossils, although not all of them in the same section. The amount of rock that is practically unfossiliferous is even smaller than in the Shalshal cliff.

The following is a section near Lilang, which I have compiled from A. von Krafft's diary and from the notes published by H. H. Hayden in his memoir on the geology of Spiti (*Memoirs, Geological Survey of India*, Vol. XXXVI, Pt. 1, pp. 62–67).

11. Nodular limestone, 60 feet (*Niti limestone* of Noetling).
10. Shales
9. Shaly limestone } 6 feet. { Horizon of *Rhynchonella Griesbachi* Bittn. / Horizon of *Pseudomonotis himaica* Bittn.
8. Grey shaly limestones and grey shales, alternating very regularly; 24 feet. } Unfossiliferous.
7. Nodular limestone with very thin shaly partings, 5 feet 7 inches. } *Hedenstrœmia Mojsisovicsi* Dien., *Xenodiscus nivalis* Dien.
6. Grey, shaly limestone, 7 inches.
5. Shales, 10 inches. } Poor in fossils. No determinable ammonites.
4. Concretionary limestones and shales, 3 feet. } Very rich in *Meekoceras*.
3. Grey limestones, 1 foot 5 inches. { *Ophiceras Sakuntala* Dien. and *Pseudomonotis Griesbachi* Bittn.
2. Sandy limestone, 1 foot 7 inches. Unfossiliferous.
1. Ferruginous limestone, 5 inches. *Otoceras* and *Ophiceras div. sp.*

[1] *F. Noetling*: Ueber das Alter den Otoceras Schichten von Rimkin Paiar (Painkhánda) in Himalaya, Neues Jahrb. f. Miner., etc. Beilagebd. XVIII, 1904, p. 541, and Lethæa mesozoica, Vol. I. Asiatische Trias, 1905, p. 127-139.

Nos. 1, 2, 3 correspond to the Otoceras beds, no. 4 to the Meekoceras beds, and nos. 5, 6, 7, 8, and 9 to the Hedenstrœmia beds *sens. str.* of the Shalshal cliff. A. v. Krafft left the age of no. 3 doubtful, not being able to assign it definitely either to the Permian or Triassic system. On the other hand he included in the lower Trias not only the horizon of *Rhynchonella Griesbachi* (no. 10), but even the Niti limestone, on the strength of the discovery of two ammonites by Hayden, which were referred to species of lower Triassic age. This question will be discussed more fully in the summary at the end of the present memoir.

A similar section of the lower Triassic rocks of Spiti in the hills S. E. of Muth has been published by Hayden (l. c. Pl. IV). But here, as in some other sections in Spiti, ammonites of the Hedenstrœmia beds occur throughout the entire series of thin-bedded limestones and shales (no. 8), whereas the band of grey limestones at the base, which has not yielded any determinable fossils (no. 6), reaches nearly 4 feet in thickness.

To Hayden we owe the credit of the discovery in 1900, of the layers of *Rhynchonella Griesbachi* and of *Pseudomonotis himaica* which had been overlooked previously.

It is evident from all these sections in Spiti, that the Meekoceras beds are more intimately connected stratigraphically with the underlying Otoceras beds, following upon the grey limestones with *Ophiceras* without any sharp boundary, whereas they are separated from the Hedenstrœmia beds by a band of rocks which are practically unfossiliferous. In fact in none of the collections made previously to 1899 had the fossils from the *Ophiceras* and *Meekoceras* horizons been kept separate. Thus the original horizon of numerous species, marked as coming from B_1 (Otoceras beds Diener 1897), in Griesbach's and Hayden's collections could not be fixed with certainty.

In the following descriptions it will therefore be found convenient, to divide the lower Triassic series of Spiti into two divisions, uniting in the lower division the Otoceras beds and Meekoceras beds, whereas the Hedenstrœmia beds and the horizon with *Pseudomonotis himaica* are included in the upper one.

Red limestones with lower triassic cephalopoda pointing to the Hedenstrœmia beds of Spiti have also been discovered among the exotic blocks of Malla Johar by A. v. Krafft (E. B. No. 20).[1]

In Byans the Productus shales have been stated by F. H. Smith to pass very gradually by interstratification into a compact mass of Chocolate Limestone. No fossils were found in the passage beds. The Chocolate Limestone is very poor in fossils in the Kalapani district, but near Kuti and Jolinka a band of sandy rock appears in the limestone, about 5 feet in thickness. This band and the neighbouring beds are rich in Cephalopoda, especially of the genus *Sibirites*. The stratigraphical importance of this discovery was recognised by A. v. Krafft, who correlated this horizon with the zone of *Stephanites superbus* of the upper Ceratite limestone of the Salt Range.[2]

[1] Notes on the exotic blocks of Malla Johar, *Memoirs, Geol. Surv. India*, Vol. XXXII, Pt. 3, p. 141.

[2] *General Report, Geol. Surv. India*, for 1900-01, p. 4.

The Chocolate Limestone passes somewhat abruptly into the grey massive limestone of the Muschelkalk, the basal beds of which, 2 or 3 feet in thickness, are often composed entirely of broken crinoid stems. In my memoir on the fauna of the Himálayan Muschelkalk (*Him. Foss.*, Vol. V, Pt. 2, p. 138) I have been able to show that the horizon with *Rhynchonella Griesbachi* is also developed in the sections near Kalapani, but in a bed differing lithologically from the Chocolate Limestone of lower Triassic age.

SYSTEMATIC DESCRIPTIONS.

A. AMMONOIDEA.

Genus: Meekoceras Hyatt.

"The genus *Meekoceras* has been largely commented upon by Waagen and Diener. The first mentioned author introduced some very important changes into the circumscription of the genus, by separating many types from *Meekoceras* and placing them in other genera. Diener, however, reinstated the genus in its original wide range. As I agree in the main with Prof. Diener, I need not repeat the points of the discussion he deals with, but may refer the reader to the lucid statement in his memoir (*Himálayan Fossils*, Vol. II, Pt. 1, p. 126) and confine myself to explaining the few points, in which I differ from him.

"The genus *Meekoceras* was founded on three species, *viz.*, *M. aplanatum* White, *M. Mushbachianum* White, and *M. gracilitatis* White[1]. The first of these three species is based on two specimens. Waagen (Fossils from the Ceratite formation, *Salt Range Foss.*, Vol. II, p. 290) considered one of them (White, l. c. Pl. XXXI, fig. 1*c*) to be a different species and genus. He renamed this specimen *Gyronites Whiteanus*, while he retained the name *M. aplanatum* for the other. As to the generic position of the latter Waagen came to no definite conclusion. He pointed out that it is doubtful whether it belongs to *Gyronites* or to *Xenaspis*.

"Diener, on the other hand, leaves both specimens in *Meekoceras*, although he was not certain whether *Gyronites Whiteanus* ought not rather be classed with *Danubites* or with *Ophiceras* (*l. c.* p. 29).

"I am going to show in the introduction to *Xenodiscus*, that all evolute types with a distinct lateral sculpture and two lateral saddles must be united with *Xenodiscus*. A third character, formerly made use of in defining *Xenodiscus*, *viz.*, the length of the body-chamber, is of too questionable a value to be applied advantageously. Now, judging from the illustration of *Gyronites Whiteanus*, as given by White, there can, in my opinion, be no doubt that it agrees perfectly with *Xenodiscus*. As the latter genus was proposed in 1879, *i.e.*, before the time that Hyatt's

[1] *C. A. White:* Triassic fossils from Southern Idaho. Fourth Annual Report of the U. S. Geograph. and Geol. Survey of the Territories, 1883, Pt. 1, p. 112, Pl. XXXI, figs. 1*a*, 1*b*, 1*d* (not 1*c*), 2*a*, *b*, *c*, *d*, Pl. XXXII, figs. 1*a*, *b*, *c*, *d*.

types of *Meekoceras* were described and figured (1883), the only correct course to adopt is to separate *Gyronites Whiteanus* from *Meekoceras* and to unite it with *Xenodiscus*.[1]

"As regards the rest of the types of *Meekoceras*, I agree with Diener that they should be left in the genus. Doubt could only arise with respect to *M. aplanatum* (l. c. Pl. XXXI, fig. 1*a*), which is more evolute than all the congeneric forms described by White, and bears a few faint ribs near the anterior termination. But there is no sufficient reason for separating this species from *Meekoceras*, the sculpture being too indistinct to be compared with that of either *Xenaspis* or *Xenodiscus*.

"A point on which I differ from Prof. Diener, relates to the subdivision of the genus *Meekoceras* into several subgenera, according to differences in the development of the auxiliary series. In this subdivision Diener follows Waagen, by classifying as subgenera certain groups of types which Waagen considered to be genera.

"The lower Triassic subgenera of *Meekoceras* alluded to are *Kingites*, *Koninckites* and *Aspidites*. Prof. Diener was no doubt perfectly right when he said that Waagen's genera, in the family of *Meekoceratidæ*, are too narrowly circumscribed in comparison with any other family of cephalopoda, and that a generic difference, founded on the development of the auxiliary series only, is not in accordance with the general custom of the interpretation of the extent of single genera.

"I would go even further and say that differences in the auxiliary series are even insufficient for the distinction of subgenera. If subgenera like *Kingites* and *Koninckites* were established, several of the Triassic and Permian genera of ammonites would likewise have to be subdivided. If this process were carried out, it would lead to an unlimited splitting up of genera. But, apart from this objection, I am convinced that the systematic value of differences in the auxiliary series has altogether been greatly overrated by Waagen, because they are far from being defined sharply, as is evident from Waagen's own classification.

"As to *Aspidites*, its generic designation, given by Prof. Waagen on p. 207 of his memoir on the fauna of the Ceratite Formation, runs as follows:—

"'Its auxiliary series in the sutural line is composed of many coarse and unequally sized denticulations, which are arranged in a completely irregular manner, but never form regular auxiliary lobes.'

"Now if we compare the illustration of *Aspidites discus* Waagen (l. c. Pl. XXV, fig. 2), we find that this species shows a perfectly regular sutural line. Its denticulations are neither very coarse, nor arranged in a completely irregular manner, but form three regular auxiliary lobes. This fact is also evident from Waagen's own description (p. 229), which runs as follows:—"There are three auxiliary lobes, which are very similar to each other."

"*Aspidites evolvens* (Pl. XXV, fig. 1) also shows great regularity, at least in the character of the first auxiliary lobe, which is subdivided by a median prominence into two perfectly equal branches. Prof. Waagen introduced for this species and a second one, *Aspidites Kingianus* Waagen (l. c. Pl. XXXII, fig. 1)

[1] See introduction to *Xenodiscus*.

a special group of '*dimeri*', which has 'its first auxiliary lobe very regularly divided by a secondary saddle into two symmetrical branches, each of which bears two denticulations.'

"This definition of the group of *dimeri* is certainly well applied to *Aspidites evolvens*, but does not agree with the figure of *Aspidites Kingianus*, since the branches of the first auxiliary lobe of this species are only occasionally equal, while as a rule one branch bears two, and the other, three denticulations. On the whole the first auxiliary lobe of this species is not by far so regular in appearance as in *Aspidites evolvens*.

"But apart from the fact, that, correctly speaking, the diagnosis of the group of '*dimeri*' does not suit *Aspidites Kingianus*, this diagnosis in itself is at variance with the general characters indicated for the genus *Aspidites*, which had been originally proposed by Waagen for *Meekoceratidæ* with a very irregular series of auxiliary elements.

"Prof. Diener proposed a small change in the diagnosis of *Aspidites*, as given by Waagen. He emphasized the fact that in *Kingites* Waagen the auxiliary series consists of a varying number of denticulations, which are of unequal size and stand all on the same level, whereas in *Aspidites* distinct auxiliary members are distinguishable among a long row of coarse and irregular denticulations.

"This diagnosis suits *Aspidites superbus* Waag. perfectly well, but if we compare the other species of *Aspidites* described in Prof. Waagen's memoir doubts must again arise as to whether they can be included in Diener's subgenus or not. This applies not only to *Aspidites evolvens* and to *A. discus*, for reasons already stated above, but also to *Aspidites magnumbilicatus*, in which latter species only two irregular denticulations, or rudimentary saddles, follow the first auxiliary lobe.

"Many palæontologists will certainly criticise the manner in which the descriptions of Waagen and Diener have been treated here, as exaggerated. But their distinctions of subgenera, or even genera, of *Meekoceratidæ* have, indeed, been based on such minute differences that we can only hope to arrive at a satisfactory classification, if every word of the original diagnosis is painfully studied.

"We now proceed to the genus *Koninckites* Waagen. Its characters of generic importance are described by Waagen (Fossils from the Ceratite formation, l. c. p. 259) as follows:—

"'The leading feature of the species of this genus is the existence of an auxiliary lobe.....which is neither of excessive breadth, nor shows very irregular denticulations, and which is separated from the rest of the auxiliary series by a distinct auxiliary saddle.'

"I have to raise some strong objections against Waagen's classification with reference to his diagnosis of the genus *Koninckites*. In the following species:—

Koninckites vetustus W. (l. c. Pl. XXVII, fig. 4),
" *voluntus* W. (l. c. Pl. XXVIII, fig. 2),
" *Vercherei* W. (l. c. Pl. XXX, fig. 1),

Koninckites Davidsonianus W. (l. c. Pl. XXXIII, fig. 4),
„ *impressus* W. (l. c. Pl. XXXV, fig. 6),

the auxiliary saddle is so very small and indistinct, that it is really difficult to distinguish it from the rest of the denticulations as a proper sutural element. This remark applies especially to *Koninckites volutus* and *K. impressus*.

"Another point to be mentioned is the following. The sutural line of *Koninckites gigas* Waag. (l. c. Pl. XXXI, fig. 2*c*) shows an auxiliary lobe, which is just as broad as the second lateral lobe, but is evidently not considered by Waagen to be of excessive breadth. If this species is included in *Koninckites* —why, we must needs ask, has *Aspidites magnumbilicatus* Waag. (l. c. Pl. XXVI, fig. 5*c*) not been placed in the genus *Koninckites*, as its auxiliary lobe is also exactly as broad as its second lateral lobe? It might be urged that the first auxiliary lobe in *Aspidites magnumbilicatus* is more irregular, but an equally irregular auxiliary lobe is also noticed in *Koninckites Vercherei* Waag. (l. c. Pl. XXX, fig. 1*c*), which has not prevented Prof. Waagen from uniting this species with his genus *Koninckites*.

"With as equal reason as *Koninckites gigas*, *Meekoceras pulchrum* Waag. (l. c. Pl. XXIX, fig. 1*c*) might be included in *Koninckites*. Its auxiliary lobe is regular, narrower than the second lateral lobe—consequently not of excessive breadth—and is followed by an auxiliary saddle, which, although very small, is scarcely less indistinct than in *K. Davidsonianus*.

"Such sharp distinctions as were made by Waagen are only possible, when single specimens of each species only are available for examination. How dangerous the sharp distinctions introduced by this learned author are, may be gathered from the great similarity between *Koninckites gigas* and *Aspidites Kingianus*, described in his memoir (Pl. XXX, fig. 2 and Pl. XXXII, fig. 1). The two specimens classed with two separate genera by Waagen are so very similar, that I cannot see any reason why they should not belong to the same species. The very slight differences in the arrangement of the umbilical lobe can easily be due to different degrees of weathering. But supposing them to be original, I very much doubt whether a specific distinction could be formed on them. In support of these remarks I may refer the reader to the variability of the sutural lines in *Meekoceras Markhami*, *Meekoceras spitiense* and *M. alterammonoides*.

"Prof. Diener's diagnosis of the subgenus *Koninckites* is, if strictly interpreted, at variance with that of Prof. Waagen. Diener proposes to unite in *Koninckites* those species of *Meekoceras*, in which the development of the auxiliary series has advanced to the individualisation of the first auxiliary saddle and, in some forms, even to that of a second auxiliary lobe. According to this diagnosis *Meekoceras pulchrum* Waag. and *M. varians* Waag. (l. c. Pl. XXIX, fig. 3) would also have to be classed with *Koninckites*, as in both species a distinct auxiliary saddle is present.

"Waagen's distinction between *Meekoceras* and *Kingites* is still less justified. It is only a matter of individual taste, whether in a row of unequal denticulations

the first auxiliary lobe should or should not be considered a distinct sutural element. If we compare, for instance, the umbilical lobe of *Meekoceras Hodgsoni* Diener (*Himalayan Foss.*, Vol. II, Pt. 1, Pl. VI, fig. 1) with that of *Kingites Varaha* Diener (l. c. Pl. VI, fig. 2, VII, fig. 6), we must needs admit that the small difference existing cannot be sufficient to justify a generic distinction. The close affinity, which, according to my opinion, really exists between these two forms does not become by any means clearer, but is on the contrary obscured, by placing them in two different subgenera.

"This much may suffice to show that the subgenera in question are not circumscribed in a very satisfactory manner. It is self evident that we find ourselves on very unsafe ground, as soon as we try to make use of these subgeneric designations in determining any new species.

"A way out of this difficulty would be to propose a new scheme for the subdivision of the genus *Meekoceras*. Seeing, however, the small success arrived at by my two distinguished predecessors, I can hardly find the courage to try so difficult a task. Moreover, the materials at hand are too limited to afford enough new points of view. I therefore prefer to abstain from a new classification, leaving the fulfilment of this task to other palæontologists. It seems not impossible to arrive at clear definitions, provided that more materials are available.

"On the other hand it cannot be denied that in each of the subgenera *Aspidites*, *Koninckites*, *Kingites*, and *Meekoceras s. s.*, certain types are present, to which the subgeneric definitions of Prof. Diener are perfectly well applicable, and which, moreover, are so characteristic, that it seems impossible to unite them with types of other subgenera.

"Without maintaining Waagen's genera of *Meekoceratidæ*, the subdivisions proposed by Prof. Diener can be made use of in arranging the Himalayan species of *Meekoceras* in several more or less roughly defined sections. I do not propose to follow Prof. Diener in every detail, but the four following groups of forms may be distinguished, according to the general arrangement of their sutural lines:—

"1. Types with broad siphonal lobe and narrow umbilical lobe. I propose to call this section, which corresponds to *Meekoceras s. s.*, and *Kingites* Waag., *Group of Meekoceras Varaha Dien.*

"2. Types with broad siphonal lobe and broad umbilical lobe, consisting of a row of irregular points. This section corresponds to Waagen's genus *Aspidites*, and I propose for it the name: *Group of Meekoceras spitiense.*

"3. Types with broad siphonal and broad umbilical lobe, in which one of the points is more or less distinguished from the rest by its greater size. The point is either entire, then resembling a true saddle, or it is subdivided by denticulations. This group, which corresponds to the genus *Koninckites* Waag., I propose to call: *Group of Meekoceras Yudishthira Dien.*

"4. Types with narrow siphonal lobe and narrow umbilical lobe. The denticulations of the lateral lobes are generally very delicate, or the lobes appear in part even goniatitic. This group includes certain types classed by Waagen with hi

genus *Gyronites* (*G. vermiformis* Waag. l. c. Pl. XXXIX, fig. 1, *G. frequens* Waag. l. c. Pl. XXXVII, figs. 1—4) and with *Lecanites* (*L. psilogyrus* Waag. l. c. Pl. XXXIX, fig. 5), which is presumably identical with *Gyronites frequens*. For this group I propose the name : *Group of Meekoceras disciforme.*

"One specimen in the collection, which has peculiar features in its siphonal lobe, must be regarded as an isolated species, and has therefore not been included in any of the above groups.

"I abstain from giving any more detailed description of these sections, as they are not sharply defined, but pass more or less into each other. Cases will always occur, in which doubts may arise, as to whether the one or the other group is present and where the classification is more or less a matter of personal taste. So, for instance, it might be doubted whether *Meekoceras tenuistriatum* nov. sp. should be classed with the first or with the second group, the umbilical lobe being broader than in *M. Varaha*, but not as broad as in *M. spitiense*. *Meekoceras alterammonoides* might with equal right be classed with group 1 or 3. One of my specimens, by which this species is represented, has a rather narrow umbilical lobe without a distinctly individualised saddle, while in the second this saddle is present and the umbilical lobe is broader."

I have quoted A. v. Krafft's introduction to *Meekoceras* in full. Since those notes were written (1901) two important memoirs have been published, in which the classification of the *Meekoceratidæ* was subjected to a thorough revision.

The first to undertake this revision was Frech (*Lethæa Palæozoica*, Vol. II, Dyas, p. 630—638 and *Lethæa Mesozoica* Vol. I, 2 Liefg., Remarks to Pl. 22—28). He proposes to drop the family of *Meekoceratidæ*, altogether, and even rejects the name of *Meekoceras*, because in Hyatt's original description not only had the three American species from the lower Trias of Idaho been included, but also several foreign species, assigned later on to *Balatonites*, *Xenodiscus* and *Dorycranites*. There being no difference whatever between the two groups of form distinguished as *Meekoceras* and *Prionolobus* by Waagen, he chooses the latter name as the generic designation of the species hitherto united in *Meekoceras*.

The genera of *Meekoceratidæ* distinguished by Waagen are divided by Frech between *Ophiceras*, *Prionolobus*, *Aspidites*, *Ambites*, *Gyronites* and *Kymatites*, while the species from the Salt Range, which had been identified with *Lecanites* by Waagen, are all united with *Ophiceras* Griesb. In *Prionolobus* he includes the more evolute types with slowly increasing whorls, faintly developed auxiliary elements, and with a body-chamber measuring more than one-half of a volution in length. *Aspidites*, in the circumscription proposed by Frech, comprises the involute types, with strongly developed auxiliary elements, with rapidly increasing whorls and with a body-chamber measuring only one-half of a volution in length.

Koninckites Waagen in which species belonging either to *Aspidites* (*K. Davidsonianus*) or to *Prionolobus* (*K. gigas*, *K. volutus*), have been mixed up by Waagen, is rejected as a group. *Kingites* Waag. represents the adolescent stage of *Aspidites*; *Proptychites* and *Clypites* are special groups within this latter genus.

The second memoir dealing with the classification of the *Meekoceratidæ* Waag., is the monograph on the Triassic cephalopod genera of America by Hyatt and Smith (*United States Geol. Survey Prof. Papers*, no. 40). It is so much the more important, because the classification proposed by these two distinguished authors has been based on personal re-examination of all the original types of *Meekoceras* discovered by White. I have the satisfaction that they agree with my own views, as explained in my memoir on the Cephalopoda of the Himálayan lower Trias in 1897, in almost every point of importance.

All forms agreeing with any one of the three species *Meekoceras aplanatum* White, *M. Mushbachianum* Wh. and *M. gracilitatis* White, which had been previously described in 1879, are regarded by them as belonging to the genus *Meekoceras* in a broader sense. The two authors are certainly right in remarking that the attempt to substitute the name of *Prionolobus* for that of *Meekoceras* is contrary to the rules of palæontological nomenclature. Four subgenera are distinguished within this genus in a broader sense, namely :—

1. *Meekoceras sens. str.* (type *M. gracilitatis* Wh.)
2. *Gyronites* Waag. (type *G. frequens* Waag., corresponding to *M. aplanatum* Wh.)
3. *Koninckites* Waag. (type *K. vetustus* Waag., corresponding to *M. Mushbachianum* Wh.)
4. *Prionolobus* Waag. (type *P. atavus* Waag., corresponding to *P. Waageni* Hyatt and Smith.)

Aspidites Waag. (type *A. superbus* Waag.) is allowed to stand as an independent genus, because it is different from any species included by Hyatt under the original description. *Clypites* is also considered as a proper genus, on account of the simple arrangement of its auxiliary series and of the development of adventitious lobes.

As is evident from a comparison of all these different attempts to arrive at a satisfactory classification of *Meekoceras*, no other genus of Triassic ammonites appears to have been treated so variously, and to offer similar difficulties to its distribution among different groups. Now the task devolves upon me of indicating a way out of this confusion.

That the genera of *Meekoceratidæ* cannot be maintained in the narrow circumscription proposed by Waagen, is pretty certain. The majority of them at least must be united in one genus, for whose denomination we have to choose between the names *Meekoceras* or *Prionolobus*. According to the strict rules of palæontological nomenclature there is only one decision possible, and this is in favour of the first alternative. As has been remarked by Hyatt and Smith, three American species of the genus were fully described and figured as *Meekoceras* in 1879, and one of the three was certainly the type. "The fact that later writers have extended the genus *Meekoceras* to take in heterogeneous elements, does not invalidate it. If any such rule in nomenclature should be accepted, almost every genus of ammonites would be thrown out and new names substituted" (l. c. p. 143).

From A. v. Krafft's own descriptions we can see that, in almost each of the

subgenera distinguished among the genus *Meekoceras* in a broader sense, certain types can be found, to which the subgeneric definitions proposed by myself in 1897, "are perfectly well applicable, and which, moreover, are so characteristic that it seems impossible to unite them with types of other subgenera."

A. v. Krafft chiefly objected to the introduction of subgenera, because he found it impossible to give a diagnosis of each subgenus, which would suit all species included, and still leave the subgenus sufficiently differentiated from the others. But there are many groups of ammonites in which this theoretical demand cannot be fulfilled, and in which we needs must make use of a rather arbitrary or artificial separation.

In each of my subgenera proposed in 1897, there is a type which agrees exactly with the diagnosis of the subgenus. In grouping all the Himálayan form described by A. v. Krafft around those subgeneric types, we shall be able to arrive at a satisfactory classification. Such new forms as cannot be compared with any of them, will have to be united in new groups, or considered as isolated species of *Meekoceras* in the broader sense.

This way out of the difficulty connected with the determination of Indian *Meekoceratidæ* is a mere preliminary expedient, and not a systematic rearrangement of all the species, as I shall not extend my researches beyond the subdivisions of the Himálayan forms of lower Triassic age.

The examination of A. v. Krafft's abundant materials, together with the results of the palæontological work accomplished by Frech, Hyatt and Smith, induces me, however, to propose one important alteration in my previous classification of the subgenera of *Meekoceras*. The two subgenera *Kingites* and *Prionolobus* will be dropped, the differences in the arrangement of their auxiliary series being too insufficient for a subgeneric distinction.

Kingites and *Prionolobus* had been proposed by Waagen for the accommodation of species with a row of auxiliary denticulations standing all on the same level, whereas an individualisation of the first auxiliary lobe within this row is considered as a leading feature of *Meekoceras s. s.* As will be shown in detail from A. v. Krafft's descriptions of several new species of *Meekoceras* from the lower Trias of Spiti, these differences are not even of specific importance, being subject to individual variation (compare the description of *Meekoceras Markhami* Dien.).

On the other hand I am not inclined to follow Hyatt and Smith in separating the evolute species with low whorls as *Gyronites* from the typical shapes of *Meekoceras*, finding it impossible to draw any boundary between the types allied to either *Meekoceras gracilitatis* or *M. aplanatum*. Nor did I deem it appropriate to separate *Aspidites* from *Meekoceras* as a proper genus, as has been suggested by those two eminent authors. The species grouped round *Aspidites superbus* Waag. are connected so closely with some of the types included in *Kingites* by Waagen, that they cannot be conceded more than subgeneric rank.

Most of the Himálayan species of *Meekoceras*, described previously, will be found redescribed in the following pages.

The number of new species is very considerable. Most of these come from Spiti, where a rich fauna of *Meekoceras* is met with in the lower division of the lower Trias. The horizon of *Meekoceras Markhami*, discovered in Painkhanda (Shalshal cliff) by Noetling, appears to be much poorer in species, although it is rich in individuals

In his introduction to *Meekoceras* A. v. Krafft has added a few remarks as to the probable derivation of this genus. I again quote his original notes in full although I do not entirely agree with his views.

"I think there can be little doubt that *Meekoceras* is a descendant of *Ophiceras*, and more particularly of the type with a narrow umbilicus, which is represented by *Ophiceras Sakuntala* Dien. The figures of this species in Prof. Diener's memoir, Pl. X, especially figs. 2, 3 and 7, show this affinity in a most striking manner. Diener himself remarks (p. 100), that *Ophiceras* is so vaguely separated from *Meekoceras*, that, with the exception of Griesbach all the authors who have treated this subject, have either united the two, or, if any, as for instance Waagen, considered *Ophiceras* to be a proper genus, he did so on the supposition that an adventitious lobe, which does not exist in reality, was present. For all that, Diener maintains the genus on the grounds of a concentric striation, restricted almost exclusively to the internal cast, and either quite absent, or very indistinct, on the surface of the shell. He concludes, that, owing to this character, *Ophiceras* differs from *Meekoceras*, and is brought into close affinity with the *Gymnitinæ*.

"Now, I have observed a spiral striation very similar to that of *Ophiceras* in several species of *Meekoceras*. The striation is on these, too, practically confined to the cast, and is scarcely perceptible on the surface of the shell. The striation was observed on the external part only in one instance, but generally it is confined to the lateral parts, chiefly to the middle region, where the striæ run along a more or less prominent spiral groove (compare the description of *M. lilangense*.) This being so, the difference between *Ophiceras* and *Meekoceras* becomes more or less obliterated.

"I agree with Diener, when he regards *Flemingites* as allied to *Ophiceras*, but this does not prevent *Meekoceras* from being another branch of the descendants of *Ophiceras*.

"In short it appears to me, that the latter genus is the ancestor of two different groups of types, one leading to *Flemingites* and the other to *Meekoceras*. While the former may be supposed to have branched off from types with wider umbilici and a stronger lateral sculpture, the latter appears to be derived from the smooth types, with narrow umbilici, represented by *Ophiceras Sakuntala* Dien.

"This alone would be sufficient to maintain the genus *Ophiceras*, but there are also the following reasons for doing so. The genus as a whole could not conveniently be classed with any other. It has been demonstrated by Diener, that all the different species of *Ophiceras* are connected very closely by transitional forms. They cannot therefore be divided up into several sub-genera, and further they all

have the marked spiral striation in common, which, although similar to that in *Xenodiscus* and *Meekoceras*, is more pronounced, and is distributed more universally over the whorls."

Genus : MEEKOCERAS (*sensu stricto*) Hyatt.

The type of this genus is *Meekoceras gracilitatis* White. In this genus are united the majority of species which have been divided by Waagen among the genera *Meekoceras*, *Gyronites*, *Kingites* and *Prionolobus*. In Waagen's genus *Gyronites* I propose to include provisionally such species as have no distinct lateral sculpture, namely :—

Gyronites frequens Waagen (l. c. p. 292, Pl. XXXVII, f. 1-7).
„ *evolvens* Waagen (l. c. p. 295, Pl. XXXV, fig. 7).
„ *superior* Waagen (l. c. p. 294, Pl. XXXVII, fig. 6).
„ *vermiformis* Waagen (l. c. p. 305, Pl. XXXIX, fig. 1).

It will be found that all these species agree, as regards their involution, with one of the original types of *Meekoceras aplanatum* White.

It must, however, be borne in mind, that all these species are very difficult to separate from *Ophiceras* Griesb. by reason of the uncertainty of their distinctive characters. The diagnostic mark of *Ophiceras*, the spiral striation, appears only on the cast ; and as it disappears when the specimen is poorly preserved, which is the case with nearly all the examples from the lower Ceratite limestone, some of the species, which have been assigned to *Gyronites* by Waagen, may really belong to *Ophiceras*.

The same remark applies to some of the species described by Waagen under the generic name of *Prionolobus*, which have no distinct lateral sculpture. They are :—

Meekoceras (*Prionolobus*) *atavum* Waagen (l. c. Pl. XXXIV, fig. 1).
„ (*Prionolobus*) *rotundatum* Waagen (*ibid*, fig. 1-3).
„ (*Prionolobus*) *sequens* Waagen (*ibid*, fig. 5).

Meekoceras rotundatum must receive a new specific denomination, as the name had already been applied by E. v. Mojsisovics to one of his Siberian species. A. v. Krafft proposes to call this type *Meekoceras Waageni*.

A considerable number of species, which were described by E. v. Mojsisovics from the Olenek beds of Siberia, under the generic name of *Xenodiscus*, should be included in *Meekoceras* and separated from *Xenodiscus*, as they do not agree with the type of the latter genus, *X. plicatus* Waagen.

On the other hand *Meekoceras falcatum* Waagen (l. c. Pl. XXXVI, fig. 4) must be excluded from *Meekoceras* and placed in *Xenodiscus*. The reasons for doing so will be stated in the introduction to the genus *Xenodiscus*.

The Himálayan species of the genus *Meekoceras* have been divided by A. v. Krafft into the groups of *M. Varaha* and *M. disciforme*. I do not consider

these groups as proper subgenera, the differences between them being too slight, and not prominent in all the species described by A. v. Krafft, especially the narrowness of the siphonal lobe, which is considered as one of the leading features in the group of *M. disciforme* by that learned author. Nor is the umbilical lobe narrower in the group of *M. Varaha* than in some species of *Koninckites* or *Aspidites*, which correspond to A. v. Krafft's groups of *M. Yudishthira* and *M. spitiense*.

Besides the Himálayan types described below, A. v. Krafft proposes to include in his group of *Meekoceras disciforme* one of the Salt Range species described by Waagen as *Lecanites psilogyrus* (l. c. Pl. XXXIX, fig. 5). He convinced himself, by an examination of the type-specimen, that on the reverse of the side figured denticulations occur at the base of the principal lateral lobe.

"This species" he writes "occurs along with *Gyronites frequens* in the lowest bed of the lower Ceratite limestone and may be supposed to be specifically identical with *Gyronites frequens*. *Lecanites planorbis* Waagen (l. c. Pl. XXXIX, fig. 3) may also belong to *Meekoceras*, *viz.*, to the group of *M. disciforme*. The sutures of the type-specimen are too much weathered to ascertain whether denticulations were originally present or not."

A. v. Krafft further includes in the group of *Meekoceras disciforme* two types, described by Waagen as *Ambites discus* and *Ambites magnumbilicatus* (l. c. Pl. XXI, figs. 4, 5, 6). His reasons for doing so will be explained in the description of *Meekoceras cf. discus* Waag.

Among the *Meekoceratidæ* of the Ceratite formation (Salt Range) the following species are good representatives of *Meekoceras s. s.* :—

M. Koninckianum Waagen (l. c. p. 245, Pl. XXVI, fig. 6).
„ *pulchrum* Waagen (l. c. p. 249, Pl. XXVII, fig. 2, 3, XXIX, fig. 1).
„ *varians* Waagen (l. c. p. 247, Pl. XXIX, figs. 2-5).
„ *planulatum* de Kon. (Waagen l. c. p. 255, Pl. XXIV, fig. 2, XXXIX, fig. 2, XL, fig. 1).

The number of species from the lower Trias of the Himalayas amounts to 22, among them 15 being new.

Meekoceras Varaha Diener. Pl. II, figs. 2-6, XIV, figs. 7, 8.

1895. *Meekoceras* (*Kingites*) *Varaha* Diener, Triadische Cephalopodenfaunen der ostsibirischen Kustenprovinz; Mémoires Com. géol. de la Russie, St. Pétersbourg, XIV, No. 3, p. 52, Pl. 1, fig. 3.
1895. *Meekoceras* (*Kingites*) *Varaha* Diener, Mitteilungen ueber triadische Cephalopodenfaunen von der Ussuri Bucht und der Insel Russkij, Sitzgsber. Kais. Akad. d. Wiss. Wien, math. nat. Kl. CIV, Pt. 1, p. 270.
1897. *Kingites Varaha* Diener, Himalayan Foss., Palaeont. Ind. ser. XV, Vol. II, Pt. I, The Cephalopoda of the lower Trias, p. 143, Pl. VI, fig. 2, VII, fig. 6.

"*Measurements* of four specimens from the horizon of *Meekoceras Markhami*, at the Shalshal cliff in Painkhanda:

	I.	II.	III.	IV.
D	21 mm.	34·5 mm.	46 mm.	59 mm.
U	2 „	4 „	5 „	7 „
A	11 „	19 „	24 „	31 „
C	5 „	9·5 „	14 „	18 „
$\frac{D}{U}$	10·5	8·62	9·2	8·42
$\frac{A}{C}$	2·2	2	1·71	1·72

" The measurements of a cross-section of the specimen Pl. XIV, fig. 7, from the Meekoceras beds of the Shalshal cliff, are as follow:—

D	=	44 mm.	d	=	16·8 mm.	d_1	= 6 mm.
U	=	4·8 „	u	=	1·5 „		
A	=	23·5 „	a	=	9·5 „	a_1	= 3·2 „
C	=	11 „	c	=	4 „	c_1	= 2 „
I	=	7·3 „	i	=	2·8 „		
$\frac{D}{U}$	=	9·56	$\frac{d}{u}$	=	11·2		
$\frac{A}{C}$	=	2·13	$\frac{a}{c}$	=	2·37	$\frac{a_1}{c_1}$	= 1·5
$\frac{a}{I}$	=	1·15	$\frac{a_1}{i}$	=	1·14		

" The development of the species is as follows :—

" *Height and thickness.*—Earliest whorls globose. At 2 mm. diameter approximately as thick as they are high, but the minute dimensions allow of no exact measurements. At a diameter of 6 mm. the height exceeds the thickness considerably. Still more pronounced is the difference at the end of the penultimate volution. Thus the species undergoes first a change from thick into compressed volutions. During the further development the whorls again grow slightly thicker.

" *Maximum thickness.*—In the innermost whorls situated about the middle of the height of the sides, shifted nearer the umbilicus during the growth.

" *Umbilical edge and wall.*—Neither edge nor wall present in the youngest whorls. Wall high, with a comparatively sharp edge in the adult stage. In the gerontic stage the edge gradually becomes rounded, but the height of the wall does not decrease.

" *External part.*—In the youngest stage whorls broadly rounded, acquiring sharp edges in the adult stage. These are well pronounced up to about the end of the chambered part in full grown specimens and become obtuse on the body-chamber.

" *Amount of involution.*—Slightly decreasing.

" *Sculpture.*—The shell is covered with very delicate falciform striæ. Low folds on the cast run parallel to these and are strongest in the middle of the outer half of the lateral parts. The lateral sculpture occasionally crosses the external

part, producing a somewhat wavy outline of the specimens. This character is best seen in Diener's type specimen from the Shalshal cliff (l. c. Pl. VI, fig. 2). Most specimens have the external part entirely smooth.

"The adult stage is characterised by a thread-like callosity running along the marginal edges.

"*Length of the body-chamber.*—More than one-half volution. No exact measurements obtainable, as the shelly test has been preserved in most examples.

"*Sutures.*—The sutures of Prof. Diener's type specimen have been refigured. Special attention may be drawn to the variability in the details of the umbilical lobe, which is illustrated by a number of drawings. Fig. 6 on Pl. II, representing the umbilical lobe of the fragmentary type specimen illustrated on Pl. VII of Diener's memoir, is the most aberrant type in this respect.

"*Geological position. Locality. Number of specimens examined.* —Horizon of *Meekoceras Markhami*, Shalshal cliff, Painkhanda, 30, coll. Noetling; horizon of *M. lilangense*, 1 mile N. of Lilang, Spiti, 7, coll. Krafft.

"Lower division of the lower Trias (Otoceras beds in the old interpretation), S. E. of Muth, Spiti, 1, coll. Hayden; N. N. W. of Kágá, Spiti, 1, coll. Hayden; 5 miles S. of Ensa, 2, coll. Hayden; Kuling, Spiti, 3, coll. Krafft.

"Lower Trias, Jolinka E. G., Byans, 1, coll. Smith.

"*Remarks.*—Diener states in his description of *Meekoceras Varaha* that there is a distant similarity with *Kingites lens* Waagen (Ceratite formation) [l. c. Pl. XXVI, fig. 4], but he noticed also that there are essential points of difference. The examination of a large number of specimens of *M. Varaha* confirmed his statement that the two species are not identical."

I have only to add to A. v. Krafft's notes that the variability of the sutural line in this species affords a strong argument against the advisability of separating *Meekoceras* and *Kingites*. According to Waagen the only distinctive feature between the two genera is the presence of a well marked auxiliary lobe, within a row of irregular umbilical denticulations, in *Meekoceras*. Now, if we pass in review the sutural lines of *M. Varaha* as illustrated in figures 3, 4, 5, 6 on Pl. II and fig. 8, on Pl. XIV, the umbilical lobe forms a straight row of irregular denticulations, among which no proper lobe can be distinguished in the specimens Pl. II, fig. 5, and XIV, fig. 8, whereas in the specimen Pl. II, fig. 3, a delicately serrated lobe is marked off from the rest of the denticulations. The specimens illustrated on Pl. II, figs. 4 and 6, are transitional shapes, the separation of the auxiliary lobe from the umbilical denticulations being marked less distinctly. If we were to follow Waagen, we should be obliged to distribute the specimens, which in all the rest of their characters are clearly identical, among two genera, whereas it is certainly more appropriate to unite them in the same species.

Among the American species of *Meekoceras*, it is *Meekoc. gracilitatis* White, the type of the genus, that, according to my view, appears to be so nearly allied to the present form, that the question whether it is not even identical, may be raised.

Meekoceras gracilitatis shows, it is true, a greater variability in ornamentation than *M. Varaha*, but there are at least some American types which agree with *M. Varaha*, even in the minor details of shape, involution and sculpture. To illustrate this we need only compare the specimens figured on Pl. II, figs. 2 and 3, with the types of *M. gracilitatis* figured by Hyatt and Smith on Pl. XII, fig. 11, and Pl. LXX, fig. 4, of their monograph of the Triassic Cephalopod genera of America. The auxiliary series is more sharply defined from the second lateral saddle than in *M. Varaha*, but this is, indeed, the only constant feature of distinction that I have been able to find between these two species.

Meekoceras Varaha and *M. gracilitatis* are certainly so closely allied that with a less narrow circumscription of species they might be considered as nearly identical.

2. Meekoceras Markhami Diener. Pl. XI, figs. 1-5, XII, figs. 1-3, XIII, figs. 1-5, XIV, figs. 4, 5.

1897. *Proptychites Markhami* Diener, Himál. Foss., Palæont. Ind., ser. XV, Vol. II, Pt. 1. Cephalopoda of the lower Trias, p. 75, Pl. VI, figs. 4, 6.

1901. *Meekoceras Noetlingi* A. v. Krafft, in Griesbach, Geol. Surv. of India, General Report, 1900-01, p. 30.

1901. *Meekoceras Noetlingi* (v. Krafft) Noetling, Beitrœge zur Geologie der Salt Range, Neues Jahrb. f. Min. etc. Beilage Bd. XIV, p. 466.

1904. *Prionolobus Noetlingi* (v. Krafft) Noetling, Ueber das Alter der Otoceras Schichten von Rimkin Paiar Neues Jahrb. f. Min. etc. Beilage Bd. XVIII, p. 546.

This species was described as *Meekoceras Noetlingi* by A. v. Krafft, who failed to discover its identity with a form which had been described by myself in 1897, from the lower Trias of Kiunglung E.G.,[1] as *Proptychites Markhami*. I included my two specimens in Waagen's genus *Proptychites*, because they seemed to agree best with some of Waagen's Salt Range types of *Proptychites* in the character of their sutural line, which had the margins of the saddles serrated up to the middle of their height. As has been demonstrated by A. v. Krafft, the species is not provided with globose inner whorls and must consequently be grouped with *Meekoceras*.

Mr. H. H. Hayden was the first to discover the identity of *Proptychites Markhami* Dien. and *Meekoceras Noetlingi* Kr., when revising A. v. Krafft's manuscript. In my memoir on the age of the Otoceras beds of Painkhanda (Centralblatt f. Min. etc., 1905, p. 3), I stated his identification of the two species, which was afterwards accepted by Noetling in his "Asiatische Trias" (*Lethæa Mesozoica*, Vol. I, Liefg. 2, 1905, p. 149).

The rich materials collected by Noetling and Hayden enabled A. v. Krafft to give an exhaustive description of *Meekoceras Markhami*. In his notes the latter denomination has been substituted for *M. Noetlingi*, but otherwise they have been left unchanged.

[1] E. G.=Encamping Ground.

"*Measurements.*

	I. Pl. XI, fig. 2.	II. Pl. XI, fig. 3.	III. Pl. XIV, fig. 5.	IV. Pl. XIII, fig. 2.
D . .	39 mm.	cca. 67 mm.	123 mm.	cca. 163 mm.
U . .	6 „	12 „	28 „	32 „
A . .	24·5 „	cca. 33 „	55 „	74 „
C . .	15 „	23 „	36 „	46 „
$\frac{D}{U}$ . .	6·5	cca. 5·58	4·39	cca. 5·09
$\frac{A}{C}$ . .	1·6	cca. 1·43	1·52	1·6

"Fig. 2 on Pl. XI represents the cross-section of a large specimen from the Meekoceras beds of the Shalshal cliff (Painkhanda). The measurements of this section are as follow :—

D = cca. 163 mm.	d = 74 mm.	d_1 = 27 mm	d_2 = 9·5 mm.	
U = 32 „	u = 8·5 „	u_1 = 2 „	u_2 = 0·5	
A = 74 „	a = 39 „	a_1 = 16 „	a_2 = 5·8	
C = 46 „	c = 20 „	c_1 = 7 „	c_2 = 3·2	
I = 23 „	i = 10·5 „	i_1 = 4·5 „		
$\frac{D}{U}$ = cca. 5·09	$\frac{d}{u}$ = 8·7	$\frac{d_1}{u_1}$ = 13·5	$\frac{d_2}{u_2}$ = 10	
$\frac{A}{C}$ = 1·6	$\frac{a}{c}$ = 1·95	$\frac{a_1}{c_1}$ = 2·28	$\frac{a_2}{c_2}$ = 1·65	
$\frac{a}{I}$ = 1·96	$\frac{a_1}{i}$ = 1·52	$\frac{a_2}{i_1}$ = 1·17		

a_3 = 2·3 mm. c_3 = 1·9 mm. $\frac{a_3}{c_3}$ = 1·21 mm.

"The specimen is somewhat damaged, so that D is not distinctly measurable. The above value of D is calculated and is, I believe, very nearly correct. The calculation was carried out as follows :—

$$D = A + U + \frac{A+a}{2} = 74 + 32 + 56·5 = 162·5.$$

"The development of the species is as follows :—

"*Height and thickness.*— Earliest whorls thick, nearly globose, but the height exceeding the thickness as soon as a diameter of 8 mm. has been reached. Adult stage strongly compressed. The most compressed whorl is that which measures 27 mm. in diameter. After this the whorls again grow thicker, although very slowly.

"*Maximum thickness.*—Situated in the youngest volutions in the middle of the sides; shifts in the half-grown stage to the vicinity of the umbilicus and moves back to its first position in the last whorl. In all full-grown specimens the lateral parts are slightly concave outside the greatest thickness.

"*Umbilical margin and wall.*—The lateral parts descend to the umbilicus in a curve, which is flat in the young and strongly rounded in the half-grown whorls, whereas the curve seen in the last volution keeps midway between these two extremes.

"*External part.*—At first highly rounded, becoming gradually broadly rounded, with very obtuse marginal edges. Sometimes, however, the highly rounded siphonal area persists up to the adult stage.

"*Amount of involution.*—Decreasing very considerably.

"To confirm the result obtained from the above cross-section, I measured also as many as possible of the entire specimens in the collections with satisfactory results.

"*Height and thickness.*—As the smallest entire specimen measures as much as 39 mm. we should expect that all of them should show the features of the whorls larger than 27 mm. in the cross-section, *viz.*, that the volutions should grow thicker towards the body-chamber. This is actually the case. In all entire specimens the penultimate volution is invariably more compressed than the last one. This difference is especially well pronounced in specimens provided with their body-chambers. A comparatively thick body-chamber is therefore one of the chief characters of this species.

"It is further in agreement with the mode of development of the present species, that small specimens are, on the whole, more compressed than large ones. In six out of seven specimens, with a diameter ranging from 39 to 100 mm., $\frac{A}{C}$ is 1·6 or more, up to 1·72, while of six out of seven specimens, ranging in diameter from 104 to 164 mm., $\frac{A}{C}$ is 1·6 or less, down to 1·41.

"In order to show the approximate limits of variation, I may mention that there is an unusually thick specimen of small dimensions, corresponding to a diameter of 67 mm., $\frac{A}{C}$ being approximately 1·43 (specimen II, above), and on the other hand an unusually compressed specimen of large size 104 mm. in diameter, $\frac{A}{C}$ being 1·67.

"*Amount of involution.*—The measurements of seventeen entire specimens lead to the same results as the examination of the above cross-section. In seven specimens, with a diameter ranging from 39 to 100 mm., $\frac{D}{U}$ is 5·7 or more, up to 8·47, whereas in eight specimens out of ten, ranging from 104 to 164 mm. in diameter, it is 5·12 or less, down to 3·96. The narrowest umbilicus was observed in a specimen of 104 mm. in diameter, $\frac{D}{U}$ being 8 (Pl. XI, fig. 1).

"This specimen may be regarded as a variety of *Meekoceras Markhami*, as it differs further by the presence of a contraction, near the anterior termination which is absent in the rest of the specimens.

"*Shell.*—Thinnest on the external part and in the upper half of the sides; thickens very considerably in the lower third of the lateral parts.

"*Sculpture.*—The ornamentation is very indistinct. It consists of numerous and delicate, curved growth-lines. They start from the umbilical suture, being

at first strongly bent backwards. In the middle of the lateral parts they describe a forward-bent curve, then turn back again and cross the external part in a second curve, which is directed forward. Owing to this sculpture crossing the external part, the outline of the specimens is occasionally somewhat wavy.

"The lines of growth are, as a rule, seen distinctly on inner casts also. The external part occasionally bears faint concentric striæ. Low, short folds are noticed often on the body-chamber. They start at varying distances from the umbilical suture (*vide* Pl. XI, fig. 2, XII, fig. 1).

"*Mouth of aperture.*—The apertural margin has been partly preserved in several of my larger specimens. It appears to run parallel to the growth lines and is not accompanied by a contraction of the shell. Such a contraction is, however, seen in the variety illustrated on Pl. XI, fig. 1, where it marks no doubt the vicinity of the apertural margin.

"In the specimens provided with the mouth margin the greatest length of the body-chamber corresponds to a circumference of 200 degrees of the last volution.

"*Sutures.*—Very variable. Characters common to all specimens examined are the following: a broad siphonal lobe with a high median prominence, a slender external saddle and a broad, low second lateral saddle.

"Principal lateral lobe always deeper than the siphonal lobe. The umbilical lobe, which could be made visible in its entire length in one of my specimens, bears a large number of coarse points, the point corresponding to the umbilical suture being the largest. Internal saddle low, followed by a very deep anti-siphonal lobe, which is divided by a short median indentation.

"*Variations.*—Median prominence of the siphonal lobe sometimes broad and entire, sometimes incised and narrow. External saddle mostly, but not always lower than the principal lateral saddle. The latter can be either very broad or very slender. Depth and width of the principal lateral lobe varying considerably.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras Markhami* Shalshal cliff, Rimkin Paiar E. G., Painkhanda, 30, coll. Noetling. Horizon of *Meekoceras Varaha* and *M. lilangense*, 1 mile N. of Lilang, Spiti, 2, coll. Krafft.

"Lower Trias, exact horizon not known, Otoceras beds in the original circumscription, 5 miles S. of Ensa, Spiti, 1, coll. Hayden; S. E. of Muth, Spiti, 1, coll. Hayden."

"3. MEEKOCERAS LILANGENSE A. v. Krafft. Pl. I, figs. 1, 2, 3, 5, 6, 7; XIV, figs. 1, 2.

Measurements.

	I. (Pl. I, fig. 5.)	II. (Pl. I, fig. 2.)	III. (Pl. I, fig. 3).
D	18 mm.	44 mm.	47·5 mm.
U	3 „	9·5 „	cca. 11·5 „

A	9 mm.	20 mm.	20 mm.
C	4 „	10 „	8·5 „
$\frac{D}{U}$	6	4·63	cca. 4·13
$\frac{A}{C}$	2·25	2	2·35

"In fig. 3 on Pl. I, a cross-section of a specimen from Lilang has been illustrated. The measurements of this cross-section are :—

D = 52·5 mm.	d = 22·3 mm.	d_1 = 9 mm.
U = 11·5 „	u = 4 „	
A = 24·5 „	a = 11·2 „	a_1 = 4 „
C = 9 „	c = 4 „	
I = 6·5 „	i = 2·8 „	
$\frac{D}{U}$ = 4·56	$\frac{d}{u}$ = 5·57	
$\frac{A}{C}$ = 2·72	$\frac{a}{c}$ = 2·8	$\frac{a_1}{c_1}$ = 2·5
$\frac{a}{I}$ = 1·87	$\frac{a_1}{i}$ = 1·4	

"The present species has the widest vertical range of any of the congeneric forms found in the Meekoceras beds of Lilang. It was obtained in five different layers, extending from the base of these beds up to and above the middle, but it is replaced higher up by *Meekoceras Varaha*, which lower down in the series occurs along with *M. lilangense*.

"The specimen from the Meekoceras beds of Po, illustrated on Pl. I, fig. 2, should be considered as prototype of this species.

"The development of the species is as follows :—

"*Height and thickness.*—The above cross-section was taken from a strongly compressed variety. Whorls at a diameter of 9 mm. almost as compressed as in the full-grown stage. The proportions are subject to slight variations only.

"*Maximum thickness.*—Coinciding approximately with the centre line of the lateral parts. The sides are in the majority of specimens slightly concave near the siphonal part of the body-chamber, the transverse section then being bottle-shaped. This is, however, not a constant feature.

"*Umbilical margin and wall.*—Umbilical margin forming an acutely rounded-off edge. Umbilical wall low and perpendicular.

"*External part.*—In the innermost whorls the external part was not accessible to observation. Marginal edges are probably present in a volution corresponding to a diameter of 9 mm. At any rate the small specimen, illustrated on Pl. I, fig. 5, has sharp marginal edges at the beginning of the last volution. Sharp marginal edges persist also at a diameter of 22·3 mm. and later on.

"*Amount of involution.*—Slightly decreasing.

"*Sculpture.*—In the majority of specimens thread-like ridges are seen to

accompany the marginal edges. These ridges are best seen on the shelly test and are covered with delicate striæ. The latter were observed, in the prototype of the species, also on the siphonal part and in the uppermost lateral parts (see enlarged figure of external part, Pl. I, fig. 2).

"The lateral parts are covered with radial folds, which are slightly falciform and reach from the umbilical suture to the external part. They are strongest in the middle of the sides. The strength of those folds is subject to some variation, several specimens even being without any distinct sculpture.

"The shell is furnished with delicate, radial lines of growth, which are most conspicuous in the middle of the sides. Several specimens show faint concentric striæ, which appear to be confined to the body-chamber and are, as a rule, only discernible on inner casts. These striæ run along a narrow, flattened spiral band in the middle of the sides. In one instance (fragment of a body-chamber, inner cast, Pl. I, fig. 7) the spiral band is replaced by a shallow furrow. Pl. I, fig. 1, represents the only specimen in the collection showing traces of this concentric ornamentation on the surface of the shell.

"All the specimens examined have a more or less oblique shape, but whether this is an original feature or not, it is impossible to decide.

"*Length of the body-chamber.*—Not known exactly, but no doubt exceeding one-half volution.

"*Sutures.*—Siphonal lobe broad, with a median prominence, which is slightly incised. All the lobes, except the umbilical one, faintly serrated. Saddles broadly rounded. The umbilical lobe with a few rather coarse denticulations.

"*Geological position. Locality. Number of specimens examined.*—Lower division of the lower Trias in Spiti; horizon of *Meekoceras lilangense* and *M. Varaha*, one mile N. of Lilang, 22, coll. Krafft; four miles W. of Po, 5, coll. Krafft.

"*Affinities.*—*Meekoceras lilangense* is closely allied to *M. Hodgsoni* Diener (*Palæont. Indica*, Himál. Foss., ser. XV, Vol. II, Pt. 1, p. 133, Pl. VI, fig. 1). I have stated above that some of the specimens lack the bottle-shaped transverse section as seen in the prototype of the species, and are at the same time devoid of marginal ridges or striæ. Such specimens closely resemble *Meekoceras Hodgsoni*, especially as their outline is almost as irregular as in the latter species (see for instance the fragment illustrated on Pl. XIV, fig. 1). None of my specimens, however, agrees perfectly with the type of *M. Hodgsoni*. A species, in which the sculpture crosses the external part, is described below as *Meekoceras lingtiense*."

"4. MEEKOCERAS LINGTIENSE A. v. Krafft. Pl. II, fig. 1.

Measurements.

D	38 mm.	$\frac{D}{U}$	= 4·47
U	8·5 „		
A	17 „	$\frac{A}{C}$	= 1·88
C	9 „		

"As stated in the description of *Meekoceras lilangense*, there occur at Lilang several specimens which deviate from the type of this species by having no thread-like marginal ridges and no bottle-shaped transverse section. The outline is somewhat wavy, as in the type of *M. Hodgsoni* Diener. These specimens have been united with *M. lilangense*, as they are doubtless varieties only of this species.

"But there is one specimen in my collection, which deviates so much from *Meekoceras lilangense*, that it must be treated separately. As it resembles *Meekoceras Hodgsoni* to a certain extent, without being identical, it must be described under a new specific name.

"External part broad, broader than in the type of *M. Hodgsoni*. Marginal edges of the cast very sharp. Numerous irregular folds are noticed on the lateral parts of the cast, but some broad folds also occur, as in *M. Hodgsoni*. Outline very slightly wavy. A small fragment of the shelly test, preserved near the anterior termination, is covered with delicate striæ, which cross the external part. This feature decidedly recalls *Meekoceras Hodgsoni*, but is directly opposed to the concentric external striæ seen on typical specimens of *M. lilangense*. The specimen from Lilang is thicker than the type of *M. Hodgsoni*. The width and character of the umbilicus very nearly agree. The body-chamber bears on one side very delicate concentric striæ.

"Length of the body-chamber approximately 250°. In this specimen the apertural margin has been partly preserved.

"*Sutures.*—Visible in part only. Second lateral lobe much shallower than the principal lateral lobe. Second lateral saddle very low and broad. Umbilical lobe with three points only, that near the umbilical suture being broad and low.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, one mile N. of Lilang, Spiti, 1, coll. Krafft."

"5. MEEKOCERAS HODGSONI Diener. Pl. II, fig. 9; Pl. III, fig. 2; Pl. XXX, fig. 1.

1897. *Meekoceras Hodgsoni* Diener, Himál. Foss., *Palæont. Indica*, ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 183, Pl. VI, fig. 1.

1897. *Meekoceras* (*Koninckites*) *Vidarbha* Diener, *ex parte*, ibidem, p. 139, Pl VII, fig. 9, *non* fig. 8*a*, *b*.

Measurements.

	Diener's type-specimen of *Koninckites Vidarbha*, Pl III, fig. 2.		Diener's type-specimen of *Meekoceras Hodgsoni*, Pl. II, fig. 9.	
D	. 21	mm.	. appr. 60	mm.
U	. 5	"	13	"
A	. 10	"	28	"
C	4·5	"	11	"
D/U	. 4·5		. appr. 4·61	
A/C	. 2·22		2·54	

"It is desirable to redescribe the present species, although no new materials have been found recently. I have first to add a few remarks to Prof. Diener's original description, and then to show that a specimen, described as *Koninckites Vidarbha*, must be united with the present species.

"Diener observes that the external part is evenly rounded in the inner volutions, up to a diameter of 15 mm., but I did not find this to be the case. A close examination of the type-specimen, which I broke in two, led to the discovery that the external part, even in the youngest visible volutions, is flattened, with distinct marginal edges. The siphonal area is, however, very narrow.

"Prof. Diener placed this species in the group of *Meekoceras varians* Waagen (Ceratite formation, l. c. p. 247, Pl. XXIX, figs. 2—5), and he supposed that it is allied to this species by the absence of marginal edges in the young stage and by an identical arrangement of the sutures. For the reason pointed out this inference is no longer justified.

"The marginal edges become somewhat obtuse at the end of the chambered part. The outline of the type-specimen is wavy, especially so near the anterior termination of the chambered portion of the shell. This is due to the lateral folds crossing the external part. Between those external folds delicate striæ occasionally occur.

"The specimen of *Koninckites Vidarbha*, alluded to above, was classified by Diener with Waagen's subgenus *Koninckites*, in the belief that a distinct auxiliary saddle was present. On careful re-examination of the specimen I found that this was not the case. The identity of the specimen examined by me with that from which Diener took the sutural line is indisputable. The specimen bears the label '*Meekoceras* (*Koninckites*) *Vidarbha* Diener, Pl. VII, fig. 9, Otoceras beds, Shalshal cliff (Rimkin Paiar E. G., coll. Diener)'. It is obvious, from the explanation to Pl. VII, that the figure of the sutures has been taken from this type-specimen.

"The actual features of a sutural line, taken from a septum situated near the anterior termination, are represented in double size on Pl. III, fig. 2 of this memoir. The second lateral saddle and the umbilical lobe are apparently goniatitic.

"The specimen of *Meekoceras Vidarbha* is no doubt identical with *M. Hodgsoni*, with which it agrees in transverse section, width of the umbilicus, sculpture, and shape of the siphonal part."

On re-examination of the specimen of *Meekoceras Vidarbha*, illustrated on Pl. VII, fig. 9 of my above quoted memoir, I am bound to confess that A. v. Krafft's remarks are partly justified. There are only a very few places on the cast, where the umbilical lobe has not been injured by weathering. In one of those places a fissure in the matrix, intersecting the true lobe, has been misinterpreted for the margin of an auxiliary saddle. But the second lateral and umbilical lobes are certainly not goniatitic, delicate indentations being distinctly visible by means of a magnifying glass, at one place.

Of the identity of this specimen with *Meekoceras Hodgsoni* I am not fully convinced. The inner whorls of the latter species are known to us only so far as they are exposed within the umbilicus of the type-specimen. They do not show any sculpture, but only some radial undulations, which are barely perceptible, and do not agree with the distinct falciform folds of the specimen illustrated on Pl. VII, fig. 9.

A. v. Krafft was, however, mistaken, when he spoke of the absence of any new examples of *Meekoceras Hodgsoni* in Noetling's and his own collections. Among his collection from the Otoceras beds of the Shalshal cliff I found a well-preserved specimen of *Meekoceras*, marked on the label as "*Meekoceras sp. ind.*, Shalshal cliff near Rimkin Pass E. G., Otoceras beds, found along with *Ophiceras*." That both specimen and label actually belong together is indisputable both being marked with the figures: K 10, 859.

The measurements of this specimen are as follow:—

Diameter of the shell		37 mm.
„ „ „ umbilicus		7 „
Height of the last volution		18 „
Thickness of the last volution		8 „

This specimen, which has been figured on Pl. XXX, fig. 1, cannot be separated specifically from *Meekoceras Hodgsoni*, with which it agrees in all its characters of specific importance. I wish to draw the special attention of the reader to the remarkable narrowness of the external area and to the compressed shape of the whorls in general, two leading features in *Meekoceras Hodgsoni*.

The discovery of a specimen of *Meekoceras Hodgsoni* in the Otoceras beds (*sensu stricto*) is of great stratigraphical interest. It fully confirms my statement (*Centralblatt f. Miner. etc.* 1901, p. 656), that my type-specimen had been collected in the Otoceras beds of the Shalshal cliff and not in the horizon of *Meekoceras Markhami*, as had been suggested by Noetling. But even if the identification of the present specimen with *Meek. Hodgsoni* should be questioned, the presence of a true *Meekoceras* in the Otoceras beds of Painkhanda would remain an indisputable fact, in contradiction to what has been suggested by Noetling as to the first appearance of this genus in the Himálayas.

"6. MEEKOCERAS BOREALE Diener. Pl. II, fig. 7, XIV, fig. 11.

1895. *Meekoceras boreale* Diener, Triadische Cephalopodenfaunen der ostsibirischen Kustenprovinz, *Mémoires Comité géol. de la Russie*, St. Pétersbourg, XIV, No. 3, p. 49, Pl. 1, fig. 3*a*, *b*, *c*.

1897. *Meekoceras boreale* Diener, Himálayan Foss., *Palæont. Indica*, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 130, Pl. VII, fig. 1, XXIII, fig. 8.

Measurements.

	I. Diener's type-specimen from the Shalshal cliff.	II. Diener's type-spec. Mém. Com. Géol. Pl. I. fig. 3.	III. Pl. XIV, fig. 11, of this mem.	IV. *Meekoceras nov. sp. aff. boreali* Diener Mém. Com. Géol., Pl. 1, fig. 5.
D	?	46 mm.	49 mm.	?
U	?	5 „	8·5 „	10 mm.
A	22 mm.	23 „	24 „	23 „

cca.

C	11 mm.	11 mm.	13 mm. .	14 mm.
D				
U	?	9·2	5·76	?
A				
C	2 . .	2·09	1·84 .	1·63

"Of this species there are three specimens available. One of them, which is more complete than Diener's type-specimen from the Shalshal cliff, is figured on Pl. XIV, fig. 11.

"The measurements of four specimens, two from Siberia, and two from the Himálayas, are given above for comparison. Of Diener's type from the Shalshal cliff A and C only are given, the other measurements (D and U) being uncertain, as not quite one-half of the specimen is preserved.

"Of the two specimens from Siberia one belongs, according to Diener, to a new species, allied to *M. boreale*.

"Unfortunately no transverse section could be procured.

"The marginal edges become somewhat obtuse towards the anterior end of the body-chamber in the specimen figured, and the same feature is noticed in Diener's type-specimen. The width of the siphonal area is considerable compared with that in other species of *Meekoceras*. In Diener's half volution the width of the siphonal area is 2 mm. at the beginning and 3 mm. at the end. In the specimen figured it measures 3 mm. at the beginning of the last volution, while at the broken end of the body-chamber it is nearly 5 mm. in width.

"The umbilicus shows a distinct edge and a comparatively high, perpendicular wall, both in the type-specimen from the Shalshal cliff and in my new example.

"The specimen figured differs from Diener's types of *Meekoceras boreale* by the greater thickness of its last volution, and from the Siberian type also by a wider umbilicus. It thus connects those types with the specimen described as *Meekoceras nov. sp. ind. aff. boreali* by Diener in the Mém. Com. Géol., l. c. Pl. I, fig. 5. As regards height and thickness of the whorls, the statement just made is proved by the measurements above. To compare the width of the umbilici, we must use the ratio $\frac{A}{U}$ because the diameter of the specimen determined as *Meekoceras nov. sp. ind. aff. boreali* is not known. We then find that in the specimen figured in the present memoir $\frac{A}{U}$ is 2·92, in that from Siberia 2·3. The latter therefore has the wider umbilicus of the two.

"The comparatively great width of the umbilicus and the occurrence of radial folds on the body-chamber of the specimen from Eastern Siberia induced Prof. Diener to regard it as a new species, although he remarks (*Palæont. Indica*, l. c. p. 132) that it will perhaps have to be considered as a variety only of *Meekoceras boreale*, if better preserved materials be forthcoming. I think the latter course will be the better one to adopt, as it appears that the greater width of the umbilicus in this instance is of no specific importance, while the existence of folds alone is hardly sufficient to establish a specific difference. I am, however, bound to mention that

the Himálayan specimen illustrated in the present memoir has no folds on the body-chamber.

"The length of the body-chamber cannot be ascertained.

"*Sutures.*—None of my specimens has the sutural line preserved well enough to be figured. The broad point or rudimentary saddle in the umbilical lobe of the type of the species from the Shalshal cliff bears a small median incision (Pl. II, fig. 7).

"*Geological position. Locality. Number of specimens examined.*—Lower Trias (exact horizon unknown), crest of ridge between Dharma and Lissar valleys, opposite Ralphu glacier, Kumaon, 1, coll. La Touche; Lilinthi E. G., Byans, 1, coll. Smith.

"Lower division (Otoceras beds in the old circumscription), 5 miles S. of Ensa Spiti, 1, coll. Hayden.

"*Remarks.*—Prof. Diener compares the present species to *Meekoceras planulatum* de Kon., but I venture to doubt whether there exists any close affinity between the two (see *Meekoceras pseudoplanulatum nov. sp.* below)."

As regards my comparison of *Meekoceras boreale* with *M. planulatum* de Kon. I wish to draw the attention of the reader to the fact that I have hinted explicitly at the difficulty of comparing *M. boreale* with other congeneric forms, not so much on account of the real absence of any species closely allied, as on account of the insufficiency of their respective descriptions and figures. My comparison of *M. boreale*, both with *M. planulatum* and with *M. gracilitatis* White, was therefore made only with great reserve.

In both cases this reserve has been fully justified. The differences between *M. boreale* and *M. planulatum* have been enumerated by A. v. Krafft in his description of *Meek. pseudoplanulatum*. The re-description of *Meek. gracilitatis* by Hyatt and Smith also shows remarkable features of distinction between the two species. *M. gracilitatis* has a narrow siphonal area, whereas this is comparatively broad in *M. boreale*. There are also some marked differences in the character of the sutures, especially of the umbilical lobe.

"7. MEEKOCERAS PSEUDOPLANULATUM v. Krafft. Pl. VI, fig. 3.

1895. *Meekoceras planulatum* (de Kon.) Waagen, Fossils from the Ceratite formation, *Palæont. Ind.*, ser. XIII, Salt Range Foss. Vol. II, p. 225, Pl. XXIV, fig. 2.

Measurements.

D	. . .	44 mm.	$\frac{D}{U}$	...	4·88
U	. . .	9 „			
A	. . .	20 „	$\frac{A}{C}$	...	2
C	. . .	10 „			

"A specimen from the Hedenstrœmia beds of Spiti is specifically identical with a specimen from the *Stachella* beds of the Salt Range Ceratite formation, which Waagen identified with *Meekoceras planulatum* L. de Koninck (*Quart. Journ., Geol. Soc., London*, Vol. XIX, p. 12, Pl. V, fig. 1; *Fossiles paléozoiques de l' Inde*, 1863, p. 10, Pl. V, fig. 1.) As the correctness of this determination is open to a certain amount of doubt, I propose for this species the new name of *Meekoceras pseudoplanulatum*.

"Waagen apparently considered the identity as certain, for having observed no sutures in his own specimen, he described them from L. de Koninck's illustration, which he figured again. But this identity between Waagen's and de Koninck's type-specimens is in my opinion, although not impossible, not assured.

"There is, first of all, no umbilical edge marked in de Koninck's drawing, while in Waagen's type specimen it is sharply defined; further, there are in the drawing peculiar lines seen on the body-chamber, which recall the septa of a *Nautilus*, but probably represent folds. Whatever may be their meaning, nothing similar is to be noticed in Waagen's specimen. It is true that there are some very low radial folds present in the latter, but these in no way resemble the lines marked in L. de Koninck's figure.

"In addition to this there exist some remarkable differences in the sutural line. As I said above, Waagen did not notice any sutures in his specimen. They are, however, visible in part near the anterior termination of the reverse of the side represented in the illustration on Pl. XXIV, fig. 2*a*. I had but to take away a very small piece of rock, to lay the umbilical lobe bare, which alone had been covered up.

"These sutures have a very different aspect from that in de Koninck's drawings (Pl. V, figs. 1*b*, 1*c*). The second lateral lobe is considerably shallower, and the second lateral saddle is well individualised, without passing into the umbilical lobe. The latter is provided with a number of delicate denticulations. The median prominence of the siphonal lobe is broad and low, not high and slender, as in fig. 1*b* of L. de Koninck's memoir.

"I have very little doubt that all the differences pointed out are partly due to incorrect drawing, and partly to L. de Koninck's type-specimen being in a weathered state. But as this type-specimen is not available for comparison, having probably been lost for ever, the best course to follow will be to confine the specific name of *Meekoceras planulatum* to the original type-specimen, and to give the specimen collected by Waagen a new name.

"The identity of Waagen's type with the Himálayan specimen from Muth has been ascertained by examining them side by side. It will be noticed that the siphonal part is slightly concave in the penultimate whorl of the Salt Range type with two marginal keels, and the same character is to be noticed in the last whorl of the specimen from Muth. The umbilical wall in either specimen is vertical and rather high. The umbilical edge is well marked. The radial folds are more prominent in the Himálayan than in the Salt Range specimen, but this is a detail

of very subordinate importance. In their proportions the two specimens are very similar, the measurements of the Salt Range type being as follow :—

D	.	50 mm.	D/U	...	5·26
U	.	9·5 ,,			
A	.	23 ,,	A/C	...	2·09
C	.	11 ,,			

"The identity of the sutures is evident from a comparison of the figures.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden.

"*Affinities.*—Prof. Waagen compares his specimen to *Meekoceras gracilitatis* White, assuming that an evolutional connection exists between these species. I need hardly say that this hypothesis requires further corroboration.

"E. v. Mojsisovics in his "Cephalopoden der Mediterranen Triasprovinz" (*Abhandl. K. K. Geol. Reichsanst.*, X. Pl. XXIX, figs. 4, 5) gives an illustration of *Meekoceras caprilense* from the Alpine Werfen beds, which would suggest a remarkable affinity between our species and the Alpine type. They agree very well in the shape of their external parts, transverse sections, and sutures. The only important difference would appear to consist in the greater width and sharper edge of the umbilicus in the Himálayan type.

"There is, however, good reason to fear inaccurate drawing in the illustrations given by E. v. Mojsisovics. A. Bittner (*Jahrb. K. K. Geol. Reichsanst.*, 1898, p. 705, Taf. XIV, figs. 15, 16), who described and figured some specimens of *Meekoceras caprilense*, which I had collected in the Werfen beds of Darwas (Central Asia), remarks that the sutures of this species are not serrated, and that it should be placed in one of the genera of *Meekoceratidæ* with goniatitic sutures. The figures given by Bittner also differ from those given by E. v. Mojsisovics by having no marginal keels. It appears to me, that any affinity between the two species is for these reasons very doubtful."

Remarks.—Since those notes were written, the generic position of *Meekoceras caprilense* has been thoroughly discussed by E. Kittl (Die Cephalopoden der oberen Werfener Schichten bei Muć, *Abhandl. K. K. Geol. Reichsanst.* XX, p. 70). His re-examination of Bittner's Alpine type-specimens convinced him of the presence of serrated lobes. He consequently agrees with E. v. Mojsisovics and Waagen in including *Meekoceras caprilense* in the genus *Meekoceras s. s.* On the other hand the sutural line of the specimens from Darwas, which were collected by A. v. Krafft in 1898, being unknown, their identity with *M. caprilense* is, indeed, questionable. It is especially their approximation to *Proavites* Arthaber, which must be taken into consideration.

I fully agree with Kittl in all his conclusions as given above and I am inclined to think that there exists a really close affinity between *Meekoceras pseudoplanulatum* and *M. caprilense*. It is only the greater width of the umbilicus in the Himálayan species that marks a feature of specific distinction.

There is no other Himálayan species of *Meekoceras* known to me which exhibits any remarkable similarity to either *Meekoc. caprilense* or *M. eurasiaticum* Frech (in G. v. Arthaber, Neue Funde in den Werfener Schichten und dem Muschelkalk des suedlichen Bakony, *Resultate der Wissenschaftl. Erforschung des Balatonsees : Palæont. Anhang*, I Bd., I Th., p. 18, Taf. I, fig. 1), which is certainly very nearly allied to the former, notwithstanding G. v. Arthaber's statement to the contrary.

"8. MEEKOCERAS SHALSHALENSE v. Krafft. Pl. XXX, fig. 2.

Measurements.

D	cca. 49 mm.	$\frac{D}{U}$	= cca. 4·9
U	10 „		
A	23 „	$\frac{A}{C}$	= 1·64
C	14 „		

"Lateral parts very slightly arched. Greatest thickness in the umbilical region. External part with marginal edges, which become obtuse towards the anterior termination. The edges are accompanied by thread-like ridges. Umbilical edge sharp, umbilical wall very high and perpendicular.

"*Sculpture.*—The sides are provided with low folds, seen both on the shell and on the cast. They rise somewhat above the umbilical edge and have a distinct falciform bend, disappearing before they reach the external part. The shell is covered with delicate growth-lines, which are not restricted to the test, but are also seen on the inner casts. Very low concentric lines are perceptible on the body-chamber.

"About one half of the last volution belongs to the body-chamber.

"*Sutures.*—Siphonal lobe broad, with a rounded, low median prominence. Saddle broadly rounded. Lateral lobes with delicate denticulations. Second lateral lobe very much shallower than the first. Umbilical lobe with a number of points, which become the coarser the nearer the umbilical edge.

"*Geological position. Locality. Number of specimens examined.*—Meekoceras beds, horizon of *Meekoceras Markhami*, Shalshal cliff, Painkhanda, 1, coll. Noetling.

"*Remarks.*—This species can easily be distinguished from any other species of *Meekoceras*, although it is founded on one single specimen only. It differs from young specimens of *Meek. Markhami* in its transverse section and in the character of its external part. The umbilicus is wider and the umbilical wall is considerably higher. *Meek. tenuistriatum* (see below) has a similar transverse section, but it is distinguished by the delicate striation of the shell and by a highly rounded siphonal part."

Notwithstanding these characters of distinction, *Meekoceras shalshalense* is nearly allied to *M. tenuistriatum*, both species agreeing not only in their outlines and in the shape of the umbilicus, but also in the arrangement of the umbilical lobe,

which is very broad and provided with coarser denticulations than in the majority of species belonging to the group of *Meek. Varaha.*

"9. MEEKOCERAS TENUISTRIATUM v. Krafft. Pl. IV, fig. 3.

Measurements.

D	50	mm.	$\frac{D}{U} = 6{\cdot}66$
U	7·5	„	
A	27	„	$\frac{A}{C} = 2{\cdot}25$
C	12	„	$\frac{a}{c} = 1{\cdot}83$
a	cca. 11	mm.	Measured near the beginning of the last volution.
c	6	„	

" The whorls of this species have wavy outlines as if distorted by pressure, but this may be an original feature. Last volution at the anterior termination compressed more strongly than at its beginning. Greatest thickness situated in the umbilical region. Sides very slightly arched. External part highly rounded, without any trace of marginal edges. Umbilical edge sharp, umbilical wall high and almost perpendicular.

" *Sculpture.*—The shell is furnished with extremely delicate striæ, scarcely perceptible to the naked eye. The striæ proceed in a slightly falciform direction from the umbilicus to the siphonal area, bifurcating repeatedly, and cross over the siphonal area. Here spiral striæ run across the radial ones, thus producing a very delicate net-work.

" In the beginning of the body-chamber low, slightly curved, folds are seen near the umbilicus, reaching half way up the sides. The folds as well as the interstices between them are covered with delicate striæ. The folds are also seen on the inner casts.

" *Length of the body-chamber.*—210°.

" *Sutures.*—Siphonal lobe broad, external saddle high and slender. Principal lateral saddle obliquely shaped, second lateral saddle short. The denticulations of the lobes are coarse. Umbilical lobe broad as compared with other species of the group of *Meekoceras Varaha*, provided with several larger points.

" *Geological position. Locality. Number of specimens examined.*—Meekoceras beds; horizon of *Meekoceras lilangense* and *Meek. Varaha*, 1 mile N. of Lilang, Spiti, 1, coll. Krafft."

"10. MEEKOCERAS cf. RADIOSUM Waagen. Pl. 1, fig. 9.

1895. *Meekoceras radiosum* Waagen, Salt Range Foss., *Palæont. Indica*, ser. XIII, Vol. II, Fossils from the Ceratite formation, p. 257, Pl. XXXVI, fig. 2.

Measurements.

D	51 mm.	$\frac{D}{U}$	=6·37
U	8 „	$\frac{A}{C}$	=2·16
A	26 „		
C	cca. 12 „	$\frac{a}{c}$	=1·83
a	11 mm.	{ Measured near the beginning of the last volution.	
c	6 „		

" There is in Mr. Hayden's collections from Gaichund in Spiti a well preserved specimen of an ammonite, which strikingly resembles Waagen's type-specimen of *Meekoceras radiosum*, from the lower beds of the Ceratite sandstone (topmost beds of Ceratite marls of Noetling) of the Salt Range.

" The sculpture of the shell consists in either specimen of low, falciform folds which become broader but fainter towards the marginal edges, where they disappear. These folds are separated by very shallow furrows. They are furnished with very delicate lines of growth, whereas the furrows are almost quite smooth. As the shell has been preserved almost entirely in the Himálayan specimen, the cast cannot be examined, but there are two low folds seen on the small part of the cast exposed near the anterior termination, and these correspond to the folds seen on the cast of Waagen's type.

" The specimen from Gaichund has on its marginal edges very delicate concentric striæ which are also seen on Waagen's specimen. They are preserved on the chambered part of the cast somewhat behind the last septum.

" A very close resemblance is also noticed in the shape of the transverse section. The specimen from Gaichund is only slightly thicker than the type of the species. In the Himálayan type $\frac{A}{C}$ is approximately 2·16, whereas in the Salt Range type of *Meekoceras radiosum* it is 2·33. If we take into consideration the fact that the type of the species is a cast, we can declare the proportions of height and thickness to be practically identical. A slight difference consists in the width of the umbilicus and in the character of the umbilical edge. In the type of the species the ratio $\frac{D}{U}$ is 7·42, whereas in the specimen from Gaichund it is 6·37. The latter therefore has a proportionately wider umbilicus than the former.

" In the type-specimen of *Meekoceras radiosum* the umbilical edge is not acute but sharply rounded, and the umbilical wall is less steep and high than in the specimen from Gaichund. This difference – to a certain extent at least—is again due to the absence of the shelly test. On the reverse of the side figured in Waagen's memoir the umbilical edge is rather prominent and acute at the only spot where a small piece of the shelly layer has been preserved. At this place the umbilical wall is also high and steep.

"In my opinion it is almost certain that the two species are identical, but as the sutures of the Himálayan specimen are not accessible for examination, and as the material at hand is very limited, I must abstain from uniting the two species definitely.

"*Geological position. Locality. Number of specimens examined.*—Lower division (Otoceras beds in the old circumscription), Gaichund, Spiti, 2, coll. Hayden. (A duplicate in the collection is too much weathered to permit of any closer comparison.)"

"11. MEEKOCERAS RUGOSUM v. Krafft. Pl. I, figs. 8 *a—c*.

Measurements.

D	47 mm.	$\frac{D}{U}$	= 5·87
U	8 „	$\frac{A}{C}$	= 2·32
A	24·5 „	$\frac{a}{c}$	= 1·9
C	10·5 „		
a	9·5 „ } Measured near the beginning of the last volution.		
c	5 „ }		

"This species in several respects resembles *Meekoceras radiosum* Waagen (see above), but as it differs in some characters of minor importance it had best be described under a new specific name.

"Its thickness is identical with that of the type of *Meekoceras radiosum* Waagen (see preceding description). The shape of the umbilical edge is very similar, but the greatest thickness occurs higher up the sides, the umbilical wall is lower and the umbilicus is wider than in either the type of that species or in *Meek. cf. radiosum* described above. Also the whorls increase more rapidly in height.

"Although the sculpture is very similar, it shows some peculiar characters. The body-chamber is covered with broad folds, which in the upper third of the lateral parts form very low, knob-shaped elevations. Immediately above these there is a smooth, concentric band, bordered by two very low ridges. Spiral striæ occur on the inner cast of the body-chamber somewhat below the middle of the lateral parts. The external part bears concentric striæ, similar to those in *Meek. radiosum*.

"On and near the marginal edges the surface of the shell is covered with delicate wrinkles, recalling the "wrinkly layer" (*Runzelschicht*) common in representatives of the genus *Arcestes*. They take a curved direction turned forward, on the lateral parts, filling out the interstices between the concentric striæ of the marginal edges. They are also seen on the siphonal area.

"*Length of the body-chamber.*—This has not been ascertained, the larger part of my type-specimen being covered with its shelly test.

"*Sutures.*—Not entirely visible. The lateral lobes are provided with delicate denticulations. Umbilical lobe narrow, with points which are not elevated considerably above the general level of the lobe. The saddle-shaped element, which is divided by the umbilical suture, is low and broad.

"*Geological position. Locality. Number of specimens examined.*—Lower division; horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, 1, coll. Krafft."

"12. MEEKOCERAS JOLINKENSE v. Krafft. Pl. IV, fig. 3; XIV, fig. 13; (*varieties*: Pl. III, fig. 3; XXX, fig. 6).

Measurements.

D	.	.	cca.	35	mm.
U	.	.	.	8	„
A	.	.	.	16	„
C	.	.	.	8	„

$\frac{D}{U}$ cca. 4·35 $\frac{A}{C} = 2$

"I have succeeded in making a cross-section through one of my specimens from Jolinka E. G.: the measurements of this cross-section are:—

D	=	23·5	mm.	d	=	10·5	mm.	d_1 = 5 mm.
U	=	6·4	„	u	=	3·6	„	
A	=	10·3	„	a	=	4	„	a_1 = 2 „
C	=	6	„	c	=	2·8	„	c_1 = 1·5 „
I	=	2·7	„	i	=	1	„	$\frac{a_1}{c_1}$ = 1·33
$\frac{D}{U}$	=	3·67		$\frac{d}{u}$	=	2·91		
$\frac{A}{C}$	=	1·71		$\frac{a}{c}$	=	1·42		
$\frac{a}{I}$	=	1·48		$\frac{a_1}{i}$	=	2		

"The development of this species is as follows:—

"*Height and thickness.*—Whorls somewhat inflated, though higher than thick corresponding to a diameter of 5 mm. They become compressed considerably during the following stages of growth, the thickness being little more than half the height—in the larger specimen exactly one-half the height—of the cross-section in the last volution.

"*Maximum thickness.*—Occurs up to a diameter of 10·5 mm. in the middle of the lateral parts, but is shifted to the umbilical region in the later stages of growth. The lateral parts become flattened at the same time.

"*Umbilical edge and wall.*—In the earliest volutions the lateral parts slope flatly towards the umbilicus without intervention of any wall or edge. In the half-grown and adult stages a sharp edge bordering a high umbilical wall is present.

"*External part.*—The external part is bordered by distinct marginal edges, as soon as a diameter of 5 mm. has been reached. These edges persist up to the anterior termination of the chambered part of the shell in full-grown individuals, but become obtuse on the body-chamber.

"*Amount of involution.*—The amount of involution is increasing, as is evident from a comparison of the ratio $\frac{d}{u} + \frac{D}{U}$ of the cross-section with $\frac{D}{U}$ of the large specimen.

"*Sculpture.*—With the exception of some very indistinct folds no sculpture is seen.

"*Length of the body-chamber.*—Not known.

"*Sutures.*—Siphonal lobe broad, with a high median prominence. Principal lateral saddle very high and obliquely shaped. Second lateral saddle low and broadly rounded. Umbilical lobe provided with several mostly coarse points.

"*Geological position. Locality. Number of specimens examined.*—Lower Trias (Chocolate limestone), Jolinka E. G., Byans, 2, coll. Smith."

Remarks.—With this species a fragmentary specimen, from the horizon of *Meekoceras lilangense* and *M. Varaha* (coll. Krafft) at Lilang, Spiti, can be united; this was labelled "*Meekoceras sp. ind.*" by A. v. Krafft and illustrated on Pl. III, fig. 3. It consists of air-chambers only. Its measurements are as follow:—

Diameter of the shell		cca.	34 mm.
,, ,, ,, umbilicus			9 ,,
Height of the last volution			14 ,,
Thickness of the last volution			7 ,,
Height of the penultimate whorl			7 ,,
Thickness of the penultimate whorl			3·5 ,,

The siphonal area is a little less broad than in the type-specimen from Jolinka, but otherwise the two examples agree almost perfectly. In the sutural line of the specimen from Lilang, the siphonal saddle is a little higher, and the principal lateral saddle is not shifted towards the umbilicus, but these differences are scarcely of varietal importance.

A characteristic feature in the sutural line of this specimen is the peculiar shape of the median prominence in the siphonal lobe. This is made up of a conical basal part, from which rises a short, pillar-shaped prominence with an opening for the siphuncle.

I am also obliged to identify with this species a specimen of *Meekoceras* collected by A. v. Krafft in the red limestone of the exotic block No. 20, 1 mile W. of the Kiogarh Chitichun pass, Malla Johar. This specimen, which has been illustrated on Pl. XXX, fig. 6, is marked on the accompanying label as *Meekoceras Kiogarhense nov. sp.*, but I could not find any reason for separating it from *M. jolinkense*.

In its outlines, transverse section, absence of sculpture and sutures, it agrees exactly with the type-specimen of *Meekoceras jolinkense*. Insignificant differences in their respective dimensions are certainly of no specific value, as will

be seen from the following measurements of the specimen from the exotic block No. 20 in Malla Johar:—

Diameter of the shell	36	mm.
„ „ „ umbilicus	7	„
Height of the last volution	17	„
Thickness of the last volution	9	„

A slight difference may be noticed in the involution of the last whorl. In the type-specimen of *Meekoceras jolinkense* the space between the umbilical sutures of the last volution and the umbilical edge of the penultimate whorl becomes slightly narrower, whereas it widens out a little in the present specimen. But this difference, which probably induced A. v. Krafft to establish a new species, is so faintly marked that I cannot consider it sufficient for a specific separation.

This is the only species in the fauna of the exotic block No. 20, pointing to the presence of the lower division of the lower Trias in the main region of the Himálayas.

"13. Meekoceras Smithii A. v. Krafft. Pl. IV, fig. 1.

Measurements.

D	cca. 49	mm.	$\frac{D}{U}$	= cca.	3·92
U	12·5	„			
A	cca. 21	„	$\frac{A}{C}$	= cca.	2·1
C	10	„			

"Whorls approximately twice as high as thick. The maximum thickness occurs just below the middle of the sides. Above this region the lateral parts are flat, while near the umbilicus they describe a curve, which descends towards the umbilical suture without forming an edge.

"Very obtuse marginal edges are developed at the beginning of the last volution. These gradually disappear towards the anterior termination.

"*Sculpture.*—No distinct sculpture is seen. In some places, chiefly in the middle of the height of the sides, very low, radial undulations may be noticed.

"*Amount of involution.*—As the umbilical suture describes a remarkably regular spiral, the amount of involution may be supposed to be constant.

"*Body-chamber.*—The specimen is almost entirely chambered. A concentric line seen on the last volution, which looks like a remnant of the umbilical portion of the body-chamber, is due to fracture.

"Shell not preserved.

"*Sutures.*—Siphonal lobe broad, with a median prominence leaving an opening for the passage of the siphuncle. Saddles rounded, lobes with delicate denticulations, which in the type-specimen have somewhat suffered from weathering.

"Septa rather distant from each other.

"*Geological position. Locality. Number of specimens examined.*—Lower Trias, Chocolate Limestone, Jolinka E. G., Byans, 1, coll. Smith.

"*Affinities.*—*Meekoceras Smithii* belongs to the same group of forms as a number of smooth types, described by Waagen under the generic name of

Prionolobus. It has already been observed in the introduction to *Meekoceras*, that these types should rather be united with the present genus, the differences between *Prionolobus* and *Meekoceras s. s.* being too insignificant for a generic separation. *Meekoceras Smithii* closely resembles some of the species of *Prionolobus* illustrated by Waagen on Pl. XXXIV of his memoir on the Ceratite formation, without being specifically identical with any of them.

" *Prionolobus rotundatus* Waagen. For this species I propose the new name *Meekoceras Waageni*. It has higher volutions and a narrower umbilicus, the ratio $\frac{D}{U}$ being 4·41, 4·53, 4·82 in the three type-specimens. *Prionolobus atavus* Waag. has a much wider umbilicus and lower whorls—$\frac{D}{U}$ being 3·37 only—and a distinctly flattened external part. *Prionolobus sequens* Waag. is likewise more evolute—$\frac{D}{U}$ being 3·33—the whorls are lower and flatter and the external part is provided with a comparatively broad siphonal area, with sharp marginal edges.

" My remarks, as given above, apply to Prof. Waagen's type-specimens, which have been re-examined."

Remarks.—I cannot help expressing some doubts as to the propriety of referring this species to the genus *Meekoceras*.

The specimen under consideration shows a great similarity to *Ophiceras Sakuntala* Diener (*Himálayan Fossils*, l. c., Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 114, Pl. X, figs. 1—8, XI, figs. 1, 2, 4), from which it differs only by the flatter slope of its umbilical region and by the development of indistinct marginal shoulders. Although I do not venture on a direct identification with any of the species of *Ophiceras* from the Shalshal cliff, the advisability of placing our species in the genus *Ophiceras* should be earnestly taken into consideration. As in Waagen's specimens of *Prionolobus* from the Salt Range, the leading features of *Ophiceras, viz.*, the concentric striæ on the cast, are not visible on account of its surface being slightly injured by weathering. But in the generality of characters it approaches *Ophiceras Sakuntala* Dien. more nearly than any of the species of *Meekoceras* from the lower Trias of the Himálayas.

There is, however, an American species, to which the present one also appears to be very closely allied, and this is *Prionolobus Jacksoni* Hyatt and Smith (Triassic Cephalopod genera of America, l. c. p. 151, Pl. LXII, figs. 11—21) from the Columbites beds of Idaho. It only needs a glance at the illustrations in figs. 11 and 15 to detect the surprising similarity of the two species in shape and involution. The authors say, in their diagnosis of *Prionolobus Jacksoni*, that the external part is high and narrow, but that no ventral shoulders are perceptible. This absence of indistinct marginal shoulders is the only subordinate feature of distinction. The umbilical shoulders are gently rounded in both species. Nor is there any noteworthy difference in the arrangement of the sutural line.

Whether *Prionolobus Jacksoni* should be grouped with either *Meekoceras* or *Ophiceras*, is another question. Hyatt and Smith are inclined to decide it in favour of *Meekoceras*, on the strength of the character of its sutures. "The general character of the septa"—they say—"is the same as that of *Meekoceras s. s.* but

there is no fourth lateral lobe" (umbilical lobe according to the terminology adopted in this memoir); "instead there is a long, straight row of denticulations. This character of the septation at once distinguishes *Prionolobus* from *Ophiceras* and *Gyronites*, which are both very similar to it in shape and character."

I am sorry to say that I cannot agree with this view, although I should be only too glad to find that the character of the umbilical lobe would afford us a means for separating *Meekoceras* and *Ophiceras*, the separation of these two genera being the most difficult and most artificial among all ammonites of lower Triassic age. But unfortunately the umbilical lobe in *Ophiceras* does not differ in any way from that in *Meekoceras* (or in *Prionolobus*), as has been suggested by Hyatt and Smith. I only need refer to my illustrations of *Ophiceras Sakuntala* (l. c. Pl. X, figs. 1*c*, 8*b*) or *O. demissum* (Pl. XIV, fig. 1*b*) to demonstrate the presence of a straight row of denticulations representing the umbilical lobe in typical species of *Ophiceras*. Nor am I convinced of the propriety of referring *Prionolobus Jacksoni* to the genus *Meekoceras*. It might perhaps be included in *Ophiceras* with as much reason as a second American species, *Prionolobus Waageni* Hyatt and Smith (l. c., p. 150, Pl. LXXVII, figs. 3—8), which reminds me very strongly of the inner volutions of *Ophiceras demissum* Oppel.

Among the Siberian species of the genus *Meekoceras* described by E. v. Mojsisovics (Arktische Triasfaunen, *Mém. Acad. Impér. des Sciences*, St. Pétersbourg, XXXIII, No. 6) it is chiefly *Meekoceras* (*Xenodiscus* Mojs. *non* Waag.) *Schmidti* (l. c. p. 77, Pl. XI, figs. 8—11) from the Olenek stage, which shows a remarkable similarity to the present one. In this species the development of the marginal shoulders exhibits a considerable variability, but the transverse section is always more rectangular than in the Himálayan form. In the sutural line the umbilical lobe does not seem to be separated from the second lateral saddle as sharply as in the latter species. Notwithstanding these differences, the two species are probably closely related, and there is a great probability that they belong to the same group of forms. *Meekoceras Schmidti* being a true representative of this genus, its affinity to *M. Smithii* might perhaps induce us to admit this species within the range of *Meekoceras*.

Considering *Ophiceras* to be the radial of the biangular and more richly differentiated species of *Meekoceras*, we should not be surprised by meeting with transitional forms between these two genera.

"14. MEEKOCERAS nov. sp. ind. Pl. III, figs. 4*a*—*c*.

Measurements.

D	61 mm.	$\frac{D}{U}$	= 4·35	
U	14 „			
A	27 „	$\frac{A}{C}$	= 1·92	
C	14 „			
$\frac{a}{c}$ measured at the beginning of the last volution	14 „	$\frac{a}{c}$	= 2·54	
	5·5 „			

"This is a single specimen, which is too unsatisfactorily preserved to justify the introduction of a new specific name.

"Last volution at the commencement more compressed than at the anterior termination. Maximum thickness midway between the umbilical suture and the siphonal part. The lower half of the sides is flat, the outer half is slightly arched. Umbilical edge rounded, umbilical wall high and sharp. The siphonal part is highly rounded at the beginning of the last volution, but becomes broad towards the anterior termination, very much as in *Meekoceras solitarium nov. sp.*

"*Sculpture.*—The body-chamber is furnished with a few low radial folds which are strongest in the middle of the sides.

"*Length of the body-chamber.*—Approximately 190°, but the peristome has not been preserved.

"The specimen is an inner cast, with but small remnants of the shell adhering.

"*Sutures.*—Not well preserved, as the chambered part of the shell is much weathered. External saddle lower than the principal lateral one, which is broad and obliquely rounded above. Second lateral saddle broad and low and distinctly flattened on the top. Principal lateral lobe much deeper than the second. Umbilical lobe narrow, with delicate denticulations.

"*Geological position. Locality. Number of specimens examined.*—Lower division of the lower Trias (Otoceras beds in the old circumscription), Khár, Spiti, 1, coll. Hayden."

15. Meekoceras sp. ind. aff. pilato Hyatt and Smith, Pl. XXVIII, fig. 2.

In H. Hayden's collections from Banna E. G., I find two specimens belonging most probably to the genus *Meekoceras*, which were left undetermined by A. v. Krafft. If I venture to compare them with *Meekoceras pilatum* Hyatt and Smith (Triassic Cephalopod genera of America, *U. S. Geol. Surv. Prof. Pap. Mem.*, 40, p. 144, Pl. LXIII, figs. 3-9), I do so because they agree fairly well with the figure of an equal sized example from Paris, Idaho.

Both of my specimens are fragmentary casts of small dimensions only. Umbilicus moderately wide, whorls strongly compressed, with their greatest transverse diameter situated in the vicinity of the sharp umbilical margin. Siphonal part narrowly rounded.

The most remarkable character of this species is its sculpture, which is very prominent, and closely resembles the ornamentation in some species of the group of *Ptychites rugiferi*. It consists of a small number of radial folds, which are most strongly marked in the umbilical region, but can be traced as far as the siphonal margin. Six folds are counted on the circumference of one half-volution. They are perfectly straight. The intercostal valleys are of unequal width.

The only feature of distinction between *Meekoceras pilatum* and the present species is the smaller number of radial folds in the latter.

Dimensions.

Diameter of the shell	89 mm.
„ „ „ umbilicus	7·5 „
Height of the last volution	19·5 „
Thickness of the last volution	14 „

Sutures.—Not known.

Locality and geological position. Number of specimens examined.—Banna E. G., Thanam valley, Bashahr, Hedenstrœmia beds, 2, coll. Hayden.

Remarks.—There is also a Triassic species from the Ceratite formation of the Salt Range, which might put in a claim for comparison with the present one. This is *Prionolobus undatus* Frech, an illustration of which has been given recently in Noetling "Die asiatische Trias" (*Lethæa Mesozoica*, Vol. I, pt. 2) on Pl. XXV, figs. 2*a*, *b*, *c*. Both the transverse section and the pattern of ornamentation at the commencement of the last volution are the same as in Frech's large specimen from Virgal (fig. 2*b*).

The sutures of my species being unknown, I cannot decide whether there is a closer affinity with the Salt Range or the American form.

Both my specimens and Frech's illustrations differ considerably from the type of *Proptychites undatus*, as described by Waagen (Ceratite formation, l. c. p. 180, Pl. XXVI, fig. 4). The species described by Frech certainly belongs to *Meekoceras* in the broad sense, not to *Proptychites*.

"16. Meekoceras Joharense v. Krafft. Pl. XXX, figs. 3, 4, 5.

Measurements.

	I.	II
D	cca. 23 mm.	51 mm.
U	5 „	11 „
A	11 „	23 „
C	cca. 6 „	12 „
$\frac{D}{U}$	4·6	4·63
$\frac{A}{C}$	1·83	1·91

"The measurements of a cross-section are as follow:—

D=57·5 mm.	d=26 mm.	$\frac{D}{U}$	= 5·22	$\frac{d}{u}$	= 5·33
U=11 „	u= 4·7 „				
A =27·3 „	a=12·8 „	$\frac{A}{C}$	= 2·16	$\frac{a}{c}$	= 2·13
C =12·5 „	c= 6 „				
I = 8·5 „		$\frac{a}{I}$	= 1·5		

"Of this species no satisfactory transverse section could be procured, as the inner whorls of the ammonites from the exotic block No. 20 are nearly always filled with crystals of calcite, and therefore of uncertain outlines in

transverse sections. As regards the earliest whorls, up to a diameter of approximately 4 mm., it could be ascertained that they are of globose shape. In later stages of growth they become compressed. At the same time marginal edges appear, which are absent in very young individuals.

"In the penultimate whorl of the figured type-specimen (cross-section) the marginal edges are sharper in the penultimate than in the preceding inner whorl. The siphonal area is very broad and slightly arched. On the siphonal area, close to the marginal edges, thin thread-like ridges are seen in young specimens. Full-grown individuals show those ridges less distinctly.

"In the penultimate whorl the largest transverse diameter is situated somewhat below the middle, whereas, in the last volution, it is shifted to the middle of the height of the sides. In the last volution the lateral parts are somewhat curved outside the middle, but nearly flat in the lower half. Whorls are approximately twice as high as thick, the ratio $\frac{A}{C}$ being variable within narrow limits. In the earliest whorls the lateral parts pass gradually into the umbilicus. Later stages of growth show a rounded umbilical edge and a rather steep umbilical wall.

"The amount of involution is apparently constant. The ratio $\frac{D}{U}$ is somewhat variable.

"One of the specimens figured shows delicate falciform growth-lines on the shell.

"*Sutures.*—Siphonal lobe broad, with a rounded median prominence. Principal lateral saddle very deep, second lateral lobe shallow, both narrow. External saddle slender and high. Principal lateral saddle broad and obliquely shaped. Second lateral saddle broadly rounded. The umbilical lobe bears a small number of rather coarse points.

"*Geological position. Locality. Number of specimens examined.*—Red limestone of the exotic block No. 20, Malla Johar, 1 mile W. of Kiogarh-Chitichun pass, probably zone of *Flemingites Rohilla* (Hedenstrœmia beds), 5, coll. Krafft. One of the specimens was found in a slab of rock together with *Xenodiscus nivalis* Dr."

Remarks.—This species recalls *Meekoceras boreale*, especially in the development of a broad external area, but is provided with a wider umbilicus. The sutural line differs by the absence of a distinct auxiliary lobe within the row of umbilical denticulations.

Among H. H. Hayden's collections from the Hedenstrœmia beds of Banna E. G., there is a fragmentary specimen of *Meekoceras* which A. v. Krafft identified with the present species. Its state of preservation is too bad to warrant a definite identification.

17. Meekoceras infrequens v. Krafft. Pl. XXX, fig. 7.

Among A. v. Krafft's collections from the exotic block No. 20, 1 mile W. of the Kiogarh-Chitichun pass, Malla Johar, there is a specimen of *Meekoceras*, marked on the accompanying label as *Meekoceras infrequens* nov. sp. No descrip-

tion of this species has been found. On the label the following measurements are given by A. v. Krafft:—

Measurements.

"D	34 mm.	$\frac{D}{U}$	= 6·8
U	5 „		
A	18·5 „	$\frac{A}{C}$	= 2·17"
C	8·5 „		

The present species is represented by a single, but well preserved specimen only, which is entirely chambered. The whorls are high and strongly compressed. The umbilicus is narrow, with an acute edge and with a perpendicular wall.

The lateral parts are slightly arched. Largest transverse diameter situated somewhat below the middle of the height.

On the external part obtuse marginal edges border the siphonal area, which is slightly arched. No sculpture can be seen, although the shelly test has been preserved.

This species is distinguished from *Meekoceras joharense* by higher volutions, by a much narrower and more slightly arched external part, and by a narrower umbilicus. From *Meekoc. boreale* Dien. it is distinguished chiefly by the arrangement of its sutures, in which no distinct auxiliary lobe is developed within the umbilical series.

Although the present species is not very well characterised, I could not find any other in the normal deposits of the lower Trias in the Mesozoic belt of the Himálayas, with which it would agree. It will therefore be retained as a new species under the denomination chosen by A. v. Krafft.

Sutures.—Siphonal lobe broad, with a high median prominence of conical shape. All the lobes, including the umbilical lobe, as far as visible, provided with delicate denticulations.

Geological position. Locality. Number of specimens examined.—Lower Trias, probably horizon of *Flemingites Rohilla.* Red limestone of the exotic block No. 20, 1 mile W. of Kiogarh-Chitichun pass, Malla Johar, 1, coll. Krafft.

18. MEEKOCERAS DISCIFORME v. Krafft. Pl. I, fig. 4, III, figs. 5, 6, XIV, figs. 9, 10.

"I consider the two specimens from Lilang, illustrated on Pl. I, fig. 4 and XIV, fig. 9 as types of this species. The specimen illustrated on Pl. III, fig. 5, is not identical with the type in every respect, but as the differences are only very slight, it will be described as a variety of *Meek. disciforme.*

Measurements.

	I. (Pl. XIV, fig. 9.)	II. (Pl. I, fig. 4.)	III. (Pl. III, fig. 5.)
D	17 mm.	38·5 mm.	51 mm.
U	5 „	11·6 „	15 „
A	7·3 „	16 „	21 „
C	4 „	8 „	10 „
$\frac{D}{U}$	3·4	3·31	3·4
$\frac{A}{C}$	1·82	2	2·1

"The illustration on Pl. XIV, fig. 10, represents the cross-section of a moderately sized specimen from Lilang. The measurements of this cross-section are as follow:—

D =	30·5 mm.	d = 13·2 mm.	d_1 = 5·3 mm.
U =	8·7 „	u = 3·5 „	
A =	13 „	a = 5·5 „	a_1 = 2·3 „
C =	7 „	c = 3 „	c_1 = 1·3 „
I =	cca. 2·5 „	i = 1 „	
$\frac{D}{U}$ =	3·5	$\frac{d}{u}$ = 3·77	
$\frac{A}{C}$ =	1·85	$\frac{a}{c}$ = 1·86	$\frac{a_1}{c_1}$ = 1·76
$\frac{a}{I}$ =	cca. 2·2	$\frac{a_1}{i}$ = 2·3	

"The development of the species is as follows:—

"*Height and thickness.*—The earliest whorls slightly thicker than the full-grown, in proportion to their height. This appears from the above cross-section as well as from the measurements of the three entire specimens.

"The maximum thickness is situated approximately in the middle of the sides.

"*Umbilical edge and wall.*—Corresponding to a diameter of 5·2 mm. the sides pass gradually into the umbilical suture. If a diameter of 13 mm. is reached, a rounded umbilical edge appears, which is better marked in the last whorl of the cross-section.

"*External part.*—Broad and somewhat curved, with acute marginal edges in the youngest whorls which are accessible to examination. The external edges are raised into thin ridges, projecting sideways, which bear no striæ. The specimens collected by Mr. Hayden differ from the type in the absence of marginal edges. This may, however, be due only to weathering.

"*Amount of involution.*—As no distinct increase or decrease of the involution can be perceived, it may be supposed to be constant.

"*Sculpture.*—Beyond delicate growth-lines, which are very slightly falciform, no sculpture can be detected. The specimen no. II is for the most part covered with its shelly test. In the other specimens small remnants only of the shell have been preserved.

"*Body-chamber.*—The greatest length of the body-chamber, as observed in specimens provided with their peristome, is somewhat more than 180 degrees.

"*Sutures.—Type.*—Siphonal lobe narrow, with a low and conical median prominence, which bears an incision on its top. The two branches of the siphonal lobe bear traces of denticulations, though too indistinct to be figured. Delicate denticulations are seen on the principal lateral lobe, and traces of such can also be detected in the second lateral lobe, but here too they are so delicate that they could barely be figured. The umbilical lobe appears to be goniatitic. Principal and second lateral saddles broadly rounded. Second lateral saddle marked off from the umbilical lobe very distinctly.

"*Variety*.—Saddles broader than in the type of the species. The second lateral saddle passes into the umbilical lobe without any sharp demarcation. As to the specimen illustrated on Pl. III, fig. 6, I believe that the absence of denticulations in its lobes is only due to weathering.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 5, coll. Krafft; lower division, exact horizon unknown, S. E. of Muth, 1, coll. Hayden; 5 miles S. of Eusa, 1, coll. Hayden.

"*Remarks*.—As stated in the introduction to *Meekoceras*, this species belongs, together with certain smooth types of Waagen's genus *Gyronites*, to one and the same group of forms. None of Waagen's species is, however, identical with the present form. The nearest allied type is *Gyronites frequens*, but it is more evolute ($\frac{D}{U}$ =2·5 in Waagen's specimen illustrated on Pl. XXXVII, fig. 1), and has no marginal edges. *Gyronites vermiformis* Waagen (Ceratite formation, l. c. Pl. XXXIX, fig. 1) differs considerably in its transverse section."

To this description of *Meekoceras disciforme* by A. v. Krafft I should like to add, that *Gyronites superior* Waagen (l. c. p. 294, Pl. XXXVII, fig. 6), from the topmost beds of the lower Ceratite limestone, appears to me to be so closely allied to the present species, that it may be considered whether they are not even identical. In their involution the two species approach each other very nearly, the ratio $\frac{D}{U}$ being 3·06 in *Gyronites superior*. The only feature of distinction is perhaps the more denticulated character of the lobes in the sutural line of the Salt Range species, which also shows a distinctly serrated external lobe.

"19. MEEKOCERAS cf. DISCUS Waagen. Pl. VI, fig. 2.

1895. *Ambites discus* Waagen, Fossils from the Ceratite formation, *Palæont. Indica*, ser. XIII. Salt Range Fossils, Vol. II, p. 152, Pl. XXI, figs. 4, 5.
1895. *Ambites magnumbilicatus* Waagen, *ibidem*, p. 154, Pl. XXI, fig. 6.

Measurements.

A	. . . . .	20 mm.	$\frac{A}{C} = 2$
C	. . . . .	10 „	

"The two species from the Ceratite marls of the Salt Range quoted above should be united in one, under the name *Meekoceras discus* Waag., as the differences between the types are not more prominent than is usual between specimens belonging to the same species.

"Waagen states that *Ambites discus* can be distinguished from *A. magnumbilicatus* by the inferior width of its umbilicus, by its more involute whorls, a lower umbilical wall, the absence of an umbilical edge, and by differences in the sutures. All these differences are, however, in my opinion, too slight to be of specific importance.

"Of the two type-specimens of *Ambites discus*, the specimen illustrated on Pl. XXI, fig. 4 is a poorly preserved fragment only, the diameter of which cannot be measured. In the second specimen (Pl. XXI, fig. 5) the ratio $\frac{D}{U}$ is 4·27 : in *Ambites magnumbilicatus* (l. c. Pl. XXI, fig. 6) it is 4·1. The width of the umbilicus is therefore practically the same, and consequently the involution cannot be very different either. Nor am I able to follow Waagen in attaching specific importance to the other very slight differences he mentions, all the more because he admits that the sculpture is exactly alike in both species.

"As regards the genus *Ambites*, I venture to doubt whether its introduction was necessary. Waagen lays special stress on the goniatitic character of the lobes, but in his type of *A. discus* I detected very delicate, indistinct denticulations on two or three succeeding principal lateral lobes. I should not therefore consider it advisable to speak of goniatitic sutures, all the more because we know that the denticulations are extremely delicate in the group of *Meekoceras disciforme*.

"A second feature claimed by Prof. Waagen as characteristic of his new genus *Ambites* is a tripartite external lobe, but here again I cannot agree with him, as the lobe alluded to is in reality exactly as in *Meek. disciforme*. It bears a low median prominence of conical shape, with a very small incision on the top. The two branches of the lobe are apparently goniatitic. In the type of *Ambites magnumbilicatus* I counted six different siphonal lobes, in which the characters are as described above, but I could not find a single one agreeing with Waagen's drawing. In the type-specimen of *Amb. discus* the siphonal lobe is not distinctly visible, the median portion being hidden by remnants of the shell.

"Under these circumstances I do not see any reason why the two species should not be included in the group of *Meek. disciforme*.

"A fragmentary specimen from Lilang is very nearly allied to this Salt Range species and may even turn out to be identical.

"My specimen is of a somewhat wavy outline and has strongly compressed volutions, which are twice as high as thick. In its transverse section it resembles *Aspidites Vidarbha* Dien., as its maximum thickness is situated in the upper part of the sides. These are flattened up to three quarters of their height, where they are suddenly bent in a very obtuse angle, to join the acute marginal edges of the flattened siphonal part. The umbilical edge is rounded, passing into a low perpendicular wall. The umbilicus is comparatively wide, but as the specimen is fragmentary, its diameter cannot be measured.

"In the character of its transverse section the Himálayan type is not perfectly identical with the Salt Range species, but there is a marked similarity. The differences, which can be detected, are the following: The Salt Range types are thicker, $\frac{A}{C}$ being 1·88 in the type of *Ambites discus*, and 1·84 in the type of *Ambites magnumbilicatus*. The lower parts of the sides are not so much flattened. Accordingly the curve, in which the lateral parts descend to the siphonal edge, is ss abrupt. The umbilical wall is a little higher and the umbilicus is narrower.

All these differences cannot, however, be considered as of great importance, especially if we take into account the remarkable resemblance in sculpture.

"In the Himálayan type the ornamentation consists of falciform folds, bent forward, reaching from the umbilicus up to the external part. The folds are strongest on the chambered portion of the shell and near the beginning of the body-chamber. They gradually become broader the nearer they approach the external part. At the commencement of the body-chamber each fold rises twice into very low, rounded knobs, which stand at approximately equal distances from each other and from the siphonal and umbilical terminations of the folds, thus producing two concentric rows.

"This kind of sculpture disappears about the middle of the preserved portion of the body-chamber, to be replaced by lower and more closely set folds, without knobs. These folds are mostly broad, a few of them only are thinner than the rest. Some have a tendency to bifurcate near the external part. On and between the folds very delicate radial striæ can be seen here and there. The space between the spiral rows of knobs is flattened and furnished with very faint concentric striæ.

"This is almost exactly the same sculpture as is seen in *Ambites discus* and *A. magnumbilicatus* Waag. There are some very slight differences, but I feel convinced that they cannot be of specific importance. The ribs of the Salt Range species bear little furrows on the top, so as to produce pairs of ribs. This is not so distinctly seen in the Himálayan type, although the character is present there also.

"Another difference is that in the Salt Range species the sculpture changes less rapidly on the body-chamber. The space between the two spiral rows of knobs in one of Waagen's types of *Ambites discus* is a shallow furrow, but we need not attach any importance to it, as similar variations may be observed in other species of *Meekoceras*, for instance in *M. lilangense*. On the other hand it may be specially mentioned, that the Salt Range types have the same wavy outlines as my Himálayan specimen. Waagen writes (l. c. p. 153) : 'the external part is not quite smooth, but bears very low undulations, which are in connection with those of the lateral parts.' The spiral furrow or band of Waagen's types bears the same faint concentric striæ that are seen in the Himálayan specimen.

"In summing up the above, we may say that the only noteworthy difference distinguishing the Himálayan specimen from *Meekoceras discus* consists of a wide umbilicus. Whether this is of specific importance or not, it is at present impossible to decide.

"The specimen described is a cast, the greater portion of which belongs to the body-chamber.

"*Sutures.*—Almost perfectly identical with those of *Meekoceras discus*.

"Siphonal lobe narrow, with a high, conical, median prominence, bearing on its top a small incision, through which the siphuncle passes. No denticulations are seen in the two branches of the siphonal lobe. In the lateral lobes denticulations can be seen only by means of a magnifying glass. In the umbilical lobe

some small incisions are discernible, but whether these are true denticulations or not cannot be decided, on account of the imperfect preservation of this lobe.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 1, coll. Krafft.

"*Remarks.*—E. v. Mojsisovics figures in his "Arktische Triasfaunen" (l. c. Pl. XI, figs. 8-11) three ammonites, which he united under the specific name of *Xenodiscus Schmidti*. It has been shown, in the introduction to this chapter, that this Arctic species belongs to the genus *Meekoceras*. Of the three illustrations mentioned above, fig. 11 is not unlike the present species in involution and transverse section; but as the sculpture characteristic of *Meekoceras discus* is wanting and as there are also differences in the arrangement of the sutural line, the relationship of the two species is rather doubtful."

20. Meekoceras dubium v. Krafft. Pl. XXIV, figs. 6-14.

1897. *Meekoceras sp. ind. ex aff. plicatili* Diener, Himalayan Fossils, *Pal. Ind.* ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 137, Pl. XV, fig. 6.

A considerable number of specimens in the Himálayan collection are marked as *Xenodiscus dubius* nov. sp. on the labels in A. v. Krafft's handwriting, but there is no description of this species among his notes. The systematic position of this new species is, indeed, somewhat doubtful, as the name proposed by A. v. Krafft implies. The ornamentation is so delicate that it might be referred to *Xenodiscus* or to *Meekoceras* (*Gyronites* Waagen), or perhaps even to *Ophiceras*, with almost equal reason.

In their general shape and involution my specimens agree most closely with the specimen described as *Meekoceras sp. ind. ex aff. plicatili* Waag. in my memoir on the lower Trias of the Himálayas. The siphonal area is always bordered by distinct marginal edges, which even in my largest examples do not become obtuse nor rounded. In the majority of the specimens the whorls are moderately compressed, but this character is subject to considerable variation. In one specimen (fig. 11) of proportionately large size, the ratio of height to thickness is 1·38, whereas in a second example, of smaller dimensions, it is 1·25 and in a third 1·63.

The greatest transverse diameter corresponds to the umbilical margin, which is marked very distinctly, forming an acute or slightly rounded edge. From this place the lateral parts converge towards the siphonal area in the form of flat planes, which are not curved at all. The umbilical wall is high and steep.

In its transverse section this species most closely resembles *Ophiceras tibeticum* Griesb., if we except the biangular character of the siphonal area, which in *O. tibeticum* passes gradually into the lateral parts; but otherwise the similarity is, indeed, very striking.

The sculpture is not at all prominent, even less so than in some species which in my memoir, quoted above, have been grouped with the genus *Ophiceras*. It is

restricted to the inner volutions of full-grown specimens, and consists of numerous low and radiating folds, which occasionally assume a slight, falciform bend.

The specimen illustrated in fig. 6 differs from the rest by its folds being somewhat broader and less numerous. In the specimen illustrated in fig. 12, which is provided with its body-chamber, the surface of the latter is perfectly smooth. The body-chamber scarcely exceeds one-half volution in length, but the apertural margin has not been preserved.

Dimensions.

	I (fig. 11).	II (fig. 9).	III (fig. 7).	IV.	V. (fig. 8).
D	38 mm.	14 mm.	19 mm.	29 mm.	23 mm.
U	16 „	5 „	6·5 „	12 „	8·5 „
A	12·5 „	5 „	6·5 „	10 „	9 „
C	9 „	3·5 „	4·7 „	8 „	5·5 „

Sutures.—Very simple, exhibiting a primitive character in the absence of a distinct auxiliary element. The umbilical lobe is not separated from the second lateral saddle. Siphonal lobe very low and broad, divided by an obtuse median prominence, with rounded branches. Lateral lobe very deep and serrated. Principal lateral saddle considerably higher than the external saddle. Umbilical lobe apparently goniatitic.

Locality and geological position. Number of specimens examined.—South-east of Muth, Spiti, lower division (Otoceras beds ?), 2, coll. Hayden ; 7 miles N. of Kágá, lower division (Otoceras beds ?), 1, coll. Hayden ; 5 miles S. of Ensa, lower division (Otoceras beds ?), 2, coll. Hayden ; crest of ridge between Lissar and Dharma valleys, exact horizon not known, 4, coll. La Touche ; Jolinka, Byans, 4, coll. Smith.

Remarks.—The indistinct character of the ornamentation makes the systematic position of this species somewhat doubtful. There are strong reasons in favour of grouping it with *Ophiceras*. Unfortunately in all my specimens the state of preservation is such, that spiral striations, the leading feature in the genus *Ophiceras*, could not be observed, even if formerly present. Although this species may perhaps belong to *Ophiceras*—I have already alluded to the remarkable similarity with *O. tibeticum*—I have not succeeded in finding out any trustworthy proof of such a conclusion.

The difficulty in deciding, whether it should rather be placed in *Xenodiscus* or in *Meekoceras* (*Gyronites*), is equally great. As the sculpture is rather insignificant it becomes more or less a matter of personal taste, whether it should be considered sufficiently well marked to warrant the inclusion of our species in the *Ammonea leiostraca* or *trachyostraca*. In this case the distinction must be made in a rather arbitrary manner.

A re-examination of my type-specimen of *Meekoceras sp. ind. ex aff. plicatili* has convinced me of its identity with the present species. This has been proved especially by a comparison with the specimens illustrated in figs. 7 and 9 of the present memoir.

21. MEEKOCERAS KYOKTICUM v. Krafft. Pl. II, fig. 8.

Measurements.

D	46 mm.	$\frac{D}{U}$	= 5·75
U	8 „		
A	22 „	$\frac{A}{C}$	= 2·2
C	10 „		
a	13 „	$\frac{a}{c}$	= 2
c	6·5 „		

"The last whorl at the anterior termination is more compressed than at the beginning. The maximum thickness falls somewhat below the middle of the sides. These are flattened in the umbilical region. The remainder of the lateral part is gently arched.

"External part highly rounded, with no marginal edges developed. Umbilical wall low and perpendicular, bordered by a rounded umbilical edge.

"No sculpture, except a few extremely low, widely separated radial folds.

"The shelly test has not been preserved. Of the last volution a small part only belongs to the body-chamber.

"*Sutures.*—Siphonal lobe narrow, with a low median prominence of conical shape, without any incision at its top. The denticulations of the lobes are very delicate throughout, especially in the siphonal lobe, where they can scarcely be seen with the naked eye. Second lateral lobe shallow. All the saddles are broad, especially so the second lateral saddle, which is flattened on the top. Umbilical lobe with many delicate but irregular denticulations.

"*Geological position. Locality. Number of specimens examined.*—Lower division (Otoceras beds in the old circumscription) 5 miles S. of Ensa, Spiti (Kyokti valley), 1, coll. Hayden."

22. MEEKOCERAS SOLITARIUM v. Krafft. Pl. III, fig. 1.

Measurements.

D	66 mm.	$\frac{D}{U}$	= 6·28
U	10·5 „		
A	32 „	$\frac{A}{C}$	= 2·28
C	14 „		
*a	17 „	$\frac{a}{c}$	= 2·42
*c	7 „		

"The whorls at the beginning of the last volution are more compressed than at the anterior termination. The greatest transverse diameter lies somewhat below the middle of the sides.

"Lateral parts slightly concave in the umbilical region of the body-chamber whereas they are gently arched higher up. External part rounded and increasing

* Measured near the beginning of the last volution.

in width abnormally towards the anterior termination. Umbilical edge obtuse, umbilical wall perpendicular.

"In one place an indistinct sculpture is seen on the body-chamber, consisting of very low folds.

"Body-chamber comprising more than one half-volution, but its exact length could not be ascertained.

"No distinct apertural margin can be seen, but there is a slight indication of a falciform line, which may perhaps correspond to the mouth of the aperture.

"*Sutures.*—The sutures of this species are remarkable in several respects. Siphonal lobe narrow and extremely shallow, bearing a median prominence, which almost attains the height of the external saddle. The latter is a little higher than the principal lateral saddle. The second lateral saddle slopes gradually into the umbilical lobe, which is very broad, and shows a great number of delicate, irregular denticulations.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, 5 miles S. of Ensa, 1, coll. Hayden.

"*Remarks.*—There is no other species of *Meekoceras* known to me, which may be compared advantageously with the present one."

Subgen. *Aspidites* Waagen.

I consider *Aspidites superbus* Waagen (Ceratite formation, l. c. p. 218, Pl. XXIII, XXIV, fig. 1) to be the prototype of this subgenus. In *Aspidites* are included such species of *Meekoceras* as are distinguished by their great involution and by the complexity of the auxiliary series. But the auxiliary lobes and saddles are of very irregular size and shape.

The development of the auxiliary elements in the inner volutions of *Aspidites* is exactly like that in full-grown individuals of *Kingites* Waagen. Thus *Aspidites* represents a branch further advanced than *Meekoceras s. s.* This fact is corroborated by the stratigraphical distribution of *Aspidites* which is found in the Meekoceras and Hedenstrœmia beds of the Himálayas, but not in the Otoceras beds, where *Meekoceras s. s.* makes its first appearance.

The following species among the *Meekoceratidæ* of the Ceratite formation of the Salt Range are good representatives of the subgenus *Aspidites*:—

Aspidites superbus Waagen (see above);

Aspidites discus Waagen (l. c. p. 228, Pl. XXV, fig. 2).

Among the species grouped with the genus *Kingites* by Waagen, *K. lens* Waagen (l. c. p. 232, Pl. XXVI, fig. 4.) might perhaps be more appropriately included in *Aspidites* than in *Meekoceras s. s.*, the umbilical lobe being very long and divided into irregular, but distinct, lobes and saddles.

In the Meekoceras beds of North America of lower Triassic age *Aspidites* is represented by *A. Hooveri* Hyatt and Smith (Triassic Cephalopod genera of North America, l. c. p. 150, Pl. XVII, figs. 1-12) and by two other new species.

The species of *Meekoceras* from the Werfen beds of the Bakony, which has been described as *Aspidites eurasiaticus* Frech by G. v. Arthaber (Neue Funde in den Werfener Schichten und dem Muschelkalk des Suedlichen Bakony, *Resultate der wissenschaftl. Erforschung des Balatonsees*, I Bd., 1 Th., p. 18, Taf. I, fig. 1) does not belong to *Aspidites* but to *Meekoceras s. s.* Its umbilical lobe is comparatively short, not longer than in the majority of species allied to *Meekoceras Varaha*, and does not show any distinct denticulations. Although this character is probably only due to weathering, distinct auxiliary elements are certainly absent.

Among Hayden's and A. v. Krafft's collections from the lower Trias of Spiti the subgenus *Aspidites* is represented by six species :—

Aspidites spitiensis v. Krafft.
„ *ensanus* v. Krafft.
„ *crassus* v. Krafft.
„ *muthianus* v. Krafft.
„ *superbiformis* Dien.
„ *nov. sp. ind. aff. superbo* Wang.

Meekoceras Vidarbha Diener, which is of doubtful systematic position, will be provisionally placed in this subgenus, since A. v. Krafft included it in his group of *Meekoceras spitiense*, which is, however, not the most typical species of *Aspidites*.

23. (1) ASPIDITES SPITIENSIS v. Krafft. Pl. IV, figs. 4*a*—*c*, 5, XVI, figs. 3—8.

Measurements.

	I. (Pl. XVI, fig. 4.)	II. (Pl. IV, fig. 4.) (Lower specimen.)	III. (Pl. IV, fig. 4.) (Upper specimen).	IV. (Pl. IV, fig. 5.)
D	39 mm.	43 mm.	43 mm.	61 mm.
U	2 „	1 „	3 „	0 „
A	22 „	26 „	24 „	28 „
C	10·5 „	10·5 „	9 „	14 „
$\frac{D}{U}$	19·5	43	14·33	∞
$\frac{A}{C}$	2·09	2·47	2·66	2

"The cross-section of a specimen from the Meekoceras beds of Rimkin Paiar E. G., has been figured on Pl. XVI, fig. 5. The measurements of this cross-section are :—

D	=	45 mm.	d	=	18·3 mm.	d_1	=	6·4 mm.
A	=	27 „	a	=	11 „	a_1	=	3·8 „
C	=	ca. 9·5 „	c	=	4·8 „	c_1	=	1·9 „
$\frac{A}{C}$	=	2·84	$\frac{a}{c}$	=	2·29	$\frac{a_1}{c^1}$	=	2

"The development of the species is as follows :—

"*Height and thickness.*—Even in young volutions the height exceeds the thickness. During their growth the whorls become more and more compressed.

"The greatest transverse diameter is situated about the middle of the lateral parts. In the body-chamber the outer half of the sides is as a rule more strongly arched than the inner one, which is often almost quite flat. This character is, however, well seen in inner casts only. In specimens with their shelly test preserved the difference in the curve is much less pronounced, as the shell, increasing in thickness towards the umbilicus, tends to round off the sides equally.

"*Umbilical edge and wall.*—Umbilicus in most specimens covered entirely by the shell, but there are instances in which the umbilicus is open. Casts have a rounded umbilical edge and no marked umbilical wall.

"*External part.*—In the earliest volutions rounded. It can be seen on the drawing of the cross-section that the volution, measuring 6·4 mm. in diameter, has a rounded siphonal part below and marginal edges above. These edges persist up to the end of the body-chamber. In some specimens a low broad keel is visible both in the inner cast and on the shell, running along the siphonal area (Pl. IV, fig. 4*b*, upper specimen).

"*Amount of involution.*—Not ascertained.

"*Sculpture.*—The ornamentation consists of low falciform folds, reaching from the umbilicus to the external part. The shell bears delicate, radial growth-lines, running parallel to these folds. The cast of the body-chamber shows in some places very thin concentric striæ similar to those in other species of *Meekoceras*.

"*Mouth of aperture.*—The apertural margin is not completely preserved in any of my specimens, but there is a smooth, narrow falciform band, perceptible in the lower of the two specimens illustrated on Pl. IV, fig. 4, rising from the umbilicus half way up the side. This band represents, I believe, part of the mouth of the aperture. The apertural margin is probably also preserved, to some extent at least, in the specimen illustrated on Pl. XVI, fig. 3, but this specimen bears no shell on the body-chamber.

"*Length of the body-chamber.*—In the specimen illustrated on Pl. XVI, fig. 3, ca. 205°.

"*Sutures.*—Siphonal lobe broad, with a low, incised median prominence. Principal lateral lobe deeper than the siphonal lobe, which is approximately as deep as the second lateral lobe. Principal lateral saddle high and rather slender; second lateral saddle short. The umbilical lobe is very broad, with a great number of sutural elements, which vary considerably in detail.

"The sutures of this species follow one another very closely. The margins of the saddles in one septum fit tightly over those in the next septum, thus producing parallel concentric lines.

"*Geological position. Locality. Number of specimens examined.*—Lower

division, horizon of *Meekoceras Markhami*, Shalshal cliff, Rimkin Paiar E. G., Painkhanda, 26, coll. Noetling.

"Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 2, coll. Krafft.

"Lower division, exact horizon not known, 5 miles S. of Ensa, Spiti, 3 coll. Hayden; N. N. W. of Kágá, 2, coll. Hayden; S. E. of Muth, 1, coll. Hayden; 4 miles W. of Po, 1, coll. Krafft.

"Lower Trias, Lilinthi E. G., Byans, 1, coll. Smith.

"*Remarks.—Aspidites spitiensis* bears a remarkable resemblance to *A. discus* Waagen (Fossils from the Ceratite formation, l. c. Pl. XXV, fig. 2). Any identity with this species can, however, be rejected with certainty. The type of *Aspidites discus* is an inner whorl of a large-sized specimen, still bearing remnants of the umbilical lobe of the next following volution, whereas *Aspidites spitiensis* is a small species. The sutures of a *A. discus*, although in general similar to those of *A. spitiensis*, are farther apart. The umbilical lobe is a little less broad and its elements are more regular than in the present species.

"As *Aspidites discus* occurs in younger beds (Stachella beds), it may be a descendant of *A. spitiensis*."

24. (2) Aspidites ensanus v. Krafft. Pl. V, figs. 3, 4, 5, 6, 7; Pl. VI, fig. 1; Pl. XIV, fig. 6.

"Although there are a good many specimens of this species available, none is well enough preserved to allow of reliable measurements. They are all either damaged or imbedded in a very tough, grey limestone, from which they could not be freed.

"At Lilang *Aspidites ensanus* occurs in the lowest bed of the horizon of *Meekoceras lilangense* and *M. Varaha*. The specimens from this locality are distorted. Those from Ensa and Po in Spiti show regular outlines.

"The cross-section of a specimen from Po has yielded the following measurements:—

D	=	?	d	=	21·3	mm.	d_1 =	8·4 mm.
A	=	?	a	=	12	„	a_1 =	5 „
C	=	10·5 mm.	c	=	4	„	c_1 =	1·9 „
		$\frac{a}{c}$ = 3					$\frac{a_1}{c_1}$ =	2·68

"The measurements of the above cross-section are, unfortunately, not complete enough to enable the development of the species to be described in full detail.

"*Height and thickness.*—The earliest whorls, which cannot be measured, are somewhat thicker than the later ones.

"*Maximum thickness.*—Sides approximately parallel, corresponding to a diameter of 3 mm. As soon as a diameter of 8 mm. has been reached the greatest thickness coincides with the umbilical region, where it persists, until in the body-chamber it is shifted somewhat higher up. Lateral parts outside the region of maximum thickness almost quite flat.

"*Umbilical edge and wall.*—No distinct umbilical wall up to the neighbourhood of the body-chamber. On the latter the sides are sometimes compressed or even concave near the umbilicus, the edge being then well marked. Umbilical wall low and vertical.

"*External part.*—Broad and flat in the young volutions, corresponding to a diameter of 3 mm. With a diameter of 8·4 mm. as in full grown whorls. Edges sharp, siphonal area narrow.

"*Amount of involution.*—Uncertain, probably decreasing.

"*Sculpture.*—The ornamentation is, unfortunately, not well shown in any single individual, but it can be made out sufficiently by comparing the various specimens. The sculpture of the shell differs from that of the inner cast, although in general characters they are similar. The shell as a rule thickens out in the umbilical region. Here the inner cast bears thick, slightly falciform folds, becoming broader and disappearing half way up the sides. These folds grow larger and thinner towards the anterior termination, where the lowest part of the sides is entirely smooth.

"The shell is covered by more delicate folds, which run parallel to those of the cast. These too are stronger on and near the chambered part than towards the anterior termination, but it seems that the folds on the shell are changed into delicate striæ earlier than the folds on the cast. At any rate it can be observed, that in some places, where the folds of the cast are still comparatively thick, the shell already bears thin striæ.

"*Body-chamber.*—In several specimens the length of the body-chamber is exactly one half-volution.

"*Sutures.*—Very variable. Siphonal lobe broad and provided with a high median prominence, which is incised on its top. The depth of the second lateral lobe is subject to considerable variation, being in two specimens even greater than that of the principal lateral lobe, in two other specimens smaller.

"External and principal lateral saddles of almost equal height. Second lateral saddle in one specimen considerably lower than the principal lateral saddle, in two other specimens of nearly equal height. Umbilical lobe broad, with a considerable number of elements varying in size and shape.

"*Geological position. Locality. Number of specimens examined.*—Lowest bed of horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 7, coll. Krafft; lower division, exact horizon unknown, 5 miles S. of Ensa, Spiti, 5, coll. Hayden; 4 miles W. of Po, 2, coll. Krafft."

25. (3) ASPIDITES CRASSUS v. Krafft. Pl. VI, fig. 4, VII, fig. 1, VIII, fig. 1.

Measurements.

	I. (Pl. VI, fig. 4.)	II. (Pl. VIII, fig. 1.)
D	40 mm.	113 mm.
U	2 „	11 „
A	24 „	6·1 „
C	10 „	? „
a	?	28 „
c	?	17 „
$\frac{D}{U}$	20	10·2
$\frac{A}{C}$	2·4	?
$\frac{a}{c}$	?	1·64

" The two large-sized specimens illustrated on Pl. VII, fig. 1 and VIII, fig. 1, are taken as prototypes of this species. With them, I am inclined to unite two small specimens, one of which has been figured on Pl. VI, fig. 4. These four specimens were obtained from two succeeding layers in the horizon of *Meekoceras lilangense* and *M. Varaha* near Lilang.

" In the two large specimens the sides are rather inflated. The greatest transverse diameter is situated in the middle of the lateral parts. External part flatly rounded. Umbilical edge sharp. Umbilical wall high and perpendicular. No sculpture.

" The small specimens differ in several respects from the types of the species. The external part is more highly arched, the umbilical edge is rounded and the whorls increase more rapidly in height. In addition to this the umbilicus of the small specimens is relatively narrower.

" As the mode of development could not be studied, it is uncertain whether these differences are due to changes during the growth or not. This appears, however, very probable, especially as the sutures are too similar to suggest a specific difference.

" The two large specimens are inner casts. Remnants of the shelly test have been preserved in the small specimen illustrated on Pl. VI, fig. 4.

" *Length of the body-chamber.*—The smallest specimen figured (Pl. VI, fig 4) is entirely chambered. In the specimen illustrated on Pl. VII, fig. 1, only a small crushed portion of the body-chamber has been preserved. The body-chamber of my largest type specimen measures approximately 180°.

" *Sutures.*—Types of the species: Siphonal lobe broad and shallow, with an incised, conical median prominence. Principal and second lateral lobes with coarse denticulations, reaching half way up the inner slopes of the external and

principal lateral saddles. Second lateral lobe slightly shallower than the principal one. External and principal lateral saddles of equal height. Second lateral saddle much lower and broad. Umbilical lobe with two large, saddle-shaped points, both of which are incised in the largest specimen, whereas one of them is entire in the second type-specimen. After these two sharp points follow.

"Sutural line of the smaller specimens: second lateral saddle slender. Umbilical lobe large, saddle-shaped, but entire, and with two sharp points.

"The large specimen illustrated on Pl. VIII, fig. 1, shows near the body-chamber several goniatitic lines crossing the actual sutures. This feature can be explained as follows: the specimen was crushed and thus the septa were broken; the goniatitic lines represent sections through the broken septa. Naturally the saddles are lower and the lobes shallower in these sections than in the sutural lines which are exposed on the surface of the cast.

"*Geological position. Locality. Number of specimens examined.*— Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 4, coll. Krafft.

"*Remarks.*—*Aspidites crassus* is presumably the ancestor of the species next to be described, *Aspidites muthianus nov. sp.* occurring in the upper division of the lower Trias of Spiti. At any rate it is the only species of *Aspidites* with a broad umbilical lobe, found in the horizon of *Meekoceras lilangense*, which to any extent resembles *Aspidites muthianus*."

26. (4) ASPIDITES MUTHIANUS v. Krafft. Pl. VI, fig. 5; XV, figs. 1, 2.

	I.	II.	III.
	Pl. XV, fig. 2.	Pl. XV, fig. 1.	Pl. VI, fig. 5.
D	62 mm.	75 mm.	122 mm.
U	8 „	9 „	14·5 „
A	33 „	42 „	69 „
C	?	19 „	30 „
$\frac{D}{U}$	7·75	8·33	8·41
$\frac{A}{C}$	?	2·21	2·3

"Lateral parts compressed and equally arched. Maximum thickness situated approximately in the middle of the sides. Umbilical edge rounded. Umbilical wall high and perpendicular. The external part is highly rounded.

"No shell preserved.

"*Sculpture.*—The lateral parts are furnished with low, radial folds of a somewhat falciform bend. Five or six folds only are present in one half-volution.

"*Amount of involution.*—Increasing slightly.

"*Body-chamber.*—In none of my specimens has a large portion of the body-chamber been preserved. All the specimens figured consist of air-chambers only.

"*Sutures.*—Siphonal lobe broad, with a very high median prominence, provided with deep indentations. Lobes highly differentiated. Saddles club-shaped, serrated along their margins up to one half their entire height. Umbilical lobe with several finger shaped points (compare also the sutures of specimen III). Specimen I bears on the reverse of the figured side remnants of the auxiliary series of the following volution, but of the internal saddle the top only is visible.

"The individual variability in the development of the auxiliary series is very considerable.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S.E. of Muth, Spiti, 3, coll. Hayden.

"*Remarks.*—*Aspidites muthianus* can easily be distinguished from *Koninckites Yudishthira* Dien., with which it occurs, by its decreasing involution and consequently by a much narrower umbilicus in the large specimens, by its different umbilical lobe and by its sutures which are generally much more differentiated."

27. (5) ASPIDITES SUPERBIFORMIS, nom. nov. Pl. XIX, fig. 1.

1897. *Aspidites superbus* Waagen *var.* Diener, *Palæont. Indica*, ser. XV, Himálayan Foss. Vol. II, Pt. 1, p. 145, Pl. XXI, fig. *a*, *b*, *c*., *non A. superbus* Waagen, Ceratite formation l. c. p. 218, Pl. XXIII, XXIV, fig. 1 (for transverse section compare this memoir, Pl. XIX, fig. 2).

"Professor Diener has described a large specimen of *Meekoceras*, collected in the Hedenstrœmia beds S. E. of Muth, which he identified with *Aspidites superbus* Waagen. On a re-examination of his type-specimen, and comparison with Waagen's type-specimen of *Aspidites superbus* from the Ceratite sandstone of the Salt Range, I have come to the conclusion that it is not identical with the latter.

"This is proved first by the fact that the specimens differ in their transverse sections (see Pl. XIX, figs. 1 and 2). Waagen's species has a highly rounded, very narrow siphonal part, whereas the specimen from Muth is broadly rounded on its external part. Both Waagen's and Diener's figures are not correct in this respect. The external part is too sharp in Diener's illustration, in Waagen's figure too broad. I may add, that the true character of the external part in both specimens is clearly seen at the beginning of the last volution only, because the specimens are otherwise strongly weathered.

"As regards the width of the umbilicus, the specimen from Muth cannot well be compared, for its umbilicus is damaged and cannot be measured. My impression is that it must have been wider in proportion than that of *Aspidites superbus*. But it will be safe to leave that character out of consideration. Nor shall I lay any stress on the fact that the indistinct sculpture, seen in Diener's type-specimen, is not present in *Aspidites superbus*.

"Diener laid great stress on the identity of the sutures in both specimens. He writes (p. 146): 'The sutural line is perfectly identical with the one in

Waagen's type-specimen of *Aspidites superbus* with the single exception of the very last element of the auxiliary series. Taking into consideration the extreme variability of the auxiliary series in similar forms, . . . this small difference can scarcely be considered of sufficient importance for a specific distinction of the two specimens'.

"But it may also be said that we must be specially careful not to identify specimens with similar auxiliary series, unless the identity is supported by characters of the shell, because we know that the arrangement of the auxiliary series is subject to considerable variation, and is therefore not a specific character of paramount importance. In the present case the transverse sections of the two specimens differ decidedly, as stated above. The agreement of the sutural line, although remarkable, is therefore only of subordinate value.

"Nor are the sutures perfectly identical in both specimens. In Waagen's type-specimen from Chidru the umbilical lobe is broader than in the Himálayan specimen from Muth. The distance, from the inner slope of the second lateral saddle, to the inner slope of the last visible point in the umbilical lobe, comprises a greater portion of the corresponding height of the sides in Waagen's than in Diener's type-specimen. This difference may appear insignificant, but it proves that the identity is not perfect.

"Diener's type-specimen from the Hedenstrœmia beds of Muth is probably identical with *Aspidites muthianus nob.* The umbilicus is unfortunately so badly damaged that it cannot be measured, but it appears to be relatively a good deal narrower than in any of my specimens of *Aspidites muthianus*. It may be suggested that this is a proof against the identity, but in reality it speaks in favour of it. As the involution of *Aspidites muthianus* increases during the growth of the species, and as the specimen described by Diener is much larger than any of the examples found by Hayden, a narrower umbilicus is exactly what we should expect. The identity is further corroborated by the fact that the larger specimens of *Aspidites muthianus* and Diener's type-specimen agree in the shape of their transverse sections. The sutures of Diener's type are partly weathered and therefore not quite identical, but the differences are too slight to be of specific importance."

To the above notes of A. v. Krafft I have to add the following remarks:—

Although the remarkable similarity of my Himálayan specimen with *Aspidites superbus* Waagen is not considerably lessened by the small differences enumerated by A. v. Krafft, I am quite ready to accept his conclusions as to the advisability of their specific separation. Against this I have no objection, because my identification[1] was not based on a personal examination of Waagen's type-specimen from Chidru, and because a difference in the shape of the transverse section could not have been guessed from Waagen's illustration.

I cannot, however, agree with A. v. Krafft in his identification of my specimen with *Aspidites muthianus*. It only needs a comparison of the illustration of

[1] I am, however, obliged to remark, that I did not venture on a direct identification but attributed a varietal importance to the small characters of distinction, which were known to me in 1897.

the present specimen, with those of *Aspidites muthianus* on the one hand and of *Aspidites superbus* on the other, to see that it is more nearly allied to the latter. With *Aspidites muthianus* it only agrees in the shape of its transverse section, with *Aspidites superbus* in all the rest of the characters. The difference in the size of the umbilicus is more considerable than should be expected. If A. v. Krafft suspected a smaller umbilicus in larger than middle-sized individuals of *Aspidites muthianus*, this was a mere conjecture, based on the examination of small and moderately sized specimens, which does not warrant a safe inference as to the rate of involution in larger individuals.

The differences in the sutural line, especially in the arrangement of the auxiliary series, are far more important than those between my specimen and *Aspidites superbus*.

For this reason I prefer to consider this specimen as prototype of a new species. Its very close affinity with *Aspidites superbus* Waag. induces me to propose the specific name of *Aspidites superbiformis*.

28. (6) ASPIDITES nov. sp. ind. aff. SUPERBO Waag. Pl. XVIII; Pl. XIX, fig. 3.

"This very interesting new species is, unfortunately, represented only by a very fragmentary specimen. The transverse section is uncertain, as one face is weathered away. The siphonal part is entire only on the body-chamber, but here it has been so strongly injured by weathering, that nothing can be said as to its actual shape.

"The diameter of the specimen must have been 350 mm. at least, the width of the umbilicus between 20 and 30 mm. The sides appear to have been smooth and very gently arched. There was probably a sharp umbilical edge present.

"A small portion of the last volution only belongs to the body-chamber. No shell has been preserved.

"*Sutures.*—Rather peculiar, especially the umbilical lobe, which is very broad and made up of a series of slender, elongated points, of which those nearest to the umbilical edge cannot be made out distinctly on the specimen. The siphonal lobe is not well preserved, but it can be ascertained that no adventitious saddle was present, and that the specimen therefore does not belong to the genus *Hedenstræmia*. The median prominence of the siphonal lobe is high. As it is strongly weathered it has been indicated in the figure (Pl. XIX, fig. 3) by dotted lines only.

"*Geological position. Locality. Number of specimens examined.*—Hedenstræmia beds, S. E. of Muth, Spiti 1, coll. Hayden."

Remarks.—This species is probably closely allied to *Aspidites superbus* Waagen from the Ceratite sandstone of the Salt Range, but the peculiar character of its auxiliary saddles forbids any direct identification.

29. (7) Aspidites Vidarbha Diener. Pl. V, figs. 1, 2; XIV, fig. 14.

1897. *Koninckites Vidarbha* Diener, *Palæontologia Indica*, ser. XV, Himálayan Fossils, Vol. II, Pl. 1, Cephalopoda of the lower Trias, p. 139, Pl. VII, fig. 8 (*non* fig. 9.)

Measurements.

	I. (Pl. XIV, fig. 14.)	II. (Pl. V, fig. 2.)	II. (Pl. V, fig. 1.)
D	38 mm.	45 mm.	53 mm.
U	5 „	4·5 „	6 „
A	18 „	23 „	27 „
C	8 „	9·5 „	12 „
a	10·5 „	13 „	? „
c	5 „	5·5 „	? „
$\frac{D}{U}$	7·6	10	8·83
$\frac{A}{C}$	2·25	2·42	2·25
$\frac{a}{c}$	2·1	2·36	?

"Two ammonites, described by Prof. Diener under the specific name of *Meekoceras* (*Koninckites*) *Vidarbha* (l. c. p. 139, Pl. VII, figs. 8 *a*, *b* and 9 *a*, *b*), belong, in my opinion, to two different species. The specimen figured on Pl. VII, fig. 9, which is the better preserved, and from which the sutural line was taken, is probably identical with *Meekoceras Hodgsoni*, as has been demonstrated above. The second specimen (Pl. VII, fig. 8) was united with the former only on account of its similarity in shape and sculpture. Its sutural line was not known to Prof. Diener.

"Among the recent collections from the lower Trias of the Himálayas there are a number of specimens, probably identical with Diener's type, from the Lissar valley, illustrated on Pl. VII, fig. 8.

"Unfortunately no transverse section, good enough to be figured, could be procured, but what I observed, in a more or less incomplete cross-section, is still worth recording.

"*Height and thickness.*—Whorls compressed, even at a diameter of 3·5 mm. only. To judge from the measurements of height and thickness of the penultimate whorl in two of my specimens (see above), the whorls at the end of the last volution are more strongly compressed than at the beginning.

"At a diameter of 9 mm. the greatest thickness coincides with the middle of the sides. Later on it is shifted further up. At the same time the umbilical region of the flanks becomes compressed and even concave, while outside the region of the greatest thickness the sides are strongly curved, so as to form an obtuse angle with the siphonal area.

"*Umbilical edge and wall.*—It appears that an umbilical wall is present only in the full-grown stage, when it is very low and vertical. Umbilical edge obtuse.

"*External part.*—At a diameter of 3·5 mm. rounded. Marginal edges appear, so far as I can make out, when a diameter of 9 mm. is reached. They are clearly seen in examples attaining a diameter of 19·5 mm. and persist during further stages of growth. The siphonal area is perfectly flat.

"*Sculpture.*—Consisting of radial, slightly falciform folds, which rise somewhat outside the umbilicus and increase in strength and width towards the external part. On the upper third of the sides they are separated by broad and shallow grooves. Further towards the marginal region the folds disappear rather rapidly. Towards the end of the body-chamber they are gradually replaced by delicate, falciform striæ. None of my specimens is well enough preserved to enable the details of the sculpture to be seen as well as might be desired.

"*Body-chamber.*—Greatest length of the body-chamber observed 210°.

"*Sutures.*—In all specimens weathered. The drawing on Pl. V, fig. 2*c* must therefore be understood to be only approximately correct. A detailed description of the sutures is hardly possible under these circumstances, but it could be ascertained that the umbilical lobe is very broad, and bears numerous points of various shape and size.

"*Geological position. Locality. Number of specimens examined.*—Lower division (Otoceras beds in the old circumscription), 5 miles S. of Eusa, Spiti, 2, coll. Hayden; S.E. of Muth, Spiti, 1, coll. Hayden, 1, coll. Krafft; crest of ridge between Dharma and Lissar valleys, opposite Ralphu glacier, Kumaon, 1, coll. La Touche; Jolinka E. G. Byans, 1, coll. Smith.

"*Remarks.*—*Aspidites Vidarbha* shows a strong general resemblance to *Meekoceras rotundatum* v. Mojsisovics (Arktische Triasfaunen, l. c. p. 83, Pl. X, fig. 16) from the Olenek beds of Siberia. In involution the two species agree very closely. The transverse section is very similar, as both species have the lower parts of the sides strongly compressed. There can, however, be no question as to the specific independence of the Himálayan form. *Meekoceras rotundatum* has irregular, comparatively narrow ribs, which increase in number towards the anterior termination, its external part is rounded and the sutures differ in having a narrower umbilical lobe."

A. v. Krafft, although hinting at the identity of this species with one of my two examples described as *Meekoceras Vidarbha*, proposed for it the new specific name of *Meekoceras himalayanum*. As this proceeding is not in accordance with the rules of palæontological nomenclature, I have restored the original name of *M. Vidarbha* in his description as given above.

Subgenus: *Koninckites*, Waagen.

In this subgenus such forms of *Meekoceras* are included as are distinguished by moderately evolute whorls, and by the presence of a prominent auxiliary saddle, following the first auxiliary lobe.

I regard *Meekoceras Yudishthira* Dien., from the Hedenstrœmia beds of Spiti, as the prototype of *Koninckites*. From the Ceratite formation of the Salt Range no good representatives of this subgenus are available, although some of the species grouped with *Koninckites* by Waagen will probably find their proper systematic position there. Among them I should like to include *Koninckites radiatus* Waagen (Fossils from the Ceratite formation, l. c. p. 273, Pl. XXXII, fig. 2) in which the development of the auxiliary series has advanced not only to the individualisation of the first auxiliary saddle, and to that of a second auxiliary lobe, but in which also the second auxiliary saddle and third auxiliary lobe are distinctly and very regularly individualised. But I must admit that this species already differs considerably from the type of *Koninckites* and approaches *Aspidites* in the arrangement of its auxiliary elements.

An excellent type of the present subgenus is *Koninckites septentrionalis* Diener (Triadische Cephalopoden faunen der ostsibirischen Kuestenprovinz, *Mém. Com. Géol. St. Pétersbourg*, XIV, no. 3, p. 53, Taf. 1. fig. 1) from the lower Trias of Vladivostok (Ussuri district).

Among the American species of *Meekoceras*, *M. Mushbachanum* White possesses all the essential characters of *Koninckites*, according to Hyatt and Smith (Triassic Cephalapod genera of America, l. c. p. 149, Pl. XV, figs. 1-9, XVI, figs. 1-3, XVIII, figs. 1-7, LXX, figs. 8-10). But I must admit that I am quite unable to discover a distinctly developed auxiliary saddle, within the umbilical series, among any of the numerous specimens figured by those two authors. If *Meekoceras Yudishthira* Dien. be regarded as the prototype of the subgenus *Koninckites* on the ground that, of all the species of *Meekoceratidæ*, it agrees best with Waagen's original diagnosis, *M. Mushbachanum* certainly shows only a very distant affinity with this Himálayan type. I consequently should prefer to leave it within the range of *Meekoceras s.s.*

The species of *Ceratitoidea* from the Muschelkalk of Ismid (Asia Minor) which have been described as *Koninckites Barbarossæ*, *K. Libyssinus*, *K. Hannibalis*, and *K. Saladini* by Toula (Eine Muschelkalkfauna am Golf von Ismid, Kleinasien, *Beitræge zur Palæont. und Geol. Oesterr. Ungarns, etc.*, X, 1896, p. 177, Taf. XXI, figs. 10, 11, XXII, figs. 1, 2), are far more closely allied to the genus *Beyrichites* than to any of the Indian representatives of *Koninckites*.

Frech united *Koninckites* and *Aspidites*, but this I think would not be in keeping with the clearly marked distinctive features, which exist between the prototypes of the two subgenera, *viz.*, *Koninckites Yudishthira* and *Aspidites superbus*.

30. (1) KONINCKITES YUDISHTHIRA Dien. Pl. XIV, fig. 3; XV, figs. 3, 4, 5.

1897. *Meekoceras* (*Koninckites*) *Yudishthira* Diener, *Palæont. Indica*, ser. XV, Himal. foss. Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 141, pl. XXII, fig. 1.

Measurements.

	I. (Pl. XIV, fig. 3.)	II. (Pl. XV, fig. 3.)	II. Diener's type-specimen.
D	55 mm.	94 mm.	132 mm.
U	10 „	19 „	28 „
A	27·5 „	44 „	64 „
C	14 „	22 „	? „
$\frac{D}{U}$	5·5	4·94	4·71
$\frac{A}{C}$	1·94	2	?

"This species was described by Prof. Diener from a single specimen collected by Mr. C. L. Griesbach from the Hedenstrœmia beds S.E. of Muth in Spiti. As Mr. Hayden has obtained several more complete specimens from the same locality, I am in a position to add to Prof. Diener's description.

"Unfortunately I was unable to obtain a cross-section, as all my specimens were either in such a state of preservation as to exclude all hope of obtaining measurements of their inner volutions, or on the other hand were too good to be spoiled.

"A cross-section can, however, be dispensed with, for there is a fragment, illustrated on Pl. XV, fig. 4, which shows that the inner volutions are compressed, while a comparison of the above measurements proves that the amount of involution is decreasing.

"In Diener's type-specimen the external part is rounded all over. This, however, is not a constant character of the species. Nearly all the specimens in Mr. Hayden's collection have the siphonal part somewhat flattened and bordered by obtusely rounded marginal edges, at least during the middle stages of growth.

"The sculpture consists of very low radial folds. I may remark that such folds are also observed in the type of the species, although they are very indistinct.

"In the specimen no. II the length of the body-chamber is one half-volution. All my specimens are internal casts, without any trace of the shelly test.

"*Sutures.*—Siphonal lobe with a high median prominence. Umbilical lobe provided with a distinctly individualised saddle, which is either entire, and then resembles in shape the second lateral saddle (Pl. XIV, fig. 3; XV, figs. 3c and 5), as in the type of the species, or has the apex incised by a secondary indentation (Pl. XV, 4c). In the smallest specimen, with the narrowest umbilicus, this saddle is divided by the umbilical edge, one half being situated on the umbilical wall. In the septum illustrated on Pl. XV, fig. 5, taken from the fragment of a very large specimen, this auxiliary saddle lies entirely on the flanks, outside the umbilical edge.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 4, coll. Hayden; 5 miles S. of Ensa, Spiti, 1, coll. Hayden.

"*Remarks.*—Prof. Diener was led to suppose by Waagen's illustration, that *Koninckites Yudishthira* is closely allied to *K. Lyellianus* de Koninck (*Quart.*

Journ. Geol. Soc. XIX, p. 12, Pl. VI, fig. 1, Fossiles paléozoiques de l' Inde, p. 10, Pl. VI, fig. 1), and to *K. gigas* Waagen (Fossils from the Ceratite formation, l. c. p. 266, Pl. XXXI, fig. 2).

"As regards *Koninckites Lyellianus* I am bound to say that Waagen's type-specimen (Ceratite formation, l. c. p. 270, Pl. XXX, fig. 3) is very imperfectly preserved. The illustration fig. 3b on Pl. XXX in Waagen's monograph, is a reconstruction based on the fragment represented in fig. 3a. On the reverse of 3a there is a broadly rounded second lateral saddle, accompanied by two small points, which belong to the umbilical lobe. After these, still outside the umbilical edge, follow two coarser points. A third point is situated on the umbilical wall. Waagen's illustration of the sutural line, fig. 3c, must have been taken from the side represented in 3a. On this, remnants of the septa of the umbilical lobes of a following volution have been preserved. They can easily be recognized as such, projecting as thin ridges from the shell of the specimen. These lines have apparently been mixed up with the sutures of the volution itself by Waagen, and thus the umbilical lobe and the second lateral saddle were incorrectly figured.

"As regards *Koninckites Lyellianus*, there is therefore no proof whatever of an affinity with *Koninckites Yudishthira*. The actual features of the sutures rather exclude than favour the probability of a close relationship.

"As to *Koninckites gigas*, I refer to my remarks in the introduction to *Meekoceras*, suggesting its probable identity with *Aspidites kingianus* Waag. It has been described by Waagen from a single fragment only, differing in its transverse section so widely from *Koninckites Yudishthira*, that a closer affinity appears to be excluded on that account alone. The sutures are also different. *K. gigas* has no umbilical edge, whereas in our Himálayan species the perpendicular umbilical wall is distinctly separated from the flattened lateral parts by a well-defined edge.

"There is, however, another Salt Range type, with which *Koninckites Yudishthira* appears to be very closely allied, and which may, on examination of larger materials, even prove identical. This species is *Aspidites evolvens* Waagen (Ceratite formation, l. c. p. 223, Pl. XXXV, fig. 1). It was described by Waagen from a very fragmentary specimen. The figure is partly restored. As the diameter cannot be measured in Waagen's fragment, the ratio $\frac{A}{U}$ may be used for a comparison of the width of the umbilici. This ratio is 2·31 in Waagen's type, 2·32 in specimen no. II of *Koninckites Yudishthira*. $\frac{A}{C}$ is 2 in the former, 2·15 in the latter specimen. The proportions therefore, so far as they can be compared, are practically identical. The transverse sections bear a striking similarity, the siphonal area being bordered by obtusely rounded marginal edges in both species. The umbilical wall is vertical and bordered by a distinctly marked umbilical edge.

"The only character of difference is the arrangement of the sutural line. But even the sutures differ considerably less than we might be led to suppose from a glance at Waagen's illustration.

"On Pl. VII, fig. 2, I have re-figured the lateral and umbilical lobes of Waagen's

type-specimen of *Aspidites evolvens*. The umbilical lobe is on the whole not unlike that in my largest specimen of *Koninckites Yudishthira* (Pl. XV, fig. 5), the first auxiliary lobe being divided by a coarse median point. The lateral saddles are rather low and resemble those of the specimen of *K. Yudishthira* illustrated on Pl. XV, fig. 3, but they differ in the comparatively small height of the principal lateral saddle in the Salt Range species.

"It is impossible to say, with such insufficient materials at hand, whether those differences in the sutures are of specific importance or not."

The only specimen of *Aspidites* (?) *evolvens* hitherto known was collected by Waagen in the Flemingites beds (Ceratite sandstone) of Nanga. I need hardly say, that this specimen is not identical with *Aspidites* (*Clypites*) *evolvens* Waag. emend. Frech, from the Ceratite marls (zone of *Prionolobus rotundatus* Noetling) which was illustrated by Frech in the first volume of the *Lethæa Mesozoica* (Lfg. 2, Asiatische Trias, Pl. XXIII, fig. 3).

31. (2) Koninckites Haydeni v. Krafft. Pl. XVII, figs. 1-6.

Measurements.

	I.	II.	III.	IV.	V.
D	23·5 mm.	36 mm.	94 mm.	144 mm.	170 mm.
U	? „	3·5 „	13 „	19 „	19 „
A	13 „	19 „	47·5 „	74 „	91 „
C	7 „	10·5 „	31 „	46 „	38 „
$\frac{D}{U}$	?	10·2	7·23	7·57	?
$\frac{A}{C}$	1·85	1·8	1·53	1·6	2·39

"In Pl. XVII, fig. 3, the cross-section of a medium-sized specimen from Gaichund, Spiti, has been illustrated. The measurements of this cross-section are as follow:—

D = 69 mm.	d = 29·3 mm.	d_1 = 11·8 mm.
U = 8·6 „	u = 3·7 „	u_1 = 1·6 „
A = 36·8 „	a = 15 „	a_1 = 6 „ a_2 = 2 mm.
C = 22 „	c = 9·7 „	c_1 = 4 „
I = 12·3 „	i = 4·5 „	i_1 = 1·5 „
$\frac{D}{U}$ = 8·02	$\frac{d}{u}$ = 7·91	$\frac{d_1}{u_1}$ = 7·37
$\frac{A}{C}$ = 1·67	$\frac{a}{c}$ = 1·54	$\frac{a_1}{c_1}$ = 1·5
$\frac{a}{I}$ = 1·3	$\frac{a_1}{i}$ = 1·33	$\frac{a_2}{i_1}$ = 1·33

"The development of this species is as follows:—

"*Height and thickness.*—The whorls become very gradually compressed during different stages of growth, but their thickness varies in different specimens. Specimens I and II, of which the measurements have been given above, are

compressed more strongly than the whorls of a corresponding diameter in the above cross-section. This is also the case in specimen no. V. In the penultimate whorl of this specimen the following measurements were obtained :—

$a = 34$ mm. $\qquad \frac{a}{c} = 1{\cdot}7$

$c = 20$ „

"The last volution of this specimen is therefore slightly more compressed, at the beginning, than is the last volution in the above cross-section at its anterior termination. The last volution of specimen no. V is still more compressed at its anterior termination, $\frac{A}{C}$ being 2·39.

"Specimen III, on the other hand, has thicker volutions than the individual from which the above cross-section was taken. To show this more in detail, the measurements of specimen III are given in full.

D	= 94	mm.	d	= 39·7	mm.	d_1	= 16	mm.
U	= 13	„	u	= 5	„	u_1	= 2·3	„
A	= 47·5	„	a	= 20·8	„	a_1	= 8·3	„ $a_2 = 2{\cdot}7$ mm.
C	= 31	„	c	= 13·7	„	c_1	= 6	„ $c_2 = 2{\cdot}3$ „
I	= 16	„	i	= 6·4	„			
$\frac{D}{U}$	= 7·23		$\frac{d}{u}$	= 7·94		$\frac{d_1}{u_1}$	= 6·95	
$\frac{A}{C}$	= 1·53		$\frac{a}{c}$	= 1·51		$\frac{a_1}{c_1}$	= 1·38	$\frac{a_2}{c_2} = 1{\cdot}17$
$\frac{a}{I}$	= 1·3		$\frac{a_1}{i}$	= 1·29				

"If we compare these measurements with those of the cross-section given above, we find that each whorl of specimen no. III is thicker than the whorl most nearly corresponding to it in diameter of the cross-section figured above. Thus the volutions corresponding to a diameter of 16 mm. are thicker in specimen no. III than those corresponding to a diameter of 11·8 mm. in the cross-section and so on, and yet the law of development is the same in both specimens, the volutions becoming gradually compressed.

"Specimen IV is another example of this thick variety. The ratio of $\frac{A}{C}$ only 1·6, and this corresponding to a height of the whorl of 74 mm. above the umbilical suture, at the end of the last volution.

"*Greatest thickness.*—In the earliest volutions situated near the middle of the height of the lateral parts. It soon descends to the umbilical region, where it persists up to a diameter of approximately 30 mm. to ascend again slightly during further stages of growth.

"*Umbilical edge and wall.*—Sides in the earliest whorls without umbilical edge, but sloping in a gradually arched curve towards the umbilicus. Corresponding to a diameter of 6 mm. a rounded edge and a steep umbilical wall make their first appearance. They persist up to the peristome of the last volution of full grown individuals, without any remarkable change.

"*External part.*—Broadly rounded throughout all stages of growth.

"*Amount of involution.*—The values deduced from the above measurements point distinctly neither to a decreasing, nor to an increasing, involution. The involution may therefore be supposed to be constant.

"*Sculpture.*—The ornamentation is confined to curved growth-lines, seen in the lower half of the lateral parts of specimens III and IV.

"*Body-chamber.*—The greatest length of the body-chamber observed is about one half-volution.

"*Sutures.*—Siphonal lobe broad, median prominence variable in height, shape, and number of incisions. Siphonal saddle slender, slightly shorter than the principal lateral saddle, which is unsymmetrical. Second lateral saddle shorter, in some specimens slightly incised along its slopes. Principal lateral lobe deeper than the second. Umbilical lobe with one rather large auxiliary saddle, which may be either incised or entire. In the specimen illustrated on Pl. XVII, fig. 1, this auxiliary saddle is flattened on its top.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 5, coll. Krafft; lower division, exact horizon not known, S.E. of Muth, Spiti, 2, coll. Hayden; S.W. of Gaichund, 4, coll. Hayden; N.N.W. of Kágá, 1, coll. Hayden; 5 miles S. of Ensa, 1, coll. Hayden."

Remarks.—As to the systematic position of the present species, I may state that the distinct development of an auxiliary lobe and saddle is enough to justify its grouping with *Koninckites*. The irregularity of the arrangement of coarse points within the rest of the umbilical lobe makes our species, however, approach *Aspidites*, which it also resembles in its narrow umbilicus.

One of the specimens collected by Hayden near Gaichund is marked on the accompanying label "*base* of Otoceras beds (Diener)." From this we may infer that *Koninckites Haydeni* is not restricted to the Meekoceras beds, in which it has been found near Lilang by A. v. Krafft, but makes its first appearance in the Otoceras beds *s. s.*

32. (3) Koninckites alterammonoides v. Krafft. Pl. XVI, figs. 1, 2.

1900. *Proptychites ammonoides* (Waag.) A. v. Krafft, *Gen. Report, Geol. Surv. of India*, 1889-1900, p. 19, 201.

Measurements.

	I. (Pl. XVI, fig. 2.)	II. (Pl. XVI, fig. 1.)
D	. 79 mm.	cca. 118 mm.
U	. 8·5 „	12·5 „
A	. 42 „	64 „
C	cca. 20 „	? „
$\frac{D}{U}$	. 9·29	cca. 9·44
$\frac{A}{C}$	cca. 2 1	?

"Lateral parts slightly arched. Maximum thickness somewhat below the middle of the sides. In the larger specimen the thickness could not be measured near the anterior termination of the last volution. Near the beginning it is exactly one half the height.

"External part broadly rounded, without any trace of marginal edges. Umbilical edge slightly rounded, bordering a high and vertical umbilical wall.

"The lateral parts are furnished with very low, falciform folds, well seen only in one portion of specimen No. I.

"The smaller specimen is entirely chambered. In the larger specimen about one half of the last volution belongs to the body-chamber. Shelly test partly preserved in both specimens.

"*Sutures.*—Subject to considerable variation. Siphonal lobe broad and provided with a high median prominence. External saddle slender. Principal lateral saddle obliquely shaped. Second lateral saddle flattened on the top, with a few very delicate incisions. The second lateral saddle differs considerably in the two specimens, that of specimen no. I having an inclined outer slope, whereas in specimen no. II this slope is almost vertical.

"In specimen no. I the umbilical lobe is made up of a row of points, none of which is distinctly individualised. The larger specimen no. II has, in this lobe, a distinctly individualised auxiliary saddle with several incisions. After this follow two smaller, rounded, saddle-shaped points.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 2, coll. Krafft.

"*Affinities.*—Prof. Waagen described two very fragmentary specimens from the Salt Range Ceratite formation as *Proptychites ammonoides* (Fossils from the Ceratite formation, *Palæont. Indica*, ser. XIII, Salt Range Foss., Vol. II, Pt. 1, p. 171, Pl. XVII, fig. 1, XIX, fig. 2), the larger of which he had collected himself from the base of the Ceratite marls W. of Khoora, together with *Proptychites Lawrencianus*. The second specimen, which was found by Wynne, is of doubtful stratigraphical position.

"This species is no doubt closely allied to the present one. As regards its true generic position, I may refer the reader to the introduction to the genus *Proptychites*.

"Waagen's types agree with our species very closely in their transverse section, being only slightly thicker. The ratio $\frac{A}{C}$ is approximately 1·9 in the larger, and 1·79 in Waagen's smaller specimen In Waagen's types the umbilicus is, however, relatively wider. Although this could not be ascertained by measurements, as less than half of the type-specimens has been preserved, it becomes apparent on comparing specimen no. II with Waagen's illustration on Pl. XVII, fig. 1.

"Waagen's specimens bear the same low folds as my larger type from Lilang. Their sutures are also very similar. A remarkable common feature exists in the flattened shape of the second lateral saddle which also bears delicate incisions on the

top in Waagen's types. The umbilical lobe in Waagen's larger specimen closely resembles the umbilical lobe in specimen no. I above. Waager's smaller specimen may be compared in this respect to my specimen no. II, although the resemblance is in this case not so close.

"A second lateral saddle with a flattened top is a quite unusual and striking character. Apart from the present form there is no species of *Meekoceras* known to me which can be compared in this respect to *Koninckites ammonoides* Waag. It is true that the second lateral saddle is often somewhat flattened, but its top is never so straight or bordered by edges to the right and left. Nor is there seen, in any other species, an incision on the top of the second lateral saddle, recalling this feature in some species of the genus *Otoceras*. This character appears to be all the more important, because it is constant, the top of the second lateral saddle being flattened in every septum of the four specimens in question.

" In spite of this I do not venture to unite the two species. We have seen that the Himálayan types have a narrower umbilicus; but although this need not be of specific importance, the question of identity cannot be decided until more material is forthcoming. Perhaps it will be possible at a later date to prove that the new species here established is only a variety of *Koninckites ammonoides*."

33. (4) KONINCKITES GIGANTEUS v. Krafft. Pl. XXIV, fig. 12; Pl. XXIX.

Measurements.

D	315 mm.	$\frac{D}{U}$	=8·28
U	38 „		
A	165 „	$\frac{A}{C}$	=2·53
C	65 „		

"This species is founded on a huge specimen, differing from any other species of the genus *Meekoceras* known to me.

"Maximum thickness situated below the middle of the sides, which are but slightly arched. Umbilicus narrow, with a very high umbilical wall, measuring about 15 mm. in height near the anterior termination of the last whorl. Umbilical edge sharp, forming a right angle. The features of the umbilicus are such as to make a decreasing amount of involution evident. At the beginning of the body-chamber and for nearly one half volution in front of the last sutural line the external part is narrow and highly rounded, as in *Aspidites superbus* Waagen. In the last portion of the body-chamber it becomes gradually broader, and near the end of the body-chamber resembles the siphonal area of *Aspidites muthianus* v. Krafft.

"No sculpture is seen on the lateral parts. Shelly test not preserved.

"*Body-chamber.*—The length of the body-chamber, the actual peristome of which has not been preserved, is at least 230°.

"*Sutures.*—As the siphonal lobe is not accessible to examination, we must consider the possibility of this species belonging to *Hedenstræmia*, not to *Meekoceras*.

From the position of the external saddle it is evident, however, that no adventitious saddle could have been present. Nor does the umbilical lobe of this species resemble in any way the corresponding lobe in species of *Hedenstrœmia*.

"Principal lateral lobe broad and deep. Principal and second lateral saddles obliquely shaped. The umbilical lobe has one distinct saddle, besides several smaller denticulations.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden.

"*Remarks.*—I was in doubt for some time, as to whether this huge specimen belongs to one of the other species from the Hedenstrœmia beds of the same locality or not, but came to the conclusion that it could not be united with any of them.

"There are only two species to which it may be more closely compared. These species are *Koninckites Yudishthira* and *Aspidites muthianus* v. Krafft. *Kon. Yudishthira* has a relatively much wider umbilicus, whereas in *A. muthianus* the sutures are much more differentiated. The external part in these two species is either somewhat flattened or broadly rounded, but never as sharp as it is on the chambered part, and at the beginning of the body-chamber, of the present species. It might be urged, that the acute shape of the external part in my type-specimen of *Kon. giganteus* has been produced merely by crushing or weathering, and I must admit, that this possibility cannot be excluded, although it is highly improbable. For it is not in the least likely that the external part should be rounded more broadly in the inner volutions, to become first narrow and then again broadly rounded on the body-chamber. But even granting all these possibilities the specimen may still be distinguished both from *Koninckites Yudishthira* and from *Aspidites muthianus*, for the reasons stated above."

Genus: PROAVITES, v. Arthaber.

1896. *Proavites* G. v. Arthaber, Cephalopoden-fauna der Reiflinger Kalke, *Beiträge zur Palæont. u. Geol. Oesterr. Ungarns, etc.*, X, p. 104.

In my memoir on the Cephalopoda of the Himálayan lower Trias (1897), I followed Waagen in uniting the evolute *Meekoceratidæ*, with goniatitic septa, of the Salt Range and of the Himálayas, in the genus *Lecanites* v. Mojsisovics.

The examination of large new materials from the lower Trias of India by Noetling, Frech and A. v. Krafft has proved the close relationship of these types with *Meekoceras s. s.*, there being transitional links between forms in which the principal lateral lobe is entire or very faintly serrated. Now I doubt very much whether the original type of *Lecanites* has anything to do with the family of *Meekoceratidæ*. This type is *Ceratites glaucus* Muenster (Leonhardt's und Bronns *Neues Jahrb. f. Miner, etc.*, 1834, p. 11, Taf. I, fig. 1), for which the generic name of *Lecanites* was proposed by E. v. Mojsisovics in 1882 (Cephalopoden der Mediterranen Triasprovinz, *Abhandl. K. K. Geol. Reichsanst.*, X, p. 200, Taf. XXX, figs. 1-6, LIII, fig. 14).

The species is found in the beds of St. Cassian of lower carnic (upper Triassic) age, and is a dwarf species, whose septa have probably acquired their goniatitic habit by reduction from more complicated sutures in its ancestors. It is an isolated form, without any affinity to the other representatives of the Cephalopod fauna of St. Cassian. The only species which appears to be nearly allied to *Lecanites glaucus*, is *L. Vogdesi* Smith and Hyatt (Triassic Cephalopod genera of America, l. c. p. 139, Pl. LX, figs. 12-22, LXXV, figs. 10-13) from the Daonella beds of the Humboldt range, of middle Triassic age.

Of the two species from the Hedenstrœmia beds of the Himálayas grouped with *Lecanites* in my memoir quoted above, one (l. c. p. 148, Pl. XXIII, fig. 2) belongs to the evolute types of *Meekoceras* (group of *M. disciforme* v. Krafft, *Gyronites* Waag.) and should not be separated from it on account of the absence of denticulations in the lateral lobes. The second, *Lecanites Sisupala* Diener (l. c. p. 147, Pl. XXIII, fig. 3), is a representative of the *Kymatitinae* Waagen and should be included in the genus *Proavites* Arthab.

PROAVITES SISUPALA Diener. Pl. XXIX, fig. 4.

1880. *Norites planulatus var.*, Griesbach, Palæontological notes on the lower Trias of the Himálayas, *Records, Geol. Surv. of India*, XIII, p. 109.

1897. *Lecanites Sisupala* Diener, Himálayan Foss., *Palæont. Indica*, ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 147, Pl. XXIII, fig. 3.

A re-examination of the sutures of my type-specimen from the Hedenstrœmia beds of the Shalshal cliff (Painkhanda) has convinced me of its close affinity to the species of *Proavites* which have been described from the Reiflinger Kalk by G. v. Arthaber. The lateral lobes are entire and separated by broadly rounded saddles. A small auxiliary lobe stands outside the umbilical suture. Each of the two branches of the siphonal lobe terminates in a single sharp point exactly as in *Proavites*.

In involution and biangular outlines our species also recalls *Proavites*, but it is compressed more strongly, and the lateral parts are curved less considerably than in the Alpine representatives of this genus. In the recent collections from Spiti, Johar and Byans the species is not represented.

Genus: PROPTYCHITES Waag. emend. Diener.

"The genus *Proptychites*, proposed in 1892 by Waagen, was considered by him to be the presumptive ancestor of *Ptychites*, chiefly on the ground of a striking similarity in the general configuration of the shell and of the sculpture. This subject has been fully discussed by Diener in his memoir on the Cephalopoda of the lower Trias of the Himálayas (l. c. p. 70). As the two genera differ considerably in the character of their sutures, and as transitional forms leading from *Proptychites* to *Ptychites* are wanting, he saw no sufficient reason for admitting a close affinity between the two genera. On the other hand he approached the question, whether *Proptychites* ought to be united with *Meekoceras*, as had been advocated by E. v.

Mojsisovics, or should be retained as an independent genus, from a new point of view.

"As the inner volutions of typical *Meekoceras* are always compressed, while those of *Ptychites* are globose, an examination of the inner volutions of *Proptychites* should naturally lead to definite results. One of the species from the lower Trias of the Ussuri district, *Proptychites hiemalis* Diener (Triadische Cephalopoden, faunen der ostsibirischen Kuestenprovinz, *Mém. Com. Geol. St. Pétersbourg*, 1895, Vol. XIV, No. 3, p. 33, Pl. II, figs. 2, 4, V, fig. 4) examined in this way, proved to have globose inner whorls. This result induced Prof. Diener to re-examine a series of forms described as *Meekoceras* in his memoir on the Cephalopoda of the Himálayan Muschelkalk, and by measuring the inner volutions he recognized two series of forms of great external similarity, but completely different development.

"Thus Diener came to the conclusion, that the genus *Proptychites* is distinguished from *Meekoceras* chiefly by its globose inner volutions, as well as by the characters of its sutural line already pointed out by Waagen.

"The latter character is, however, no sufficient guide in every species, as some types with elongate saddles, with a short siphonal lobe and with a high, often richly serrated median prominence are known to have distinctly compressed inner volutions. It must consequently appear very doubtful whether, in any case, the genus can be recognized by reference to the sutures alone.

"This fact having been noticed in *Proptychites ammonoides* Waagen, it became necessary to re-examine the species from the Salt Range classed with the genus *Proptychites* by Waagen, in order to see, whether some of them did not actually belong to *Meekoceras* in a broader sense. I have endeavoured to do so, but as I could examine the inner volutions in a few instances only, the results are in reality not of a definite character.

"*Proptychites aberrans* Waagen (Fossils from the Ceratite formation l. c. p. 179, Pl. X, fig. 2) is the only species, which can be left in the present genus with certainty. The inner volutions are globose, the ratio $\frac{a_1}{c_1}$, $\frac{a}{c}$, $\frac{A}{C}$ being approximately 0·76, 1·13, 1·5 respectively.

"Two other species, *Proptychites plicatus* Waagen (l. c. p. 182, Pl. XXIV, fig. 3) and *P. undatus* Waagen (l. c. p. 180, Pl. XXIV, fig. 4) also most probably belong to the genus *Proptychites* in the interpretation of Diener. In the first mentioned species the ratio $\frac{a}{c}$ and $\frac{A}{C}$ is 1·32 and 1·57, respectively. The last volution therefore becomes strongly compressed, whereas in the penultimate volution the thickness is not much inferior to the height. In the second species $\frac{a}{c}$ is 1·46, $\frac{A}{C} = 1·75$. These two species are, moreover, distinguished by a very remarkable circumplicate sculpture, recalling the ornamentation in the group of *Ptychites rugiferi*.

"*Proptychites Lawrencianus* Waagen (l. c. p. 168, Pl. XVII, fig. 2, XVIII, fig. 1) is of somewhat doubtful systematic position, but as it is nearly allied to a

new species described below (*Proptychites typicus* v. Krafft), it is probable that it belongs actually to *Proptychites* in the interpretation of this genus proposed by Prof. Diener.

"The systematic position of the following species is also doubtful:—

Proptychites obliqueplicatus Waagen (l. c. p. 183, Pl. XVII, fig. 3).
„ *magnumbilicatus* Waag. (l. c. p. 173, Pl. XIX, fig. 1).
„ *Oldhamianus* Waag. (l. c. p. 166, Pl. XIX, fig. 3).
„ *latifimbriatus* Waag. (l. c. p. 170, Pl. XVIII, fig. 2).

"On the other hand *Proptychites ammonoides* Waag. (l. c. p. 171, Pl. XVII, fig. 1), is certainly no *Proptychites*, as the genus is now defined, the penultimate volution being more compressed than the last one. This species must consequently be included in *Meekoceras*, notwithstanding the brachyphyllic development of its saddles. The same remark applies to the three following species:—

Proptychites discoides Waagen (l. c. p. 174, Pl. XX, figs. 1, 2).
„ *trilobatus* Waagen (l. c. p. 178, Pl. XX, fig. 3).
„ *Khoorensis* Waagen (l. c. p. 176, Pl. XX, fig. 4).

all of which can be safely attributed to *Meekoceras* in a broader sense.

"Diener described four species of *Proptychites* from the lower Trias of the Himálayas, namely:—

P. Markhami Dr. (l. c. p. 75, Pl. VI, figs. 4, 6).
P. Scheibleri Dr. (l. c. p. 79, Pl. VI, fig. 3).
P. sp. ind. (l. c. p. 78, Pl. VI, fig. 5).
P. sp. ind. ex aff. obliqueplicato (l. c. p. 81).

"Of these the first is of doubtful generic position. The same remark applies to *Proptychites sp. ind.*, known only by a fragment which has the last volution strongly compressed, and to *Proptychites sp. ind. ex aff. obliqueplicato*, of which the inner volutions have not been preserved. *Proptychites Scheibleri*, which is a good representative of the present genus, has not been found again, although a somewhat similar new species occurs in Spiti."

My own opinion being in accordance with A. v. Krafft's view, as explained in his notes, I have only to add that *Proptychites Markhami* does, indeed, belong to *Meekoceras*, not to *Proptychites*, as I have been able to demonstrate by developing its inner volutions.

As to the species from the Muschelkalk, which I originally included in *Meekoceras* and subsequently in *Proptychites*, the examination of inner volutions of *Hollandites Voiti* Oppel and the discovery of *Hollandites Cecilii*, a species most intimately allied to *Meekoceras Nalikanta* Dien., have convinced me that their proper systematic position is probably among the representatives of *Ceratites* (*Hollandites*). Full particulars on this subject are given in my memoir on the fauna of the Himálayan Muschelkalk (*Palæont. Indica*, ser. XV, vol. V, Pt. 2, p. 41).

1. PROPTYCHITES TYPICUS v. Krafft. Pl. XIX, figs. 4, 5; XX, fig. 6; XXI, figs. 2, 3, 4.

Measurements.

	I.	II.	III.	IV.
D . .	23 mm.	27·5 mm.	54 mm.	71 mm.
U . .	7·5 „	6·5 „	12 „	12·5 „
A . .	9 „	13 „	24 „	36·5 „
C . .	8·5 „	10 „	17 „	23 „
$\frac{D}{U}$ . .	3·06	4·23	4·5	4·88
$\frac{A}{C}$ . . .	1·05	1·3	1·41	1·58

"This species is represented in Hayden's collections from Spiti by a considerable number of specimens. Favourable circumstances have allowed me to procure several cross-sections. The cross-section illustrated on Pl. XXI, fig. 2, represents a stout variety. The dimensions of four volutions are as follow :—

D = 74 mm.	d = 35 mm.	d_1 = 15 mm.	d_2 = 7·3 mm.
U = 13 „	u = 7 „	u_1 = 3·3 „	
A = 37 „	a = 17 „	a_1 = 7 „	a_2 = 3·8 „
C = 24 „	c = 13 „	c_1 = 7 „	c_2 = 4·4 „
I = 14 „	i = 5 „	i_1 = 2·5 „	
$\frac{D}{U}$ = 5·69	$\frac{d}{u}$ = 5	$\frac{d_1}{u_1}$ = 4·54	
$\frac{A}{C}$ = 1·54	$\frac{a}{c}$ = 1·22	$\frac{a_1}{c_1}$ = 1	$\frac{a_2}{c_2}$ = 0·80
$\frac{a}{I}$ = 1·21	$\frac{a_1}{i}$ = 1·4	$\frac{a_2}{i_1}$ = 1·52	

"A second cross-section through a specimen from Ensa, which represents a compressed variety, shows the following measurements :—

D = 48·4 mm.	d = 23·6 mm.	d_1 = 12 mm.
$\frac{A}{C}$ = 1·47	$\frac{a}{c}$ = 1·22	$\frac{a_1}{c_1}$ = 1·04

"It results from this proportion that the cross-section through the specimen from Ensa is more strongly compressed than that from Kágá corresponding to a diameter from 12 to 15 mm. and equally compressed corresponding to a diameter from 23·6 to 35 mm.

"*Height and thickness.*—As regards the development of this species the following data are obvious from the figured cross-section. Inner volutions globose up to a diameter of 15 mm. whereas the specimen becomes gradually more and more compressed in later stages of growth. The largest transverse diameter coincides with the umbilical edge. Umbilical margin sharply defined throughout the growth of the species. External part rounded, passing gradually into the flanks, which are slightly arched."

"*Amount of involution.*—Decreasing. This is evident from the measurements of the above cross-section and also from those of the entire specimen. It will be noticed that specimens I, II and III have proportionately wider umbilici than the corresponding inner whorls of the cross-section. In specimen I with a diameter of 23 mm. the ratio $\frac{D}{U}$ is lower, and consequently the umbilicus is proportionately wider than in an inner volution of 15 mm. of the cross-section. Similar differences prevail as regards specimens II and III. As the specimens are specifically identical, we must conclude that the width of the umbilicus is variable in this species. This view is supported by the presence of a specimen with an unusually narrow umbilicus, but as its specific identity with *Proptychites typicus* is not perfectly certain, it may be left out of consideration at present and dealt with separately hereafter.

"*Sculpture.*—Young individuals of this species have low folds, which start from the umbilical edge and are directed slightly backward. They are obliterated before reaching the external part. The periphery of the inner volutions is of indistinctly polygonal outlines, as a flat knob to each fold corresponds in the siphonal part. In larger specimens no folds are seen.

"*Body-chamber.*—The greatest length of the body-chamber observed is somewhat more than one half-volution.

"*Sutures.*—Siphonal lobe broad and rather shallow, with a high median prominence, bearing an incision on its top. Principal lateral lobe very deep. Its denticulations reach some distance up the inner slope of the external saddle. Second lateral lobe considerably shorter than the principal. External and principal lateral saddles of equal height, second lateral saddles lower. All saddles slender and with rounded tops.

"Umbilical lobe beginning with delicate denticulations, which are followed by coarse points, continued beyond the umbilical edge. In the sutural line of my smallest specimen the larger points of the umbilical lobe are situated entirely on the umbilical wall.

"*Geological position. Locality. Number of specimens examined.*—Lower division, exact horizon unknown, 5 miles S. of Ensa, Spiti, 7, coll. Hayden; N.N.W. of Kágá, 4, coll. Hayden; S.E. of Muth, 3, coll. Hayden; Kuling 1, coll., Krafft.

"Ridge between Dharma and Lissar valleys, opposite Ralphu glacier, Kumaon, 1, coll. La Touche; Jolinka E. G., Kuti Yangti valley, Byans 3, coll. Smith.

"*Remarks.*—The present species is no doubt nearly allied to *Proptychites Scheibleri* Diener (Cephalopoda of the lower Trias, Himal. Foss, Vol. II, Pt. 1, Pl. VI, fig. 3), which was collected in the shales immediately above the main layer of *Otoceras Woodwardi* in the section of the Shalshal cliff. This species is distinguished from the present one by different sutures and by the entire absence of an umbilical edge, the flanks passing gradually into the umbilical wall. As none of my numerous specimens of *Proptychites typicus* resembles *P. Scheibleri* in these

two characters, I deemed it necessary to establish a new species. *P. Scheibleri* is also stouter than any of my specimens of *P. typicus*, $\frac{A}{C}$ being 1·46, corresponding to a diameter of 84 mm.

"It is probable that *P. Scheibleri* is geologically older than the present species, which most likely comes from the beds with *Meekoceras lilangense* and *M. Varaha* and may therefore be a descendant of *P. Scheibleri*. Unfortunately the exact stratigraphical position of *P. typicus* is not known to me.

"In its sculpture *Proptychites typicus* is somewhat similar to *P. oblique-plicatus* Waagen (Ceratite formation l. c. Pl. XVII, fig. 2) from the Stachella beds of the Ceratite formation. There can, however, be little question of affinity, for the Salt Range form has a much wider umbilicus and a narrow siphonal part. It is also not at all certain that Waagen's species really belongs to the genus *Proptychites* in the interpretation accepted in this memoir.

"As the same objection might be raised against the majority of other species described by Waagen, with the exception only of *Proptychites aberrans*, which is entirely different from *P. typicus*, it is useless to discuss the affinity of our species to the Salt Range forms in detail. I feel, however, bound to remark that *Proptychites Lawrencianus* Waagen, from the base of the Ceratite marls (l. c. Pl. XVII, fig. 2, XVIII, fig. 1,), may on examination of larger materials from the Salt Range, turn out to be very nearly allied to or even identical with *Proptychites typicus*.

"In the smaller of the two specimens of *Proptychites Lawrencianus* illustrated by Waagen, the last volution is near its aperture considerably more compressed than near its commencement, the ratio being $\frac{A}{C} = 1{\cdot}61$, $\frac{a}{c} = 1{\cdot}36$. This points decidedly to a representative of the genus *Proptychites*, but the question can only be decided by cutting a specimen in two, which with Waagen's type-specimen is of course impossible. The transverse section of *Proptychites Lawrencianus* is not unlike that of the present species, and the sutural lines also show remarkable affinities.

2. Proptychites sp. ind. aff. typico v. Krafft. Pl. XXI, fig. 1.

"As mentioned in the description of *Proptychites typicus*, there is in the collections of Mr. Haydon from the Otoceras beds (in the wider circumscription) of Ensa, a specimen of this genus, with a considerably narrower umbilicus than has been noticed in any of my numerous examples of *P. typicus*.

"Although this character may not be of great importance in a species, whose umbilicus differs so much in width in separate individuals, I have decided to treat this specimen separately, as there are no means of proving its specific identity with the former species.

"The measurements and proportions obtained by procuring a cross-section through this specimen, are as follow :—

D	=	42·5	mm.	d	=	18·5	mm.	d_1	=	9 mm.	
U	=	6	„	u	=	2·6	„	u_1	=	1·3 „	
A	=	21·7	„	a	=	9	„	a_1	=	4·2 „	a_2 = 1·5 mm.
C	=	15	„	c	=	9	„	c_1	=	4·6 „	c_2 = 1·7 „
I	=	7·8	„	i	=	3·6	„	i_1	=	1·3 „	
$\frac{D}{U}$	=	7·08		$\frac{d}{u}$	=	7·11		$\frac{d}{u}$	=	6·92	
$\frac{A}{C}$	=	1·44		$\frac{a}{c}$	=	1		$\frac{a_1}{c_1}$	=	0·91	$\frac{a_2}{c_2}$ = 0·88
$\frac{a}{I}$	=	1·15		$\frac{a_1}{i}$	=	1·16		$\frac{a_1}{i_1}$	=	1·15	

"It will be seen from these measurements, that the quotient of diameter to width of umbilicus is much higher than in even the largest specimen of *Proptychites typicus*. Unfortunately the sutures cannot be made out properly. On the flanks of this specimen very low folds, with a slightly falciform bend, were noticed, but this fact can scarcely warrant the conclusion that the species are identical. I therefore prefer to leave the question as to its identity with *Proptychites typicus* open.

"*Geological position. Locality. Number of specimens examined.*—Lower division, 5 miles S. of Ensa, Spiti, 1, coll. Hayden."

Genus: Ophiceras Griesb.

Of all genera of lower Triassic age this is the most difficult to separate from its allies on account of the uncertainty of its characters. From *Xenodiscus* Waagen it is distinguished by the fainter sculpture of its inner whorls, and by the entire absence of distinct radial plications on the last volution. From the widely umbilicated species of *Meekoceras* (*Gyronites* Waag.) it differs in the delicate spiral striation of the inner layer of the shell. But this diagnostic mark is accessible to examination in exceptional cases only. It is hidden when the shell is preserved, and it disappears from the cast when the specimen has been slightly injured by weathering.

Some of the Salt Range species, assigned to *Gyronites* by Waagen, may therefore belong to *Ophiceras*. Frech and Noetling united the majority of species, grouped with *Gyronites*, *Ambites* and *Kymatites* by Prof. Waagen, with *Ophiceras*, but their true systematic position is as yet unknown.

To the species of *Ophiceras* described in my memoir on the Cephalopoda of the Himalayan lower Trias (Palæont. Indica, ser. XV. Vol. II. Pt. 1), a new one from the Shalshal cliff (coll. Noetling) has been added by Frech and Noetling. This is *Ophiceras stricturatum* (Lethæa Palæozoica, II. Die Dyas, p. 634f, fig. 3), which is distinguished by a deep furrow intersecting the last whorl near its anterior termination. This furrow runs across the umbilical wall in a backward

direction, and afterwards describes a falciform curve on the lateral parts between the umbilical edge and the siphonal part.

This species is not represented in the materials entrusted to me for examination.

In the lower Trias of Idaho indubitable representatives of *Ophiceras* (*O. Dieneri*, *O. Spencei*) have been discovered by Hyatt and Smith (Triassic Cephalopod genera of America, U. S. Geol. Surv. Prof. Pap. no. 40, 1905, p. 118), agreeing in all their distinctive features with the Indian congeneric forms.

1. Ophiceras tibeticum Griesb.

1880. *Ophiceras tibeticum* Griesbach, Palæontological notes on the lower Trias of the Himalayas, Records, Geol. Surv. of India, Vol. XIII, p. 109, Pl. III, figs. 1-7.

1897. *Ophiceras tibeticum* Diener, Himálayan Foss. l. c. Vol. II, Pt. 1, p. 105, Pl. VIII, figs. 1-7.

This characteristic species is not rare in the Otoceras beds of Spiti. Among Hayden's collections ten specimens may be safely identified with *O. tibeticum*, exhibiting nearly the same wide range of variation which has been noticed in the examples from the Shalshal cliff and from Kiunglung E. G. The typical form is represented by an excellently preserved specimen from Kágá, occurring together with an equally well preserved specimen of *Ophiceras Sakuntala* Dien.

Specimens referable to *O. tibeticum* are known from the Otoceras beds of the following localities in Spiti: S. E. of Muth, 5 miles S. of Ensa, Kuling, N. N. W. of Kágá.

2. Ophiceras cf. serpentinum Dien.

1897. *Ophiceras serpentinum* Diener, Himálayan Foss. l. c. Vol. II, Pt. 1, p. 110, Pl. XIII, figs. 1-7.

Two small specimens of *Ophiceras* from the lower Trias (Chocolate Limestone) of Jolinka E. G., Byans (coll. Smith) resemble *O. serpentinum* Dien. in their obliquely elliptical shape and cordiform cross-section. But they are not sufficiently well preserved to warrant a complete identification. They are referred to *Ophiceras* on the ground of their external shape only, their mode of preservation excluding the presence of any characters of the shelly test.

3. Ophiceras Sakuntala Dien.

1897. *Ophiceras Sakuntala* Diener, Himálayan Foss. l. c. Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 114, Pl. X, figs. 1-8, XI, figs. 1, 2, 4.

Of this species, the most frequent in the main layer of *Otoceras Woodwardi* in the Shalshal cliff, five specimens are known to me from Spiti. They were collected by Hayden in the Otoceras beds S. E. of Muth, 5 miles S. of Ensa and N. N. W. of Kágá respectively. Two examples belong to the typical form, three to the var. *evoluta* Frech et Noetling (Lethæa Palæozoica, Vol. II. Die Dyas, p. 634*f*, fig. 1), but their siphonal part is rounded more regularly than in the illustration given by those authors.

The typical form of *O. Sakuntala* is also represented by three fairly well preserved specimens of large dimensions from the crest of the ridge between the Dharma and Lissar valleys, opposite Ralphu glacier (coll. La Touche).

4. Ophiceras cf. demissum Oppel.

1865. *Ammonites demissus* Oppel, Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti und Gnari Khorsum in Tibet, Palæontol. Mitteil. aus dem Museum des Königl. bayrischen Staates, Stuttgart, I, Theil, p. 290, Taf. LXXXVI, fig. 1.

1897. *Ophiceras demissum* Diener, Himálayan Foss. l. c. Vol. II, Pt. 1, p. 121, Pl. XIV, figs. 1-7.

Oppel's type-specimens of *Ophiceras demissum* were collected by the brothers Schlagintweit near Tengdi in Spiti. A small example of *Ophiceras* (coll. Hayden) from the Otoceras beds of Khar is before me and reminds me very strongly of *O. demissum* in its involution and in the presence of narrow folds and wrinkles. Its small dimensions (diameter of the shell 13 mm.), however, exclude a safe identification.

5. Ophiceras Chamunda Dien.

1897. *Ophiceras Chamunda* Diener, Himálayan Foss. l. c. Vol. II, Pt. 1, p. 123, Pl. XII, figs. 1-4.

This species, which may be roughly defined as the elliptical variety of *Ophiceras Sakuntala* Diener, is very common in the Otoceras beds S.-W. of Gaichund, where eleven specimens have been collected by Hayden.

A type, transitional between this species and *O. Sakuntala*, is represented by a large specimen from the Otoceras beds of Khar (coll. Hayden).

6. Ophiceras obtuso-angulatum, nov. sp. Pl. XXVII, fig. 6.

A single but fairly well preserved specimen of an *Ophiceras*, from A. v. Krafft's collection from the lowest layer of the Meekoceras beds near Lilang is before me, which, although allied very nearly to *O. platyspira* Diener (Himál. Foss. l. c. p. 113, Pl. XII, figs. 5, 6), differs from it in some distinctive features. As these characters of specific importance are accessible to examination, I do not hesitate to introduce a new specific name, although for a complete diagnosis more specimens would be required.

In its general shape, involution and sculpture *Ophiceras obtuso-angulatum* is very similar to *O. platyspira*. But the whorls overlap one another very slightly, considerably less so than in *O. platyspira*. Its outlines are less strongly elliptical, and its transverse section is more slender, than in the typical form of the latter species. A distinct umbilical margin persists through all stages of growth. As in *O. platyspira*, the siphonal margin is well defined and forms a distinct edge, which is obtusely rounded off, but the external area is very narrow and perfectly flat, not broad and flatly curved as in *O. platyspira*.

The sculpture of the lateral parts is confined to the inner volutions. It consists of very low and regular, radial plications. The last volution is perfectly

smooth. The regularity of the ornamentation of the inner whorls recalls *Xenodiscus*, but the sculpture is too indistinct to warrant the removal of our species from *Ophiceras*. The plications are restricted to the umbilical region, exactly as in the last whorl of the specimen of *Ophiceras tibeticum* illustrated in my memoir quoted above, on Pl. VIII, fig. 6*a*.

Sutures.—As far as known agreeing with those in *Ophiceras platyspira* and *O. serpentinum*.

Dimensions.

Diameter of the shell		59 mm.
" " " umbilicus		28 "
Diameter of the shell	in the penultimate whorl	cca. 44 "
" " " umbilicus		19 "
Diameter of the shell	at the place of its greatest expansion	34 "
" " " umbilicus		13 "
Height	of the last volution	18 "
Thickness		12 "

Locality and geological position. Number of specimens examined.—Lilang, lowest bed of the horizon of *Meekoceras lilangense*, 1, coll. Krafft.

Genus: Xenodiscus Waagen.

1879. *Xenodiscus* Waagen, Palæontologia Indica, ser. XIII, Salt Range Foss., Vol. I. Productus limestone Foss., p. 32.

1897. *Danubites* Diener, Palæont. Indica, ser. XV. Himálayan Foss. Vol. II, Pt. 1, Cephalopoda of the Lower Trias, p. 24.

1902. *Xenodiscus* Frech, Lethæa Palæozoica, Vol. II, Pt. 2, Die Dyas, p. 631*a*.

"The genus *Xenodiscus* was proposed in 1879 by Prof. Waagen. It originally served to accommodate two species from the Productus limestone of the Salt Range, *viz.*, *Xenodiscus plicatus* and *X. carbonarius*, along with a number of types occurring in the lower Trias of the Salt Range. It is unnecessary to repeat the designation originally given to the genus, as its author subsequently restricted the name *Xenodiscus* to one single species, *X. plicatus*, and introduced the new genera *Xenaspis* and *Gyronites* for *Xenodiscus carbonarius* and the lower Triassic types respectively.[1]

"Thus *Xenodiscus* in its later circumscription was restricted to the species of Permian age which had been first described. The genus is, however, by no means rare, but there are, as we shall see, numerous representatives in the lower Trias of the Salt Range, of the Himálayas and of Siberia (Olenek beds), though the species from the last mentioned beds, described as *Xenodiscus* by E. v. Mojsisovics, have nothing to do with Waagen's genus but belong to *Meekoceras*.

"Of the type of the genus, *Xenodiscus plicatus*, one single specimen only is known. Waagen in his description states that the body-chamber has been almost entirely preserved, but I found on re-examining his type, that the shell is fractured, near the anterior termination of the last volution, in such a way that nothing definite can be said as to the original length of the body-chamber.

[1] Palæont. Ind. ser. XIII, Vol. II, Ceratite Formation, Pt. 1, pp. 161, 288.

"According to Waagen, the length of the body-chamber amounts to nine-tenths of the last volution. But in front of the sutural line, which Waagen mistook for the last septum, a second one can be distinctly seen. Measured from the bottom of the principal lateral lobe of this sutural line to the anterior termination, the body-chamber amounts to 295° or approximately eight-tenths of the last volution. But as indistinct traces of a third septum can be seen still further in front of the former one, the actual length of the portion of the body-chamber preserved may be even less than 295°.

"On the body-chamber the sculpture disappears gradually, not abruptly.

"As regards the sutural line, I am bound to remark that it is impossible to give a clear picture of its details, the outlines of the saddles and lobes being vague and indefinite, but it can be seen that the saddles were provided with broadly rounded tops. The second lateral saddle cannot be seen distinctly and must be more or less guessed at. It cannot, however, be doubted, that a second lateral saddle is actually present, for the position of the principal lateral saddle is exactly the same as in other types with two normal lateral saddles. Denticulations may be noticed in the lobes in a few places, but it is not possible to make them out in full detail.

"In spite of the indistinctness of the sutural line, the specimen is undoubtedly fitted to form the type of a proper genus, as all its important characters have been preserved.

"The genus *Xenodiscus* can be easily distinguished from any of the other Permian and Triassic genera of ammonites with ceratitic sutures. *Ophiceras* Griesbach does not possess the marked and regular radial sculpture we meet with in the present genus, some of the most remarkable types being even without any sculpture, as for instance *O. Sakuntala* Diener.

"As to the genus *Xenaspis* Waagen (Salt Range foss. l. c., Vol. II, Ceratite Formation, p. 161), it is to be regretted that Waagen's types are insufficiently preserved. The specimen, which has been figured by Waagen on Pl. II, fig. 2, of the "Productus limestone fossils," is badly weathered. There being no sutures accessible to examination, the length of the body-chamber is uncertain. Waagen states, it is true, that the body-chamber must have been very long, but no evidence as to this could be gathered from his types. In the largest specimen figured only one-half of the last volution has been preserved, and this belongs to the body-chamber. Two lateral saddles can, however, be seen at the lower, broken termination of the half volution.

"Since the inner whorls of *Xenaspis carbonaria* are smooth, there can be little doubt that Waagen was right in separating it from *Xenodiscus*, but a thorough diagnosis of the genus *Xenaspis* is as yet almost impossible. As Dr. Noetling has recently (1900) obtained large numbers of *Xenaspis carbonaria* Waagen from the Middle Productus limestone of the Salt Range, the decision as to the systematic position of this type should perhaps be deferred, until his material has been worked out."

"I shall now attempt to demonstrate that numerous species, formerly classed with other genera, can be included in *Xenodiscus*.

"There are first a number of types from the lower Trias of the Himálayas, described by Diener under the generic name of *Danubites*. Diener separated these forms from *Xenodiscus* solely by reason of an apparent difference in the length of the body-chamber. 'In all the Himálayan *Danubites*,' he writes 'which as regards soulpture bear the greatest similarity to *Xenodiscus plicatus*, the body-chamber occupies but very little more than one-half of a volution. From these forms *X. plicatus* consequently differs in this character in a rather remarkable way, and it cannot be denied that this character is of an undoubtedly important generic value, as it is closely connected with the interior organisation of the individual (l. c. p. 85).'

"To me a distinction between *Danubites* and *Xenodiscus* seems, however, impossible on the strength of this character. A specimen of *Danubites Kapila* Dien., since collected by Hayden, has a body-chamber measuring almost one entire volution, and several examples of other species of *Danubites* have been found with body-chambers measuring more than one-half volution in length, their circumference ranging up to 250°. On the other hand there is no conclusive evidence that body-chambers of a maximum length of 180° do actually occur in *Danubites*. Diener described a specimen of *Danubites cf. trapezoidalis* Waag., in which the apertural margin is said to have been preserved, and of which the body-chamber measures one-half volution only. I have re-examined this specimen, but could not convince myself of the correctness of Diener's view. The anterior termination is too much weathered to say anything definite as to the true position of the actual peristome. In my opinion Diener's suggestion therefore needs further corroboration. In a second specimen with a body-chamber of one-half volution in length (*Danubites Sitala* Dien.), the peristome is indicated by a sudden contraction at the anterior termination, but of the apertural margin itself no trace is visible. This specimen proves therefore even less than the former, although its body-chamber can certainly not have exceeded three quarters of the last volution in length.

"It has consequently not been ascertained, that there really is a marked difference in the length of the body-chamber of *Xenodiscus* and *Danubites*. The maximum length of the body-chamber in *Xenodiscus* is still unknown. There is one specimen of *Danubites Kapila* Dien., in which the body-chamber is even longer than in the type of the genus *Xenodiscus*, whereas several specimens of *Danubites* approach Waagen's type in this character. In most cases no evidence can be gained, while there is no individual which may be definitely asserted to possess a body-chamber of one-half volution only. Under these circumstances I do not think that we can help including the species of *Danubites* referred to in the genus *Xenodiscus*.

"The length of the body-chamber is evidently of very questionable systematic value. Only in exceptional cases can this character be ascertained. The consequence is that we should do better to leave it out of discussion altogether. This

remark applies especially to the present genus, as there is sufficient reason to believe that the length of the body-chamber does not differ considerably in all the specimens in question.

"These differences are, in my opinion, not remarkable enough to justify any generic distinction. There are several genera of ammonites in which the length of the body-chamber varies in different species. One instance has been quoted by Diener (l. c. p. 84). *Ptychites euglyphus* v. Mojsisovics exceeds the congeneric species in the length of the body-chamber by almost one quarter of a volution. I may further refer to the genus *Clymenia*, in which species with long and short body-chambers are known.*

"Among the species from the lower Trias of the Himálayas classed with *Danubites* by Diener, we generally observe a flattened external part, but it is evident that this character is not of generic importance. The flattening of the external part, moreover, sometimes becomes very indistinct on the body-chamber.

"I accordingly place the following species described from the lower Trias of the Himálayas in the genus *Xenodiscus* :—

Xenodiscus Himalayanus Griesb.
„ *rigidus* Dien.
„ *Kapila* Dien.
„ *nivalis* Dien."

"In the above list I have left out a number of species also described by Diener, which are nearly allied to *Xenodiscus rotula* Waag. and *X. radians* Waag. from the Ceratite formation of the Salt Range, and are perhaps, at least partly, not specifically independent. They will be treated in detail in the description of these two Salt Range species.

"Another group of types which, according to my opinion, should be united with the genus *Xenodiscus*, is the group of *Ceratites obsoleti* E. v. Mojsisovics (Arktische Triasfaunen l. c. p. 24).

"It was for this group, in common with the group of *Celtites Floriani*, that E. v. Mojsisovics introduced the subgenus *Danubites* in 1893 (Abhandl. K. K. Geol. Reichsanst., VI-2, p. 398). The *Ceratites obsoleti* agree with *Xenodiscus* in all important characters. I include them consequently in this genus, excepting, however, *Ceratites sigmoideus*, which differs from the rest in sculpture and involution, as has already been noticed by Diener (l. c. p. 25).

"The Siberian species, which I am inclined to unite with *Xenodiscus*, are the following :—

Xenodiscus multiplicatus v. Mojs.
„ *hyperboræus* v. Mojs.
„ *fissiplicatus* v. Mojs.
„ *discretus* v. Mojs.

* See E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 64.

"Another group of types belonging to *Xenodiscus* Waagen has been described by Waagen himself from the lower Trias of the Salt Range under the generic name of *Celtites*. Some of these types were placed in the genus *Danubites* by Diener, as, for instance, *Celtites trapezoidalis*. Others, however, he believed to differ from *Danubites* on the authority of Waagen, who stated them to be provided with a long body-chamber. Waagen himself considered *Celtites* to be closely allied to *Xenodiscus*, but on the strength of imaginary differences in the sutural line he came to the conclusion that it could not be a direct descendant of *Xenodiscus*.

"In his notes on the *Tropitidæ* of the Salt Range (l. c. p. 67) Waagen remarks that the second lateral lobe in *Celtites* is very small, and of a rather uncertain position, being sometimes above and sometimes below the line of involution of the preceding whorl. From this he infers that *Celtites*, like *Ceratites*, must have taken its origin from a genus, which had not developed a second lateral lobe.

"I leave the question untouched, whether the line of argument followed by Waagen is justified or not. The position of the second lateral lobe not having been determined in *Xenodiscus plicatus*, there is consequently no proof that *Xenodiscus* and *Celtites* do actually differ in this character. On the other hand it is certain that both are provided with two lateral saddles. This feature, in common with the agreement in all the rest of their characters, should be sufficient to prove the identity of those two genera.

"*Celtites* occasionally appears to have very faint transverse ribs on the external part. This character is well seen in *C. subrectangularis* Waagen (l. c. p. 73, Pl. VII, figs. 3, 6), but the sculpture is too weak to establish a generic difference.

"I therefore include the species from the Salt Range, classed with *Celtites* by Waagen, in the genus *Xenodiscus*. Unfortunately none of these species can be said to have been well established, Waagen's materials being, almost without exception, in a very indifferent state of preservation. The types of *Celtites dimorphus*, *C. lævigatus*, and *C. ovalis* especially are so ill-preserved that they do not deserve further consideration. Two types have been lost; *Celtites teres* Waagen (l. c. Pl. VII-*a*. fig. 4) and *C. acuteplicatus* (l. c. Pl. VII, figs. 5, 6, 7).

"One of Waagen's species, *Celtites multiplicatus*, ought to receive a new name, the same specific denomination having been applied by E. v. Mojsisovics to one of his *Ceratites obsoleti* from the Olenek beds, which falls into the range of *Xenodiscus*. But the insufficient state of preservation of Waagen's type prevents me from proposing a specific name.

"A species described as *Dinarites coronatus* by Waagen should also be added to the list of *Xenodiscus*, as it resembles *X. nivalis*, from the Hedenstrœmia beds of the Himálayas.

"Three species belonging to *Xenodiscus* have been described by Waagen under the generic name of *Gyronites*. Two of them, recently found also in the lower Trias of the Himálayas, have body-chambers of more than one-half volution in length. These species of *Gyronites* Waagen have been classed with *Danubites* by Diener. They will consequently have to be included in *Xenodiscus*, the two genera being, in my opinion, identical.

"These three species of *Gyronites* are :—

Xenodiscus radians Waag.
" *rotula* Waag.
" *plicosus* Waag.

"*Gyronites Nangaënsis* Waag. and *G. arenosus* should also be included, but the types are not well enough preserved to justify further consideration.

"Among the representatives of the genus *Lecanites* described by Waagen there are also several types olosely similar to *Xenodiscus*. *Lecanites ophioneus*, *L. laqueus*, *L. undatus* differ from *Xenodiscus* solely by their goniatitic sutures. If we consider how easily the denticulations of the lobes are destroyed by weathering, it appears very probable that these types actually belong to the genus *Xenodiscus*, especially as the preservation of the type-specimens is by no means satisfactory.

"The following species of *Prionolobus* Waagen resemble *Xenodiscus* so closely that I cannot see any sufficient reason for a generic distinction.

Prionolobus Buchianus Waag.
" *compressus* Waag.
" *ovalis* Waag.
" *plicatus* Waag.

"The last-mentioned species must receive a new name, this specific denomination having been attributed to the type of *Xenodiscus* by Waagen in 1879. For this species I propose the name of *Xenodiscus khoorensis*.

"I further include in *Xenodiscus Meekoceras falcatum* Waagen (l. c. Pl. XXXVI, fig. 4), as it agrees with *Xenodiscus* in sutures, shape and sculpture, and moreover shows the same striking change in ornamentation on the last volution, as has been observed in the group of *X. himalayanus* (see below).

"Diener (l. c. p. 17) remarks that *Meekoceras falcatum* should be included in the genus *Ceratites*, and placed somewhere near *Ceratites connectens* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. Pl. III, fig. 10), but the relationship to *Xenodiscus* appears to me decidedly closer than to the isolated type, to which Diener refers.

"A diagnosis of the genus *Xenodiscus* will now be appropriate. Taking into account the slight differences which distinguish certain species from the type, this diagnosis may be summarised as follows.

"Whorls evolute. Lateral parts covered with radial ribs. External parts as a rule quite smooth, rounded or flattened, occasionally with very faint transverse ribs. Body-chamber more than one-half volution in length. In some species the sculpture becomes more delicate or disappears completely on the body-chamber. Sutures ceratitic, two lateral saddles."

I have quoted A. v. Krafft's notes in full. Since they were written, a considerable number of palæontologists, dealing with Permian and Triassic cephalopoda, have advocated an amalgamation of the lower Triassic species grouped with *Danubites* or *Gyronites*, and of Waagen's genus *Xenodiscus*.

Noetling in his Beitræge zur Geologie der Salt Range (Neues Jahrb. f. Min. etc.

Beilagebd. XIV, 1901, p. 460) was the first to reject a restriction of the genus *Xenodiscus* to *X. plicatus* on account of the length of its body-chamber. He declares himself strongly opposed to the method of separating genera of ammonites on the basis of the length of the body-chamber, because in fossil shells this character is only accidentally available for examination.

Frech in his classification of Permian and lower Triassic ammonites (Lethæa Palæozoica II, Bd. 2, Theil. p. 634*a*) takes a similar view. He likewise objects to the value of the length of the body-chamber as a character of generic importance, and consequently unites the strongly sculptured Ceratites of the lower Trias (*Danubites, Gyronites, ex parte*) with *Xenodiscus*.

The third distinguished palæontologist who proposes to unite the Indian species, classed hitherto with *Danubites*, with Waagen's genus *Xenodiscus*, is E. v. Mojsisovics (Cephalopoden der Hallstætter Kalke, Abhandl. K. K. Geol. Reichsanst., VI. Supplementband, 1902, p. 323). He remarks that even in *Xenodiscus plicatus* the body-chamber is yet considerably shorter than in any of the European representatives of *Celtitidæ*, provided with body-chambers measuring from 1 to 1½ volutions in length. According to his view the difference in the length of the body-chamber between the Permian *X. plicatus* and the lower Triassic species described by myself as *Danubites* is too small to justify a generic separation.

In my description of *Xenaspis carbonaria* (Himálayan Foss., Pal. Ind., ser. XV. Vol. I, Pt. 5, Permian Fossils of the Central Himálayas, p. 9), I have explained the reasons which induced me to insist on the importance of the length of the body-chamber in the classification of Triassic ammonites. Regarding the question of the generic independence of *Xenaspis* and *Xenodiscus* I said :—"The generic claims of *Xenodiscus* or of *Xenaspis* are therefore equal to those of *Celtites*, which has been acknowledged as a proper genus by all palæontologists, but is distinguished from the *Ceratitidæ* only by the length of its body-chamber. In one case only should I feel considerable uncertainty as to whether *Xenodiscus* and *Xenaspis* should or should not be considered generically distinct from *Gyronites*. If a number of examples were found, which from their intermediate character left us in doubt as to which of these genera they should be referred to, the advisability of questioning the generic importance of the length of the body-chamber in these ammonites might be admitted."

Now this case has actually occurred. It has been demonstrated by A. v. Krafft that a considerable variability really exists in the length of the body-chamber among the Lower Triassic species, which I united with *Danubites*, and that the body-chamber, so far as known, exceeds one-half volution without ever reaching one entire volution in length. Differences within this limit are, indeed, scarcely fit for a systematic basis in the classification of ammonites, being probably of no more than individual importance.

I consequently accept the genus *Xenodiscus* in the new circumscription proposed by A. v. Krafft.

E. v. Mojsisovics, in his above-quoted memoir, advocates a generic separation of the Indian forms united in the genus *Xenodiscus* from his group of Arctic

Ceratites obsoleti, on the monophyletic principle of phylogeny. He thinks that for the latter group the name of *Danubites* might be retained. To this separation of Arctic and Indian species, agreeing in all essential characters, I must still object, considering phylogenetic speculation as a very unsafe guide in the classification of ammonites. The name *Danubites* must be restricted to the European group of *Danubites Floriani*. As this group had been used by E. v. Mojsisovics as one of the types of *Danubites* in 1893 the new subgeneric name of *Florianites*, proposed in 1900 by A. Hyatt, will have to be dropped.

To the Siberian species of *Danubites*, which must be placed in the genus *Xenodiscus* in the new circumscription, *Danubites Nicolai* Diener (Mém. Com. Géol. XIV, No. 3, Pl. II, fig. 1) must be added. It is a representative of the Indian *Xenodiscus himalayanus* Griesb. in the lower Triassic fauna of the Ussuri district near Vladivostok.

The wide geographical distribution of *Xenodiscus* is evident from the beautiful monograph of the Triassic Cephalopod genera of North America published by Hyatt and Smith (U. S. Geol. Surv. Prof. Pap. no. 40, Washington, 1905). *X. Bittneri* (l. c. p. 123, Pl. XX, figs. 5-15, XXI, figs. 1-13) would fall within the range of this genus, even if the latter were taken in the narrow circumscription proposed by Waagen in 1895, its body-chamber measuring about one volution in length. A second species belonging to *Xenodiscus* was originally described as *Meekoceras aplanatum* by White. As has been demonstrated by Waagen (Ceratite formation, l. c. p. 291), C. A. White included under this name two different species, which were illustrated in his contributions to invertebrate Palæontology (No. 5, Triassic fossils of S. E. Idaho, Annual Rep., U. S. Geol. Surv. for the year 1878 Pt. II) on Pl. 31, fig. 1*a*, *b*, *d* and fig. 1*c*, respectively. For the first of the two only can the name of *Meekoceras aplanatum* be retained, whilst for the second the name of *Gyronites Whiteanus* was proposed by Waagen. In my memoir on the cephalopoda of the Himálayan lower Trias (l. c. Vol. II, Pt. 1, p. 28) I suggested that *Gyronites Whiteanus* might perhaps form part of the genus *Danubites*, but did not venture to decide the question, on account of the unsatisfactory illustrations given by White. A re-examination of White's type-specimen by J. Perrin Smith (l. c. p. 164) has confirmed my suggestion, the ornamentation of the shell speaking decidedly in favour of an identification with *Danubites* (*Xenodiscus* in A. v. Krafft's circumscription).

It is this American species, which A. Hyatt intended to take as the prototype of his new genus *Wyomingites* (Zittel's text-book of Palæontology, English edition, 1900, Cephalopoda, p. 556), as has been stated by J. P. Smith (l. c. p. 147).

The only American species which really belongs to *Danubites* is probably *D. Strongi* Hyatt et Smith (l. c. p. 165, Pl. IX, figs. 4-10), which by reason of its helmet-shaped cross-section reminds me of the group of *Danubites Floriani* Mojs.

In the Mediterranean region *Xenodiscus* is represented by a type from the upper Werfen beds of Muć, which has been elevated to the rank of a proper subgenus, *Paraceratites*, by Kittl (Die Cephalopoden der oberen Werfener Schichten von Muć in Dalmatien, Abhandl. K. K. Geol. Reichsanst. 1903, Bd. XX, p. 28).

The prototype of this sub-genus, *Paraceratites prior* (l. c. p. 29, Taf. XI, figs. 4, 13), appears to be very closely allied to the Indian group of *Xenodiscus nivalis*. In its sutural line it agrees exactly with some of the more primitive forms of Himálayan *Xenodisci*. There is one species especially, *Xenodiscus asiaticus* v. Krafft (see the following description), from which it is only distinguished by its more rapidly increasing volutions, but which it otherwise resembles very closely in its cross-section, sculpture and sutures.

The species of *Xenodiscus* from the lower Trias of the Himálayas can be grouped conveniently according to their sculpture. Those known to me in 1897 I proposed to arrange in the following three groups:—

1. Species in which the sculpture remains one and the same on the body-chamber and on the chambered part of the volutions.
2. Species in which the sculpture of the last whorl—as a rule body-chamber—differs from that of the inner volutions.
3. A group, represented by one single species only—*Xenodiscus nivalis* Dien.—recalling the genus *Tirolites* Mojs., in which the marginal portions of the ribs are developed more strongly than the umbilical.

A. v. Krafft thinks that the second and third group should be united, as the marginal portion of the ribs is not always more strongly developed than the lateral one, and as the sculpture on the last volution changes in *X. nivalis* as well as in the representatives of the second group.

To this amalgamation of the second and third groups I must, however, strongly object. The group of *X. nivalis* is certainly one of the best defined sections among the genus, distinguished from the other groups not only by its peculiar sculpture, but also by its square transverse section. It even differs from the congeneric forms so remarkably, that it might rather perhaps be considered as the type of a proper subgenus. For an Alpine representative of this group the subgeneric name of *Paraceratites* has been proposed by Kittl.

Of the well established species from the Himálayas one only (*Xenodiscus rigidus* Dien.) certainly belongs to the first section, whereas five belong to the second and two to the third group. The rest cannot be definitely placed in either.

For the first section the group name of *Xenodiscus rigidus* is proposed by A. v. Krafft, who rejects the group name of *X. Purusha*, as the systematic position of this species is not considered by him to be fixed with sufficient security.

For the second section the name 'group of *Xenodiscus himalayanus*', proposed by myself in 1897, is retained.

The well established species of *Xenodiscus* from the lower Trias of the Himálayas whose systematic position has been fixed with certainty, may thus be arranged as follows:—

I. Group of *Xenodiscus rigidus*.
X. rigidus Dien.
II. Group of *Xenodiscus himalayanus*.
X. himalayanus Griesb.

X. rotula Waag.
X. radians Waag.
X. lilangensis nov. sp.
X. Kapila Dien.
III. Group of *Xenodiscus nivalis.*
X. nivalis Dien.
X. asiaticus v. Krafft.

1. Xenodiscus rigidus Diener.

1897. *Danubites rigidus* Diener, Himálayan Foss. Palæont. Ind. ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 36, Pl. XV, figs. 4, 5.

"This small species has very peculiar features, the external part being remarkably broad and the sculpture very regular. There is consequently no reason to doubt its specific independence. One specimen from Ensa, collected by Mr. Hayden, could be identified with this species more or less provisionally, but it is not well enough preserved to be figured."

2. Xenodiscus himalayanus Griesbach. Pl. XXIII, fig. 2.

1880. *Ophiceras himalayanum* Griesbach, Palæontological notes on the lower Trias of the Himálayas, Records, Geol. Surv. of India, Vol. XIII, Pt. 2, p. 111, Pl. III, fig. 8.
1886. *Ceratites himalayanus* E. v. Mojsisovics (*non C. himalayanus* Blanford), Arktische Triasfaunen, Mém. Acad. des Sciences, St. Pétersbourg, VII, sér. Vol. XXXIII, No. 6, p. 20.
1897. *Danubites himalayanus* Diener, Palæont. Ind. ser. XV, Himál. Foss. Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 41, Pl. XIV, fig. 14.

Measurements.

D	55 mm.	$\frac{D}{U} = 2{\cdot}29$
U	24 „	
A	18 „	$\frac{A}{C} = 1{\cdot}38(?)$
C	13 ? „	

"This species was founded on a single specimen imbedded in a slab of dark limestone side by side with a small individual of *Otoceras Woodwardi* Griesb. As Mr. La Touche obtained a second fairly well-preserved specimen from the lower Trias of the Lissar valley, it may be figured and described here.

"Its identity with Griesbach's type cannot be doubted, as it agrees with it in all its important characters. I may specially draw attention to the similarity in the shape of its umbilical wall, which in the inner volutions is low and increases in height from the commencement of the last volution. The number of ribs is the same, *viz.*, ten in one-half volution on both specimens.

"About one-half volution belongs to the body-chamber. This bears much more delicate ribs than the chambered part. Some of the ribs are stronger than the majority, an irregularity also noticed in the type.

"In its transverse section the present specimen differs slightly from Griesbach's type, inasmuch as the siphonal area is somewhat flattened in the body-chamber, but this small difference is assuredly not of specific importance.

"The proportions of the two specimens cannot well be compared, as the body-chamber of the type is somewhat crushed, thus excluding reliable measurements.

"*Sutures.*—Not visible clearly enough to be figured or described in detail.

"*Geological position. Locality. Number of specimens examined.*—Crest of ridge between Dharma and Lissar valleys, opposite Ralphu glacier, Kumaon, 1, coll. La Touche. Geological horizon not known exactly, presumably from the Otoceras stage.

"*Remarks.*—Prof. Diener describes a specimen of *Xenodiscus* from the same locality (coll. Griesbach) as *Danubites ex. ind. ex aff. himalayano.* This specimen is much too badly preserved to permit of a complete identification. Perhaps it may even belong to the present species."

2. Xenodiscus rotula Waagen. Pl. XXIII, figs. 4, 5, XXV, fig. 11, XXVII, figs. 4, 5,
and
3. Xenodiscus radians Waagen. Pl. XXV, figs. 1-3.

1895. *Gyronites rotula* Waagen and *G. radians* Waagen, Fossils from the Ceratite formation l. c., p. 300, 302, Pl. XXXVIII, figs. 3-5, 6-8.

Measurements.

a.—Xenodiscus radians Waag.

	I. (Pl. XXV, fig. 3.)	II. (Pl. XXV, fig. 1.)
D	42 mm.	45 mm.
U	21 „	20 „
A	11 „	13 „
C	8·5 „	10 „
$\frac{D}{U}$	2	2·45
$\frac{A}{C}$	1·29	1·3

b.—Xenodiscus rotula Waag.

	I. (Pl. XXVII, fig. 4.)	II. (Pl. XXVII, fig. 5.)
D	29 mm.	35 mm.
U	12 „	16 „
A	9 „	10·5 „
C	6·5 „	8 „
$\frac{D}{U}$	2·41	2·18
$\frac{A}{C}$	1·38	1·31

"These two species are treated here simultaneously, as they are very closely allied."

"The difference on which Waagen founded their specific distinction consists in the sculpture, *Xenodiscus radians* having more numerous and more sharply defined folds than *X. rotula*. The Himálayan types showing this difference clearly, their identity with the Salt Range species may be established with full certainty by a comparison with Waagen's type-specimens.

"Differences such as might, from Prof. Waagen's description, appear to exist, were found to be insignificant. Waagen states that *Xenodiscus rotula* has marginal edges in young stages, which disappear in older specimens, whereas *Xenodiscus radians* is said to have a broadly rounded external part. On re-examination of Waagen's type-specimens, I found that both species are provided with a flattened external part in young individuals, whereas in more advanced stages of growth the marginal edges become obtuse, without disappearing altogether. In this respect the Salt Range types agree perfectly with the Himálayan ones. In *X. radians* the ribs, as pointed out by Waagen, are inequidistant. This feature may also be observed in the specimens from Muth. As regards the sculpture of the body-chamber I am able to supplement Waagen's description. Only one of his specimens of *Xenodiscus radians* shows part of the body-chamber (Pl. XXXVIII, fig. 7), and on this the ornamentation remains the same as on the chambered portion of the shell. In the Himálayan types, however, in which a considerably greater part of the body-chamber has been preserved, the sculpture changes towards the anterior termination, the ribs becoming much more delicate and more numerous. This change in the ornamentation appears to take place either at the beginning of, or on, the body-chamber.

"None of the specimens of *Xenodiscus rotula* from the Salt Range has its body-chamber preserved, but the Himálayan examples show that a similar change of sculpture occurs in that species.

"The partly chambered fragment illustrated on Pl. XXII, fig. 5, resembles the body-chamber of the specimen figured on Pl. XXVII, fig. 5 in sculpture, thus proving that the ornamentation may become more delicate even before the body-chamber is reached.

"A remarkable character of the two species, not previously recorded, is a shallow spiral groove running along the middle of the sides of the body-chamber and bearing a few very indistinct concentric striæ. It begins as soon as the lateral sculpture becomes more delicate, and occasionally therefore occurs on the chambered portion of the last whorl in *X. rotula* as well as on the body-chamber. It is never equally well seen on both sides, but is clearly developed on one side in almost every well-preserved specimen (see remarks on *Ophiceras Dharma* Diener below).

"The specimen of *Xenodiscus radians* from the Ceratite formation of the Salt Range illustrated by Waagen on Pl. XXXVIII, fig. 7 of his memoir, also shows this spiral groove on the body-chamber, but the furrow is considerably deeper than in the Himálayan types. This difference is probably due to accidental deformation of Waagen's type-specimen.

"The spiral sculpture on the body-chamber of *X. radians* and *X. rotula* agrees in every respect with that seen in certain species of *Meekoceras*

(*M. lilangense*). The apertural margin has not been preserved in any of these specimens.

"*Body-chamber.*—The length of the body-chamber has been measured in three specimens :

Xenodiscus radians { I—230° / II—between 220° and 230°.

Xenodiscus rotula I—250°.

"Shelly layer occasionally preserved, but in fragments only.

"*Sutures.*—In *Xenodiscus radians* the ceratitic development of the lobes is more prominent, according to Waagen, than in *X. rotula*, but it is doubtful whether this statement is justified. In one of my specimens of *X. rotula* the entire umbilical lobe as well as the internal saddle and antisiphonal lobe are visible. The depth of the latter is not quite certain, but it is no doubt considerable.

"*Geological position. Locality. Number of specimens examined.*—*Xenodiscus rotula :* Lower division (Otoceras beds ?), 5 miles S. of Ensa, Spiti, 6, coll. Hayden; S. E. of Muth, Spiti, 1, coll. Hayden; lower Trias (Chocolate Limestone), Jolinka E. G., Byans, 2, coll. Smith.

"*Xenodiscus radians :* Lower division (Otoceras beds ?), 5 miles S. of Ensa, 9, coll. Hayden ; S. E. of Muth, 8, coll. Hayden; N. N. W. of Kágá, 1, coll. Hayden; Lilang, 1, coll. Krafft; Chocolate Limestone, Jolinka E. G., Byans, 4, coll. Smith.

"The identification of the duplicates could not in all cases be carried out with sufficient certainty, owing to their indifferent state of preservation.

"*Remarks.*—According to the explanation of Pl. XXXVIII in Waagen's memoir, his type-specimens of *Xenodiscus rotula* and *X. radians* were collected from the lower region of the Ceratite Sandstone. The original labels of the specimens say 'about region of ceratite sandstone.' From this discrepancy doubt must arise as to whether the geological position of the two species has been satisfactorily ascertained.

"A similar difficulty exists with respect to the Himálayan specimens, the labels giving the Otoceras beds as the habitat of the examples from Spiti. There can, however, be little doubt that the majority of Hayden's specimens from Spiti were found in the horizon of *Meekoceras lilangense* and *M. Varaha.*[1] This must be taken into consideration if we utilize the two species in correlating the Salt Range with the Himálayan lower Trias.

"*Affinities.*—Prof. Waagen has already pointed out the relations of these two species to other types. I may be allowed to add here the following ones. *Xenodiscus himalayanus* is easily distinguished by its coarser ribs and much more clumsy proportions. *X. Whiteanus* Waagen has no falciform ribs and is provided with a wider umbilicus. *X. hyperboræus* v. Mojsisovics is no doubt very similar

[1] One specimen from A. v. Krafft's own collection—illustrated on Pl. XXV, fig. 2—is marked on the accompanying label in A. v. Krafft's handwriting : "Lilang, Spiti, horizon of *Ophiceras Sakuntala.*" This would prove the specimen to have been found in the Otoceras beds *s. s.*

to both *X. radians* and *X. rotula*, but has a rounded external part. It might nevertheless be possible to establish its identity with the present species by a comparison of the type-specimens, but this can never be satisfactorily done by the help of figures alone."

Xenodiscus Bittneri Hyatt et Smith (Triassic Cephalopoda of America, l. c. p. 123, Pl. XX, figs. 5-15, XXI, figs. 1-13), from the lower Muschelkalk of California, appears also to be closely allied to *X. rotula*. It agrees with this species in involution, transverse section and sculpture. The contrast of broad, radial plications, on the inner whorls and of delicate, numerous, slightly falciform folds on the last volution is very prominent. The American species differs from *X. rotula* in the ornamentation of the siphonal part, which is crossed by the lateral ribs in adolescent stages of growth, and in the serrated branches of its external lobe in the sutural line.

Remarks on Xenodiscus poënsis A. v. Krafft.—A specimen from the Otoceras or Meekoceras beds of Po (Spiti), coll. Hayden, is marked as *Xenodiscus poënsis nov. sp.* on the accompanying label in A. v. Krafft's handwriting. In my opinion this specimen cannot be specifically separated from *X. radians* Waag.

Remarks on *Ophiceras Dharma* Dien., *Dannbites planidorsatus* Dien., *D. lissarensis* Dien., *D. ellipticus* Dien., *D. Sitala* Dien., *D. sp. ind. ex aff. planidorsato.*

"1. *Ophiceras Dharma* Dien.—This species was founded on two fragments from the lower Trias of the Lissar and Dharma valleys. The larger specimen, illustrated on Pl. XV, fig. 8, of Diener's memoir on the Cephalopoda of the Himálayan lower Trias, is very likely identical with *Xenodiscus rotula* Waag. On the penultimate whorl radial ribs are seen, while the body-chamber, as far as preserved, shows delicate striæ. On the reverse of the side figured the same spiral sculpture is seen as in *X. rotula*. The second fragment (Pl. XV, fig. 9) has higher volutions and may therefore be supposed to be a different species or even genus, although it is barely determinable. To this specimen the name of *Ophiceras Dharma* should be restricted.

"2. *Xenodiscus planidorsatus* Dien.—The two specimens, on which Diener founded this species (l. c. Pl. XV, figs. 1, 2), are probably identical with *X. rotula* Waag. In the specimen illustrated in fig. 1 the ribs are somewhat falciform and die out gradually towards the external part. The second specimen is less well preserved, but I have no doubt that it belongs to the same species as fig. 1.

"3. *Xenodiscus lissarensis* Dien.—This species is probably an independent one, although this can scarcely be proved with the fragmentary material at hand. In one of the specimens (Pl. XIV, fig. 8) the external part is rounded, no flattening being perceptible, while the other two specimens are doubtful in this respect. The sculpture changes towards the anterior termination of the last whorl, one specimen (Pl. XIV, fig. 11) having rather delicate ribs on the chambered portion of the last volution, a character in which it would agree with *X. rotula*. Until better specimens are forthcoming, the specific independence of *Xen. lissarensis* will remain open to doubt."

"4. *Xenodiscus ellipticus* Dien.—As regards this species, I have little doubt that it is identical with *Xen. radians* (see also Diener, l. c. p. 33). The specimen illustrated by Diener on Pl. XIV, fig. 12, has a flattened external part, but specimen fig. 13 allows no definite statement in this respect, being too much weathered. The sculpture of the latter specimen agrees with that in *X. radians*, the ribs being falciform, rather sharp where better preserved, inequidistant, and disappearing towards the external part. Specimen fig. 12 is strongly weathered, yet the pattern of the sculpture of *X. radians* can be partly noticed. The elliptical shape of these two specimens is more likely to be due to crushing than to an original elliptical growth. Prof. Diener remarks, it is true, that the specimens were brought from Kuling together with many other fossils, which do not show any trace of having been crushed or squeezed. Nevertheless I do not think that we can conclude from this fact that their outlines were originally elliptical. In Mr. Hayden's collection from the fossiliferous locality of the Hedenstrœmia beds, S. E. of Muth, there are several elliptical specimens of *Flemingites Rohilla* Diener, while Prof. Diener's type-specimen from the same locality is not deformed.

"5. *Xenodiscus Sitala* Diener.—The two specimens figured are in my opinion too fragmentary and weather-worn to deserve the introduction of a new specific name. *X. Sitala* is probably an independent species, although its sculpture is not unlike that of *X. radians*."

4. XENODISCUS LILANGENSIS v. Krafft. Pl. XXV, figs. 6, 7, 8, 9, 10.

Measurements.

	I.	II.
D	42 mm.	58 mm.
U	19 „	27 „
A	12 „	17·5 „
C	6 „	11 „
$\frac{D}{U}$	2·21	2·14
$\frac{A}{C}$	2	1·59

"The present species was found at Lilang in the lowest bed of the horizon of *Meekoceras lilangense* and *M. Varaha*, together with the former of these two leading species, and with *Meekoceras ensanum*. Like all the other ammonites from this hard limestone bed, they are of an inferior preservation in state of examples from the higher beds in the sequence. I consider the specimens illustrated on Pl. XXV, figs. 6 and 7, as prototypes of the species. The two specimens, figs. 8 and 9, I look upon as varieties, the sculpture of their inner volutions being somewhat different.

"The maximum thickness is situated in the lower part of the sides, but does not coincide with the umbilical edge. The latter is rounded. Umbilical wall high and sloping in the full-grown stage. All the better preserved specimens show a flattened external part with distinct marginal edges.

"On young individuals short, thick radial ribs occur. These ribs somewhat recall the sculpture of *Xenodiscus plicosus* Waag., but in typical specimens they are broader and higher and stand further apart. The two varieties illustrated in figs. 8 and 9 differ from *X. plicosus* in this character even less than the prototypes of the present species. Eleven to twelve ribs can be counted on the circumference of one volution.

"During the further progress of growth the umbilical part of the ribs becomes lower, until at last the ribs are most strongly developed near the middle of the height of the flanks. At the same time they increase in length and assume a falciform bend.

"The ribs again become more delicate and numerous towards the anterior termination of the last whorl, where the sculpture resembles that of *Xenodiscus radians* Waag. (see fig. 7). In this specimen and in one of the varieties (fig. 9) the ribs reach almost up to the siphonal part, while in one of my examples they are seen to be interrupted by a smooth spiral band, somewhat below the middle of the sides, which recalls the spiral band on the body-chamber of *X. radians*. The double change of sculpture is rapid in some specimens (fig. 7), in others more gradual (figs. 6, 8).

"*Body-chamber.*—In one of my specimens the length of the body-chamber is somewhat more than one-half volution. The body-chamber of my largest example also exceeds one-half volution, but its length cannot be determined accurately. No sutures are seen in the rest of the figured types, the dimensions of the body-chamber consequently being doubtful.

"In several specimens the shelly test has been partly preserved.

"*Sutures.*—In none of the better preserved specimens have the sutures been observed in detail. A specimen from Po, belonging probably to the present species, shows the base of the lateral lobes provided with delicate denticulations.

"*Geological position. Locality. Number of specimens examined.*—Lower division; lowest bed of the horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 8, coll. Krafft; Lower division, horizon not known exactly, Po, Spiti, 3, coll. Krafft.

"*Remarks.*—*Xenodiscus lilangensis* appears to be very closely allied to *Prionolobus Buchianus* (de Kon.) Waagen (Fossils from the Ceratite formation, l. c. p. 320, Pl. XXXV, fig. 5), which is unfortunately represented in the Salt Range collection by one single weather-worn fragment only. Waagen united this fragment with L. de Koninck's species, although the identity could never be ascertained. The measurements given by him can hardly claim to be more than approximate. D and C are altogether unmeasurable.

"The figure 5*a* in Waagen's memoir does not show clearly enough the flattening of the external part, which is quite perceptible in the last volution. Waagen, it is true, says on pp. 320 and 321 of his description, that external edges are 'decidedly absent.' To my eye the siphonal part appears to be decidedly flattened, and meets with the lateral parts in very distinct although obtuse edges. I have examined his type-specimen with a lens several times.

"*Prionolobus Buchianus* resembles the present species chiefly in its sculpture, the penultimate whorl being provided with short ribs, which are developed very strongly in the vicinity of the umbilical edge, while on the last volution the sculpture changes to longer ribs, more nearly approaching each other and somewhat falciform. The character of the umbilical wall also agrees very nearly. From Waagen's illustration we might infer that in *Prionolobus Buchianus* the involution is greater, but this is by no means certain, the type-specimen being imbedded so firmly in the matrix that the outlines of the penultimate whorl cannot be seen.

"I think there can be little doubt that *Prionolobus Buchianus* is very closely allied to our species, but any more definite statement as to an actual identity is impossible, owing to the scarcity and the imperfect state of preservation of the fossil material from the Salt Range."

5. Xenodiscus Kapila Diener. Pl. XXIII, fig. 3, XXVII, figs. 2, 3.

1897. *Danubites Kapila* Diener, Himálayan Foss., Palæont. Ind. ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 50, Pl. XV, fig. 16.

Measurements.

	I. (Pl. XXVII, fig. 3.)	II. (Pl. XXVII, fig. 2.)	III. (Pl. XXIII, fig. 3.)
D	. . 38 mm.	42 mm.	app. 58 mm.
U	. . 19 „	22 „	29 „
A	. . 10 „	10·5 „	15 „
C	. app. 12 „	? „	app. 17 „
$\frac{D}{U}$	. . 2	1·9	2
$\frac{A}{C}$	. app. 0·83	?	app. 0·82

"This very characteristic species, of which Prof. Diener had one specimen only for his description, was collected in large numbers in the Hedenstrœmia beds S. E. of Muth (Spiti) by Mr. Hayden. The state of preservation of most of the specimens is unsatisfactory, but there are a few examples which show the specific characters more completely than Diener's type-specimen. I am thus enabled to supplement his diagnosis by the following notes.

"The most remarkable feature of this species consists in the very small amount of involution in the last whorl. The latter indeed scarcely touches the siphonal area of the penultimate one. In consequence of the slight cohesion of these two volutions they are separated very easily by pressure, and this partly accounts for the generally unsatisfactory state of preservation of the specimens.

"Another very characteristic feature is to be recognized in the change of sculpture taking place towards the anterior termination of the last whorl. On the penultimate volution of the specimen illustrated on Pl. XXVII, fig. 3, there are eight high and sharp ribs, with wide, somewhat irregular intervals, which die out before reaching the rounded siphonal margin. The last volution of this specimen

contains at least 18 or 19 ribs, longer and generally more delicate than those of the preceding whorl, the distances between the ribs being very irregular. Similar features may be noticed in the two other specimens figured, which are less well preserved.

"The place where the sculpture begins to change is, however, not the same in all my specimens. In the one first mentioned the change occurs in front of the last air-chamber. In specimen II (Pl. XXVII, fig. 2) we notice that a whole volution back from the beginning of the body-chamber the ribs already begin to become more delicate and more numerous.

"*Body-chamber.*—In specimen I, the last volution belongs almost entirely to the body-chamber, being situated only a little in front of a radius connecting the centre of the umbilicus with the broken anterior termination. Length of the body-chamber in specimen II, approx. 210°, in specimen III doubtful.

"Among the duplicates there are several specimens with body-chambers exceeding one-half volution in length.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 30, coll. Hayden.

"*Remarks on Danubites Purusha* Diener.—Provided that *Xenodiscus Purusha* Dien. is really an independent species, it must probably be removed from the group of *X. rigidus* and placed in the vicinity of *X. Kapila*.

"The specimen, whose sutures have been figured by Diener in his memoir on the Cephalopoda of the Himálayan lower Trias on Pl. XV, fig. 15, is perfectly indistinguishable from examples of *X. Kapila* in Hayden's collection. As regards the specimen illustrated on Pl. XV, fig. 14, it is true that its transverse section appears slightly less square than in most specimens of *X. Kapila*, but I convinced myself that this character is subject to some variability.

"Diener places *X. Purusha* in a group named after this species, believing the sculpture on the chambered part to be of the same pattern as on the body-chamber. This is, however, uncertain. What can be seen on the type would rather point to the ribs standing generally at greater intervals on the chambered part of the last volution, than on the body-chamber. This character, as well as the irregularity of the intervals between the ribs, also noticed by Diener himself, agrees with the sculpture of *X. Kapila*. Prof. Diener thinks that *X. Purusha* may easily be distinguished from all the rest of the nearly allied species by the unusual depth of its siphonal lobe. And this is true so far as it concerns the group of *X. rigidus*. But *X. Kapila* also has a very deep siphonal lobe.

"I do not propose to unite the two species, but the name of *X. Purusha* will have to be restricted to the specimen illustrated by Diener on Pl. XV, fig. 14, of his memoir."

To A. v. Krafft's remarks, which have been quoted here in full, I have only to add that, according to my opinion, *Xenodiscus Purusha* is certainly fit to claim the rank of a proper species. Whether or not the sculpture of the body-chamber ought to be considered identical with that of the chambered portion of the shell, is very difficult to decide. In my original diagnosis I stated the

facts, as follows :—"Although the pattern of the sculpture remains about the same on the body-chamber and on the chambered part of the shell, the ribs generally stand somewhat closer together near the aperture, than at the commencement of the last volution. The sculpture is, however, on the whole not quite regular, the breadth of the intercostal intervals varying to a certain extent."

There is, as the reader may infer from this quotation, no essential difference between A. v. Krafft's and my own statement regarding this question. I am, therefore, ready to admit that the systematic position of *Xenodiscus Purusha* in the group of *X. rigidus* has as yet not been established with full certainty.

7. Xenodiscus cf. plicosus Waagen. Pl. XXV, fig. 4.

1895. *Gyronites plicosus* Waagen, Fossils from the Ceratite formation, Palæont. Indica, ser. XIII, Salt Range Fossils, Vol. II, p. 298, Pl. XXXVIII, fig. 11.

In the Himálayan collection there are two specimens of *Xenodiscus*, bearing on the labels the designation of "*Xenodiscus cf. plicosus* Waag." in A. v. Krafft's handwriting, but no description of the species has been found among his notes. An examination of those specimens has convinced me that they actually belong to a species which is probably identical with *X. plicosus* Waagen, from the lowest bed of the lower Ceratite limestone of the Salt Range.

The smaller specimen, which is more complete but consisting of air-chambers only, has been chosen for illustration. In general shape, involution, and sculpture it agrees exactly with Waagen's type-specimen, so far as I am able to judge from a plaster-cast available for comparison. The only difference lies in the shape of the external shoulders. In my type-specimen from Spiti the siphonal part is distinctly biangular, being separated from the gently arched flanks by well defined edges. Waagen describes the siphonal part in his type-specimen of *X. plicosus* as broadly and evenly rounded and passing gradually into the lateral parts, but hints at the probability that external edges were present in younger stages of growth. In my second specimen, which is a little larger, the external edges are obtusely rounded. Thus there is some probability in favour of their disappearing gradually in more advanced stages of growth.

The sculpture consists of radiating ribs, which are comparatively few in number, but sharp and marked very strongly in the umbilical region. They are completely obliterated in the vicinity of the external margin. Fourteen ribs are counted within the circumference of the last volution (18 in Waagen's type-specimen). All the ribs are perfectly straight.

Dimensions.

Diameter of the shell	25	mm.
„ „ „ umbilicus	10	„
Height of the last volution	8	„
Thickness of the last volution	4·5	„

Sutures.— Agreeing closely with those of *Xenodiscus radians*. Lobes and adjoining saddles of equal width. The lobes are faintly serrated, but their ceratitic

development is only visible if they are examined by means of a magnifying glass. In Waagen's type-specimen the sutures are so badly injured that no clear idea of their arrangement can be gathered.

Locality and geological position. Number of specimens examined.—Lower division (Otoceras beds ?), S. E. of Muth, 1, coll. Hayden; 5 miles S. of Ensa, 1, coll. Hayden.

Remarks.—The identity of this Himálayan form with the Salt Range species is pretty certain, although the slight difference in the shape of the external region may leave a shade of doubt.

8. XENODISCUS NIVALIS Diener. Pl. XXIV, figs. 1, 2, 3, 5, Pl. XXV, fig. 5.

1897. *Danubites nivalis* Diener, Cephalopoda of the lower Trias, Himálayan Foss., l. c. p. 51, Pl. XV, figs. 7, 8, 9.

"As a great number of examples of this common characteristic species are now available, its description as given by Diener can be completed in some respects. Especially well-preserved specimens were obtained by Mr. F. H. Smith from the Chocolate Limestone of lower Triassic age at Jolinka E. G., in the Kuti Yangti valley, Byans.

Measurements.

	I.	II. (Pl. XXIV, fig. 1.)	III.	IV. (Pl. XXIV, fig. 5.)
D	13·5 mm.	22 mm.	38 mm.	57 mm.
U	6·5 „	10 „	18 „	29 „
A	4 „	7 „	11 „	15 „
C	5 „	7 „	10 „	12 „
$\frac{D}{U}$	2	2·2	2·11	1·96
$\frac{A}{C}$	0·8	1	1·1	1·25

"The volutions of young specimens are broader than they are high, whilst this is reversed in adult ones. Width of the umbilicus approximately one-half of the diameter.

"*Sculpture.*—The radial folds in some specimens become very broad and are more like knobs than ribs. They very often reach their greatest elevation, not in the vicinity of the siphonal edge, but somewhat lower down on the sides, occasionally even near the umbilical edge. These characters vary even in one and the same specimen. According to the breadth of the ribs or knobs, their number ranges from seven to twelve in one volution. The ribs are in some instances rather sharply defined, the intercostal valleys being flat, whereas in others they pass more gradually into these intercostal depressions, which are equally rounded.

"In several specimens the outlines of the shell are more or less irregular or wavy, due to the sculpture crossing the external part.

"Diener has already noticed that the sculpture changes on the body-chamber, the ribs being thinner and more numerous. The specimen illustrated on Pl. XXV,

fig. 5, shows that this change occasionally takes place before the body-chamber has been reached. The ribs, which become more delicate, cross over the external part in a forward-bent curve.

"The contractions mentioned by Prof. Diener are clearly visible in several of my specimens and they partially account for the wavy outlines alluded to above. They are seen on the external part of the shell only, being broad and indistinctly bordered behind, while in front there is a steep but low incline. These contractions are more prominent in the inner whorls and disappear completely in adult specimens.

"*Body-chamber.*—Greatest length of the body-chamber, observed in the specimen illustrated on Pl. XXV, fig. 15, a little more than one-half volution.

"Only fragments of the shelly substance have been preserved.

"*Sutures.*—Delicate denticulations have been noticed in the lateral lobes of several specimens. The two branches of the siphonal lobe terminate in sharp points and are not rounded below. Umbilical lobe consisting of a sharp point at the inner slope of the second lateral lobe, and of a curved line connecting this point with the umbilical suture. A noteworthy feature of this species is the irregularity of the distances between the septa, which points to an irregularity in the progress of growth.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, 1 mile N. of Lilang, 1, coll. Krafft; S.E. of Muth, Spiti, 8, coll. Hayden; 6, coll. Krafft. Chocolate Limestone, Jolinka E. G., Byans, 30, coll. Smith.

"*Remarks.*— *Xenodiscus nivalis* is very nearly allied to *Dinarites coronatus* Waagen (Fossils from the Ceratite formation, l. c. Pl. VII, fig. 9) from the Ceratite sandstone of the Salt Range. The only noteworthy difference is that the volutions grow more rapidly in height in the Salt Range species. As all the numerous specimens from the Hedenstrœmia beds of the Himálayas differ in this respect, it appears certain that the two species are not identical."

A species very closely allied to the present one has been described by Schellwien as *Xenodiscus tanguticus* (Palæozoische und triadische Fossilien aus Ostasien, in Futterer: Durch Asien, III, p. 159, Taf. V, fig. 2) from the lower Trias of the Semenow Range (Kwen-lun Mountains). His species is, unfortunately, based on very fragmentary materials only. So far as I am able to judge from Schellwien's illustrations, *Xenodiscus tanguticus* is not identical with *Xen. nivalis*, the marginal elevations of the lateral ribs being still more prominent than in the Indian form and assuming the shape of true thorns, as in *Tirolites*, and the sutural line differing in the absence of an auxiliary lobe.

9. Xenodiscus nov. sp. ind. ex. aff. nivalis Dien. Pl. XXIV, fig. 4.

There is among Mr. Hayden's collections from the Hedenstrœmia beds of Ensa a single specimen of *Xenodiscus* of very large size, which undoubtedly belongs to a new species with relationship to *Xenodiscus nivalis*. On the label it is marked

as *Xenodiscus cf. nivalis* in A. v. Krafft's handwriting, but it is certainly specifically different from this form, although its deficient state of preservation prevents me from proposing a new specific name.

Dimensions.

Diameter of the shell	94 mm.
„ „ „ umbilicus	51 „
Height of the last volution	25 „
Thickness of the last volution	14 „

$\frac{D}{U} = 1{\cdot}84 \quad \frac{A}{C} = 1{\cdot}78.$

The specimen, which is a full-grown individual, has somewhat elliptical outlines and shows very numerous evolute whorls within the umbilicus. The umbilicus is proportionately wider than in the largest specimens of *X. nivalis*. Nor do the proportions of height and thickness conform to what might be expected in examples of the latter species of equal size. The aperture of the last volution is nearly twice as high as broad, whereas in the majority of adult examples of *X. nivalis* these two dimensions are equal, and even in the largest type known (Pl. XXIV, fig. 5), the height of the transverse section does not greatly exceed the width.

Another difference consists in the shape of the external area, which is almost flat and approximately biangular, being bordered by obtuse edges.

The sculpture closely resembles that of *Xenodiscus nivalis* without, however, being absolutely identical. One half of the last volution has been preserved sufficiently well to show its ornamentation distinctly. It bears about eleven straight ribs, some of them acute and some more bulky, but in general narrower than I have ever seen them in the body-chamber of *Xen. nivalis*. The majority of the ribs have a perfectly radial direction, but some of them are bent somewhat backwards, exactly as in the large specimen of *Xen. nivalis* from Lilang to which allusion has been made above. The intercostal valleys are considerably broader than the ribs. It is only in the vicinity of the aperture that the distances between the ribs become irregular. The greatest height of such ribs as have not been injured by weathering, has been noticed to occur somewhat below the marginal region, but never along the siphonal margin itself. The ornamentation can in some degree be traced across the external part, the outline of which is accordingly somewhat wavy.

In the inner volutions, whose surface has been almost entirely destroyed, indistinct round knobs are seen in one place only. Nothing definite can be said therefore as to their sculpture.

Length of the body-chamber approximately 215°. No trace of the shelly substance preserved.

Sutures.—Only a small part of the last septum is known to me. On the siphonal area a portion of the external saddle can be detected. The principal lateral lobe is apparently of considerable length, agreeing in this respect with the corresponding sutural element in *X. nivalis*.

Geological position. Locality. Number of specimens examined.—Hedenstrœmia beds, 5 miles S. of Ensa, 1, coll. Hayden.

10. XENODISCUS ASIATICUS v. Krafft. Pl. XXVI. fig. 5.

Measurements.

Diameter of the shell	cca. 114	mm.
„ „ „ umbilicus	49	„
Height of the last volution	38	„
Thickness of the last volution	30.5)	„

$\frac{D}{U}$ = cca. 2·32 $\frac{A}{C}$ = cca. 1·26.

This is the largest species of *Xenodiscus*, and is of particular interest, being closely allied to a form from the upper Werfen beds of the south-eastern Alps which has been described as *Paraceratites prior* by Kittl.

The only specimen by which this species is represented in the Himálayan collection is fairly complete, but weather-worn, especially so in the vicinity of the anterior termination of the last whorl. The measurements given above are therefore not quite reliable. But the proportion given for height and thickness cannot be very much beside the mark, as in another part of the last volution, where these dimensions can be measured more accurately, I obtained the quotient 1·23.

In its involution this species agrees with the preceding one, but resembles *Xenodiscus nivalis* much more closely in its transverse section. The whorls have a squarish cross-section, being slightly higher than broad. The greatest thickness coincides approximately with the middle of the height. Both the siphonal and umbilical margins are rounded; especially the latter, from which the umbilical wall slopes gently and regularly towards the umbilical suture. The siphonal part is broadly rounded.

Although the surface has been partly injured by weathering, the sculpture is very clearly marked. It consists of lateral, radial folds, terminating in large spines along the siphonal margin. As each whorl only just covers the siphonal part of the preceding one, without enveloping the flanks, the marginal spines of the inner volutions usually stand out quite free, without coming into contact with the umbilical wall of the following whorl.

The last volution bears approximately fourteen ribs, the penultimate one nine or ten, and the next inner volution apparently not more than seven.

In the penultimate whorl the ribs appear to be very short and rise suddenly into marginal spines, which are very strongly developed. No umbilical tubercles occur, but in the last volution elevations are in some places seen in the umbilical region of the sides, less strong and more rounded than the marginal spines, but generally speaking the ribs are confined to the upper portion of the sides. Nowhere do any secondary ribs occur.

The marginal spines do not increase in the same proportion as the dimensions of the whorls, for those seen in the last volution are not much larger than those of the penultimate volution. It appears from the increasing number of the spines

that the width of the interstices bears no proportion to the dimensions of the whorls.

No traces of the shell have been preserved.

Length of the body-chamber 270° or three quarters of the last volution. The actual peristome cannot have been situated much in front of the aperture.

Sutures.—The sutural line is not entirely known, nor can it be made out sufficiently well to be separately figured. Neither the siphonal lobe nor the siphonal saddle are visible. There are two lateral lobes present, but only one lateral saddle. The apex of the second lateral saddle is divided by the umbilical suture.

Locality and geological position. Number of specimens examined.—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden.

Remarks.—A. v. Krafft described this species as *Tirolites asiaticus* nov. sp., although not without considerable hesitation. "This new species"—he writes—"differs from *Tirolites injucundus*, and also from any of the European types in its slowly increasing whorls. In addition to this it attains a much greater size, the diameter being approximately twice that of most European species. It therefore represents a new group of forms, which is, moreover, characterised by a body-chamber at least one quarter of a volution longer than is generally met with in *Tirolites*."

There can be no doubt that in this species the similarity in sculpture with *Tirolites* is even more remarkable than in *Xenodiscus nivalis*, and that the small number of sutural elements is also a feature common to *Tirolites*. But on the other hand the very large number of slowly increasing whorls points decidedly to a species with a relationship to *Xenodiscus nivalis*.

Paraceratites prior Kittl (Die Cephalopoden der oberen Werfener Schichten von Muć in Dalmaten, Abhandl. K. K. Geol. Reichsanst. XX. p. 29, Taf. XI, figs. 4, 13) appears to be nearly allied to the present species. It is less evoluto and its whorls increase more rapidly, but in cross-section, sculpture, and arrangement of the sutural line, the two forms resemble each other very closely.

Genus: FLEMINGITES Waagen.

1892. *Flemingites* Waagen, Records, Geol. Surv. of India, XXV, p. 184. Jahrb. K. K. Geol. Reichsanst. XLII, p. 380.

1895. *Flemingites* Waagen, Salt Range fossils, Palæont. Indica, ser. XIII, Vol. II, Fossils from the Ceratite formation, p. 90.

1897. *Flemingites* Diener, Himálayan fossils, Palæont. Ind., ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 90.

1902. *Flemingites* Frech, Lethæa Palæozoica, II, p. 638.

1904. *Flemingites* J. P. Smith, Comparative Stratigraphy of the marine Trias of Western America, Proceed. Californ. Acad. of Sciences, 3rd ser., Vol. I, p. 377.

1905. *Flemingites* Hyatt et Smith, Triassic Cephalopod genera of America, U. S. Geol. Surv. Prof. Pap. No. 40, p. 120.

Four species belonging to the genus *Flemingites* were described by myself in 1897 from the lower Trias of the Himálayas. One of them, which I compared

to *Fl. trilobatus* Waagen, has been re-described by A. v. Krafft under the new specific name of *Fl. Griesbachi*, after much larger and better preserved materials had been collected by himself and by Mr. H. Hayden.

With regard to *Flemingites Rohilla* Dien. a few remarks only have been added by A. v. Krafft to my original description, regarding the true character of the median prominence in the siphonal lobe.

No new specimens of *Fl. Salya* Dien., in a satisfactory state of preservation, were available for examination.

Fl. Guyerdeti Dien., from the horizon of *Otoceras Woodwardi*, has not been found again. This species is the only one of the genus occurring in beds older than the Hedenstrœmia stage.

To these four species a fifth has been added by A. v. Krafft, the materials of which, however, prove to be too scanty to justify the introduction of a new specific name.

Ammonites peregrinus Beyrich (Ueber einige Cephalopoden aus den Muschelkalk der Alpen, etc. Abhandl. Kgl. Akad. Wiss. Berlin, 1867, p. 123, Taf. V, fig. 4), from the lower Trias of Ladakh, has been grouped with *Flemingites* by Frech (Ueber Triasammoniten aus Kashmir, Centralblatt für Min. etc. 1902, p. 134) on account of the strong denticulations of its lateral lobes.

The true systematic position of *Flemingites* is still uncertain, although there is some probability in favour of its being a branch of the genus *Ophiceras* Gries., as has been suggested by Frech (Lethæa, l. c. p. 638). In *Flemingites prænuntius* an intermediate shape has been described by that author (Centralblatt l. c. p. 135). This species, from the lower zone of the Ceratite marls, has spiral lines, but no radial sculpture or faintly serrated lateral lobes, as are seen in *Ophiceras*, but agrees with *Flemingites* in the presence of a distinct auxiliary lobe and saddle and of a very deep antisiphonal lobe. *Flemingites Guyerdeti* Dien., which is likewise older than the typical species of the genus from the Salt Range, is also devoid of any radial sculpture, but has only a short umbilical lobe.

On the other hand one might suppose with nearly equal reason, that *Xenodiscus*, not *Ophiceras*, was the real ancestor of *Flemingites*. This suggestion appears to be justified by the remarkable similarity of *X. plicatus* Waag. and *Flemingites radiatus* Waagen (Ceratite formation, l. c. p. 197, Pl. XI, fig. 1). Waagen, it is true, states that even in the most strongly sculptured species of *Flemingites* the inner volutions are perfectly smooth, but his illustrations on Pl. XI, figs. 1*a* and 3*a* are not in accordance with this statement.

I agree therefore with J. Perrin Smith in the opinion that the derivation of *Flemingites* is still unknown, and that its relationship with *Gymnites* and with the subfamily of *Gymnitinæ* in general is rather doubtful.

1. Flemingites Rohilla Diener. Pl. XXII, fig. 3.

1897. *Flemingites Rohilla* Diener, Himálayan Foss., Palæont. Ind., ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 93, Pl. XVIII, figs. 2, 3, 4, Pl. XXIII, fig. 1.

In the Himálayan collection this species is represented by a considerable number of specimens, among which fairly well preserved examples are, however very much in the minority. A. v. Krafft had therefore but very little to add to my original description. He also remarked on the great variability in the strength of the ribs, to which no special importance could be attributed. All his specimens were entirely chambered, with only very small parts of the body-chamber adhering occasionally to the last septum.

The only point in which he differs from my diagnosis of this species, is the description of the sutural line.

"As regards the sutural line" he says "I must correct an inaccuracy into which Diener was led by the peculiar way in which one of his type-specimens was preserved. Diener described the median prominence of the siphonal lobe as high, with almost parallel sides and with a flatly arched apex, which bears a very small incision on either side. But these are not the real outlines of the siphonal prominence. The drawing in Diener's memoir must have been taken from a curious line evidently produced by weathering, which I noticed in specimen Pl. XXIII, fig. 1. This line starts from the siphonal lobe and forms, so to speak, a roof over the actual median prominence. The latter is indeed tolerably high, but not as high as Diener supposed. Its top is of a more or less highly rounded shape, and has no such high-standing incisions as are indicated in the figure accompanying Diener's description.

"A second example illustrated by Diener on Pl. XVIII, fig. 2, shows a siphonal prominence, which agrees with that noticed in my Himálayan examples (see figure of sutures in my specimen illustrated on Pl. XXII, fig. 3).

"Diener compared *Flemingites Rohilla* with *Fl. glaber* Waagen (l. c. Pl. III, fig. 2), as he believed the siphonal prominence to be very similar in both species. Any such resemblance is, of course, fictitious, as it relies on the error alluded to above."

A re-examination of my type-specimen has convinced me of the correctness of A. v. Krafft's observations. I do not hesitate therefore to accept his view as to the advisability of removing *Flemingites Rohilla* from the group of *Fl. glaber*.

Geological position. Locality. Number of specimens examined.—Hedenstræmia beds, S. E. of Muth, Spiti, 10, coll. Hayden, 1, coll. Krafft.

2. Flemingites muthensis v. Krafft. Pl. XXII, fig. 2.

Measurements.

	I.	II.
D	65 mm.	app. 98 mm.
U	27 „	40 „
A	22·5 „	26 „
C	16 „	? „
$\frac{D}{U}$	2·4	2·4

"This species is closely allied to *Flemingites Rohilla* Dien., but can be distinguished by its much more robust and more regular sculpture. The affinity with *Flemingites Rohilla* is evident from the similarity in general shape, transverse section and sutures.

"Siphonal part flattened, with sharp marginal edges, including a narrow siphonal area. Maximum thickness situated below the middle of the sides. These are flatly curved on their outer halves, but strongly arched in the umbilical region, and descend in a steep curve towards the umbilical suture. There is no umbilical edge present.

"The sculpture consists of stout knobs protracted into short ribs, which are sometimes highest either near or below the middle of the height of the lateral parts. Although these ribs broaden out and become almost obliterated in the direction of the siphonal part, the sculpture may be said to cross the external area, as the latter bulges out along the radius of each rib, thus producing a somewhat polygonal outline. This character is especially well marked in my type-specimen, which is of moderate size, much more so than in large examples. Whether the sculpture changes on the body-chamber or not cannot be decided, as in neither of my two specimens can the length of the body-chamber be made out with certainty. But the anterior portion of my larger specimen, which, so far as can be ascertained, is less distinctly sculptured than the rest of the last volution, probably belongs to the body-chamber.

"Indistinct spiral striations can be seen locally in the smaller specimen.

"*Sutures.*—Similar to those of *Flemingites Rohilla*. The external saddle is not denticulated along its inner slope. Siphonal prominence not entirely known. The second lateral lobe bears the same oblique denticulation as is seen in *Fl. Rohilla*.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 2, coll. Hayden."

3. Flemingites Griesbachi v. Krafft. Pl. XXII, fig. 1, XXIII, fig. 1, Pl. XX, figs. 2-5 (sutures).

1897. *Flemingites sp. ind. ex aff. trilobato* (Waag.) Diener, Himál. Foss. Pal. Ind., ser. XV, Vol. II, Pt. 1 Cephalopoda of the lower Trias, p. 91, Pl XVII, fig. 2.

Measurements.

	I. (Diener's type.)	II. (Pl. XXIII, fig. 1.)	III. (Pl. XXII, fig. 1.)
D .	67 mm.	110 mm.	120 mm.
U .	23 „ *	35 „	44 „
A .	27 „	46 „	48 „
C .	14 „	24 „	? „
$\frac{D}{U}$.	3·04	3·14	2·93

* The actual width of the umbilicus is 23 mm. As this specimen has no shell, while the other specimens have part of the shell preserved, which was taken into account when measuring the width of the umbilicus the diameter of the umbilicus in specimen I is given as 23 mm., the difference of 1 mm., corresponding approximately to the double thickness of the shell in a small specimen.

"This species was first collected by Mr. C. L. Griesbach S. E. of Muth, Spiti, and described by Prof. Diener. Scarcity of material prevented Diener from giving it a new specific name. He compared it to *Flemingites trilobatus* Waagen, with which he found it to agree, especially in the character of its sutures. Among the recent collections of *Flemingites* made by Mr. Hayden this species is, with the exception of *Fl. n. Rohilla*, the most common type. Thanks to the large number of well preserved specimens now available, the species can be more fully described and named specifically.

"As far as conclusions can be drawn from measurements of my type-specimens, the involution appears to decrease slightly during their growth. This is, however, not quite certain, as the measurements are not entirely reliable. The thickness of the last volution, especially near its anterior termination, could not be measured exactly in any of my specimens. But where I was able to measure height and thickness of the whorl at any other place, I found the last volution to be a little less than twice as high as broad.

"In well-preserved specimens the external part is broadly rounded. It does not pass gradually into the lateral parts, but is separated from the latter by obtuse marginal edges. Now ere did I observe sharp marginal edges in unweathered specimens. In one of my specimens the inner volutions show the external part rounded off almost evenly. There are, however, several weathered specimens, in which the marginal edges are of acute shape—the result of the weathering, which has attacked one of the sides more strongly than the siphonal part. Diener's type-specimen is a weathered specimen of this character. Diener, consequently, was led to believe that the inner whorls of this species are provided with sharp marginal edges.

"The largest transverse diameter is situated somewhat below the middle of the height of the lateral parts. The flanks are curved rather strongly near the umbilicus and join the umbilical suture without forming any distinct edge. Umbilical wall low and vertical.

"*Sculpture.*—The sides bear straight, radial ribs, dying out gradually towards the umbilical and siphonal regions. Their highest elevation is slightly below the middle of the lateral parts. The ribs vary somewhat in number and strength, but Diener could not ascertain whether the unequal strength of the ribs was due to weathering or not. This question can now be easily decided, the irregularity being clearly original. The figured specimens exhibit distinct sculpture on the inner volutions also, whereas in the type described by Diener the sculpture of the inner whorls has been destroyed.

"Counting the stronger ribs only, we find that approximately ten of them occur in one volution. The ribs appear to increase in strength in proportion to the dimensions of the specimen. My largest specimen, attaining a diameter of 246 mm., shows very stout ribs near the end of the chambered part of the shell, and these ribs are separated by deep and rounded intercostal valleys.

"Definite statements as regards the sculpture of the body-chamber are out of the question, as the only two specimens of *Fl. Griesbachi* with their body-chambers preserved are badly damaged and crushed in the anterior part of the last volution.

It appears, however, that the sculpture becomes more delicate again and the ribs more numerous. The specimen illustrated on Pl. XXII, fig. 1, might justify us in assuming that two or three ribs together form radial elevations separated by deep furrows; but whether these apparent elevations and furrows were original, or have been produced merely by weathering must be left undecided.

" Remnants of the shelly substance, with the characteristic spiral striations, have been preserved in several of my specimens.

" *Body-chamber.*—The length of the body-chamber is apparently 295° in the specimen illustrated on Pl. XXIV, fig. 1. In my largest example more than one-half of the last volution belongs to the body-chamber. The specimen illustrated on Pl. XXIII, fig. 1, is almost entirely chambered.

" *Sutures.*—The illustrations of the sutural lines of four specimens tend to show the variability prevailing in the arrangement of the sutural elements. This variability is so marked that we must conclude that, in *Flemingites*, the sutures are altogether of little systematic value ; for were we to classify the specimens here described according to this character, we should be obliged to introduce almost as many species as there are specimens.

" The siphonal lobe and its median prominence are seen in specimen I. The median prominence is of great height and richly denticulated along its sides. The siphonal lobe reaches in this specimen almost as low down as the principal lateral lobe, whereas in specimen IV it is very shallow. The external saddle in specimens I and II is almost as high as the principal lateral saddle, in specimen III distinctly lower, but in specimen IV higher. The lateral saddles are also subject to variation in height, shape, and in the manner in which their sides are denticulated, but it is hardly necessary to describe the features of the various specimens in detail. Variations are also seen in the umbilical lobe.

" *Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 10 (many of them fragments), coll. Hayden; Lilang, 1, coll. Krafft; 5 miles S. of Ensa, 6, coll. Hayden. Chocolate Limestone, Kuti, Byans, two doubtful specimens, coll. Smith.

" *Affinities.*—This species must in the first instance be compared to *Flemingites trilobatus* Waagen, to which it is closely allied, according to Diener. I must confess myself unable to decide the question of affinity, but it appears certain that similarities in the arrangement of the sutural line do not suffice to establish a close relationship between species of this genus.

" Waagen's diagnosis was based on the description of a single fragment, whose characters are not very distinctly marked. The arrangement of the spiral striations of the shell is approximately the same in the Salt Range and in the Himálayan species, the concentric striæ diminishing in strength the nearer they approach the umbilical region. But it is doubtful whether or not this character is really of systematic importance.

" Diener was probably right in comparing the two species, but it is utterly impossible to decide the question of identity, taking into consideration the defective state of preservation of Waagen's type-specimen.

"We are, moreover, justified in doubting the specific independence of *Flemingites trilobatus*, which may perhaps be identical with *Fl. flemingianus* de Kon. The involution, transverse section and sculpture are certainly sufficiently similar to warrant the supposition that the specimen described as *Fl. trilobatus* by Waagen represents an inner whorl of *Fl. flemingianus*.[1] Unfortunately, both in the large specimen of *Fl. flemingianus* Waagen[2] (Salt Range Foss. l. c. Pl. XII, XIII) and in this specimen the inner whorls are damaged. I am therefore unable to arrive at a definite conclusion as to their identity.

"Leaving this question aside, we may compare *Flemingites Griesbachi* itself with *Fl. flemingianus*, as the large size attained by both species, and similarities in involution and sculpture, point to a very close affinity. As stated above, the inner whorls of *Fl. flemingianus* cannot be compared, because where present in the type of the latter species they are damaged. The penultimate and last volutions of *Fl. flemingianus*, so far as they consist of air-chambers, hardly differ in sculpture from *Fl. Griesbachi*. There is only a slight difference, as in the Salt Range species the external part is highly and evenly rounded, without any trace of marginal edges. Another difference in sculpture is seen in the very last portion of the chambered part of the shell. It is probable also that the body-chambers of both species were differently sculptured. In Waagen's type of *Fl. flemingianus* we have a number of rather closely set ribs, covering the sides of the four or five last air-chambers, but with the beginning of the body-chamber the sculpture changes abruptly.[3] The ribs become very much stronger, highly elevated near the middle of the lateral parts, and considerably more distant.

"If we now compare the largest specimen of *Fl. Griesbachi*, we find that a sculpture very similar to that in the body-chamber of *Fl. flemingianus* occurs in the last portion of the chambered part. This feature by itself would be of slight importance, since the change of sculpture may not always coincide with the beginning of the body-chamber, but what is of greater importance is the fact that the first part at least of the body-chamber, on the specimen mentioned, has what appear to be bundles of ribs, united into radial elevations. Waagen, it is true, speaks of thin folds on the body-chamber of *Flemingites flemingianus*, but they are much less distinct on his well-preserved specimen than the bundles of ribs are on the weathered body-chamber of *Fl. Griesbachi*. Thus the sculpture of the body chamber of *Fl. Griesbachi*, taken as a whole, cannot be said to agree with that of *Fl. flemingianus*.

"The body-chamber of my largest specimen, although damaged, must be supposed to have originally been more strongly compressed than in *Fl. flemingianus*. The furrow running along the middle line of the siphonal part of Waagen's types

[1] "According to Waagen the majority of the ribs in either species are alternately weaker and stronger (l. c., pp. 193 and 199)."

[2] "Waagen figured a second specimen on Pl. XIV, but this specimen is missing in the collection of types. It must have been lost along with two other specimens, since Waagen states (l. c., p. 201), that he and Mr. Wynne had collected four specimens altogether."

[3] "This is not shown enough in Waagen's illustration."

cannot be seen in my largest example, although the siphonal part is well enough preserved in one place.

"For the sake of comparison I give the measurements of Waagen's type and of the specimen mentioned. It will be seen that *Fl. flemingianus* is more evolute than any of the specimens of *Fl. Griesbachi*.

	Flem. Flemingianus (Waagen's type).	*Fl. Griesbachi* (largest specimen).
D	253 mm.	246 mm.
U	116 „	101 „
A	74(?) „	81 „
C	58 „	? „
$\frac{D}{U}$	2·18	2·43
$\frac{A}{C}$	1·27(?)	?

"I am therefore inclined to believe that *Flemingites Griesbachi* is closely allied to, but not specifically identical with, *Flem. flemingianus* de Kon, from the Ceratite Sandstone of the Salt Range."

4. FLEMINGITES nov. sp. ind. Pl. XXVIII, fig. 3.

"Among my collections from the horizon of *Hedenstræmia Mojsisovicsi* at Lilang there is a fragmentary specimen of a *Flemingites* with beautifully preserved spiral striæ. It may be specially mentioned as it belongs presumably to a new species.

"Transverse section compressed, being twice as high as broad. External part almost quite flat and provided with distinct, although somewhat obtuse marginal edges. Sides very flatly and regularly arched. Umbilical margin rounded off, umbilical wall high and sloping towards the umbilical suture in a regularly rounded curve. The whorls overlap one another but very little.

"Hardly any sculpture is seen on this specimen. In one place only could a very low radial rib be noticed, which becomes obliterated in the middle of the side, when a similar, but still lower fold, appears at some distance from the former. The spiral striation is unusually distinct, although most of the shelly substance has been weathered away. The striæ occur at irregular distances from each other, and are strongest near the external part and on the middle of the sides. In the umbilical region the striæ are seen less clearly, and the external part appears to be quite smooth.

"As no sutures are visible, the fragment must belong to the body-chamber.

"*Remarks.*—None of the Salt Range forms of *Flemingites* can be closely compared with the specimen from Lilang. *Flem. glaber* Waag. is, perhaps, the most similar in transverse section, but the external part is narrower and the maximum thickness less. All the rest of the congeneric species from the Salt Range differ considerably. *Flem. radiatus* Waag. and *Flem. rotula* Waag., two species very nearly allied, if not identical, with each other, have much flatter sides and more

prominent sculpture. Still more strikingly do the other species of *Flemingites*, as described by Waagen, differ from the present form.

"As the other Himálayan representatives of the genus *Flemingites* are likewise much more distinctly sculptured, we may suppose that this fragment belongs to a new species.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, Lilang, Spiti, 1, coll. Krafft."

5. FLEMINGITES sp. ind. ex aff. SALYA Dien. Pl. XXII, fig. 4.

There are two specimens in Hayden's collection from the Hedenstrœmia beds of Spiti, recalling *Flemingites Salya* Diener (Cephalopoda of the lower Trias, Himál. Foss. l. c. p. 96, Pl. XIX, fig. 1), but whether they are identical with that species or not, cannot be decided. They are strongly crushed and do not allow exact measurements of their transverse sections to be made. They are otherwise also too badly preserved to deserve a special description.

In one of the specimens the sutural line is fairly well exhibited. It agrees with the type of *Flem. Salya* in the general arrangement and even in the details of the configuration of lobes and saddles. It must, however, be borne in mind, that in the genus *Flemingites* great individual variability has been noticed in the development of the sutures, and that this character cannot therefore be considered to be of paramount specific importance.

Geological position. Locality. Number of specimens examined.—Hedenstrœmia beds, 5 miles S. of Ensa, Spiti, 1, coll. Hayden, S. E. of Muth, 1, coll. Hayden.

Remarks.—It is probably to *Flem. Salya* that the American representative of the genus, *Fl. Russellii* Hyatt et Smith (Triassic Cephalopod genera of America, l. c. p. 121, Pl. I, figs. 1-3, LXX, figs. 1-3), is nearly allied, although the relationship does not appear to be a very close one. They agree in their involution, but the American species has the siphonal part more narrowly rounded and the ribs in the outer volution less closely set. The short siphonal lobe in the sutural line is remarkable. It reaches only one-half the length of the principal lateral lobe, exactly as in *Flem. radiatus* Waag. It must, however, be mentioned, that Noetling (Beilageb. XIV, Neues Jahrb. f. Min., etc., p. 459) is inclined to consider *Flem. radiatus* as a juvenile individual of *Flem. flemingianus* only, not as a proper species.

Genus: OTOCERAS Griesbach.

1880. *Otoceras* Griesbach, Palæontological notes on the lower Trias of the Himálayas, Records, Geol. Survey of India, XIII, p. 105.

1897. *Otoceras* Diener, Himál. Foss. Palæont. Ind., ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 151.

To my diagnosis of *Otoceras* very little has since been added. It has been demonstrated by Frech (Lethæa Palæozoica, II, Dyas, p. 575, 629), who claims a generic rank for *Otoceras*, that in *O. Woodwardi* Griesb. the two branches of the

siphonal lobe eventually become bicuspidate. On re-examination of my type-specimens from the Otoceras beds of the Shalshal cliff I have not noticed this character in any of the other species, and even in *Otoc. Woodwardi* it is quite an exception. In the majority of examples each of the two narrow lateral branches of the siphonal lobe terminates in one single sharp point.

A species from the lower Triassic beds of the Ussuri district, resembling *Otoceras* in the inflated shape of its umbilical region, which I described as *Proptychites otoceratoides* (Mémoires Com. Géol. St. Pétersbourg, XIV, No. 3, p. 36, Taf. III, fig. 2), has been included in *Otoceras* by several distinguished authors (G. v. Arthaber, Frech, and Noetling). I cannot agree with this view. The Siberian species differs from *Otoceras* in one of its most essential characters, namely, in the shape of the siphonal part, which is neither acute, nor tricarinate, but regularly rounded. Another distinctive feature is the development of its siphonal lobe, which is deep, broad and strongly serrated. I must therefore insist on removing the Siberian species from *Otoceras*. Its external resemblance to the latter is only one of the many cases of convergence, which are noticed so often among groups of *Ammonoidea* developing along very different phyletic lines.

In accordance with E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 221), I think that the intimate relationship between *Otoceras* and *Hungarites* does not make the elevation of *Otoceras* to a proper genus necessary. But if a generic rank should be conceded to *Otoceras*, as has been advocated by Frech, its place must certainly be near *Hungarites*, which makes its first appearance together with *Otoceras* in the Permian rocks of Julfa (Armenia). I am not able to understand the reasons which induced Hyatt (Cephalopoda in Zittel's Text book of Palæontology, English ed., p. 553) to group it with *Nannites* in his section of *Nannitidæ*.

In 1897, but very few representatives of *Otoceras* were known to me from the lower Trias of Spiti, one single specimen only of *O. Clivei* from Kuling allowing of a specific determination. Hayden's and A. v. Krafft's collections have considerably increased the number of forms known from Spiti, but nevertheless *Otoceras* is met with there less frequently than in the Shalshal cliff or near Kiunglung E. G., on the southern slope of the Niti pass.

I need not enter into a detailed description of the specimens referable to the species enumerated in my memoir quoted above, as their examination has not led to any new results. The difficulty of distinguishing the different species has obliged me to abstain from a specific determination of the majority of the specimens collected by Hayden, which are either fragments of body-chambers or of which the sutural line cannot be made accessible to examination. Among these, specimens are represented from the following localities: N. N. W. of Kágá; 5 miles S. of Ensa; N. N. W. of Danksa E. G.; Ratang river; Rhár; S. W. of Gaichund. Among the species which I have been able to determine the group of *Otoceras fissisellatum* is not represented.

No specimens of *Otoceras* are as yet known from the lower Trias of the Lissar and Dharma valleys and of Byans.

1. Otoceras Woodwardi Griesb.

1880. *Otoceras Woodwardi* Griesbach *pro parte*. Palæontological notes on the lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, p. 105, Pl. I, fig. 4, II, figs. 2, 3, 6, *non* 1, 4, 5.

1897. *Otoceras Woodwardi* Diener, Himál. Foss., Palæont. Ind., ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 156, Pl. II, fig. 1, Pl. III. fig. 1, Pl. IV, figs. 2, 4, 5, Pl. V, figs. 1, 3, 5, Pl. VI. fig. 16.

1901. *Otoceras Woodwardi* Frech, Lethæa Palæozoica, Vol. II, Dyas, p. 575, fig. 4, p. 628.

Otoceras Woodwardi turns out to be the most frequent species of the genus both in the Shalshal cliff and in Spiti. In Hayden's collection ten specimens, allowing of a safe determination, have been noticed. They were found at the following localities: Khár; 5 miles S. of Ensa; S.E. of Muth; Kuling.

2. Otoceras cf. undatum Griesb.

1880. *Otoceras Woodwardi var. undata* Griesbach, l. c. p. 107, Pl. I, fig. 5.

1897. *Otoceras undatum* Diener, Himálayan Foss., l. c. p. 162, Pl. IV, fig. 6.

A fragmentary specimen, collected 5 miles S. of Ensa by Hayden, reminds me of *Otoceras undatum* by the presence of wavy folds on the lateral parts; but these folds are too indistinct to warrant a complete identification of the species.

3. Otoceras Clivei Diener.

1897. *Otoceras Clivei* Diener, Himálayan Foss., l. c. p. 161, Pl. III, figs. 2, 4, Pl. V, fig. 4, Pl. VII, fig. 17.

This species, which differs from *Otoceras Woodwardi* Griesb. in the smaller number of auxiliary elements outside the umbilical suture, is represented in Hayden's collections by four specimens from the following localities:—5 miles S. of Ensa; S. E. of Muth; S. W. of Gaichund.

4. Otoceras nov. sp. ind. aff. Clivei Diener. Pl. XXXIX, fig. 3.

There is a single fragmentary specimen from the Otoceras beds S. W. of Gaichund (coll. Hayden) which, although recalling *Otoceras Woodwardi* in the shape of its umbilicus and in the mode of its involution, must be separated from all species of *Otoceras* hitherto described on account of the peculiar character of its sutural line.

Only one distinct lateral lobe and saddle are developed, which agree tly with the corresponding elements in *O. Woodwardi*. But the large lateral saddle is followed immediately by a broad umbilical lobe, within which two low saddles are individualised among the remainder of the points and denticulations. We might consider the first as an equivalent of the second lateral and the second as principal auxiliary saddle. In this case the present suture would be comparable to that of *O. Clivei*.

A tendency to variation in the sutures of *O. Clivei*, directed towards the development of a very broad and coarsely serrated second lateral lobe, and a reduction of the second lateral saddle, might lead to a suture similar to that which

is seen in the present species. The suture illustrated is not confined to one single septum but can be noticed in all the septa accessible to examination.

This is another instance of the extraordinary variability of the sutures in *Otoceras*, as has been explained in my memoir on the Cephalopoda of the Himálayan lower Trias (l. c. p. 154).

Genus: Ceratites de Haan.

Ceratites pumilio v. Krafft. Pl. XXVI, fig. 3.

In the Himálayan collection two specimens were found with this name on their labels in A. v. Krafft's handwriting, but not accompanied by any description in the text. I consider the more complete specimen from the Hedenstrœmia beds S. E. of Muth (coll. Hayden) as prototype of the new species. Although poorly preserved and considerably injured, it is undoubtedly a true representative of the genus *Ceratites*.

Its measurements are as follows:—

Diameter of the shell		30 mm.
„ „ „ umbilicus		13 „
Height	of the last volution	15 „
Thickness	of the last volution	12 „

This is a widely umbilicated shell, with a square transverse section, the greatest thickness corresponding to the middle of the sides. The external part is smooth, flatly curved and provided with a very broad and low median keel. It is marked off from the lateral parts, which are almost flat, by a distinct marginal shoulder, which is not acute. Umbilical wall high and steep.

The inner volutions being almost entirely destroyed within the wide, open umbilicus, the sculpture is visible on the last whorl only. It consists of strong, radial ribs reaching from the umbilical edge to the marginal shoulder. They are nearly straight, directed radially and as broad as, or slightly broader than, the intercostal valleys. They are low and narrow in the vicinity of the umbilical margin, but broaden out towards the middle of the flanks, where they reach their maximum height. The majority of the ribs are perfectly straight, but some show a slightly falciform curve, being faintly curved forward near the umbilical and siphonal margins. They terminate abruptly along the marginal shoulder, without swelling into knobs or tubercles.

The aperture is situated a very short distance in front of the last septum. A very small part of the body-chamber only has thus been preserved.

Sutures.—Although partly injured by weathering, the sutural line can be followed with sufficient accuracy.

Siphonal lobe broad, serrated, with a high and rounded median prominence. External saddle lower than the principal lateral one. All saddles with regularly rounded tops and entire margins. Lateral lobes with delicate denticulations, which

are restricted to their very bases. Umbilical lobe with strong indentations, but no auxiliary saddle is individualised. The sutural line of this specimen has not reached a higher stage of development than in the majority of species of *Ophiceras* or *Xenodiscus*.

The second specimen, identified with *Ceratites pumilio* by A. v. Krafft, is a fragment from the nodular limestone (Niti limestone, Noetling) above the horizon of *Rhynchonella Griesbachi*, collected near Muth by H. Hayden in 1901. As the presence of this species and of *Tirolites injucundus* v. Krafft is the chief argument in favour of a correlation of the Niti limestone with the lower Trias (Scythian stage), I am obliged to say a few words about this specimen, which would otherwise not be worth mentioning. It is a very poorly preserved fragment, consisting of air-chambers only, as may be seen from the illustration on Pl. XXVI, fig. 4. That it belongs to the genus *Ceratites*, is pretty certain, but its identity with *C. pumilio* cannot be established with any probability. On the contrary, what is seen of the sculpture tends to show that there is some difference in the direction of the ribs, which are more distinctly sigmoidal in the specimen from the Niti limestone than in the prototype of *C. pumilio*. In the sutural line a distinct auxiliary saddle seems to be present, but this character could not be ascertained with precision.

It is obvious that no reliable conclusions can be based on materials in such a defective state of preservation.

Even the prototype of *Ceratites pumilio* is scarcely sufficiently well preserved to deserve a distinct specific name, were it not for the interest which attaches to it as being the only true *Ceratites* found up to the present in the lower Trias of the Himalayas. The pattern of its ribbing and the absence of any tubercles suggest its relationship to the group of *Ceratites circumplicati* (*Hollandites*). It agrees with typical species of this group in the shape of the cross-section and in sculpture. The presence of strong and broad ribs, which terminate abruptly along the marginal shoulder, thus causing the siphonal margin to exhibit a crenulated outline, and the development of a low keel in the middle of the external part, are features characteristic of the genus *Ceratites*.

On the other hand it cannot be doubted that our species has also a great resemblance to some species of *Xenodiscus* of lower Triassic age, especially as regards the development of the sutures and the comparatively wide umbilicus. If a larger number of intermediate links connecting *Xenodiscus* and *Ceratites* could be found, such a discovery would perhaps support the suggestion that *Xenodiscus* may represent the presumptive ancestor of the group of *Ceratites circumplicati*.

It will no doubt require many more exhaustive researches into the Cephalopoda of the lower Trias, to establish clearly the actual derivation of the group of *Ceratites circumplicati* (*Hollandites*), but the above suggestion may not be out of place here, as it corroborates the conclusion arrived at by my examination of the *Ceratitidæ* of the Muschelkalk, that even the Indian representatives of the genus *Ceratites* may have sprung from very different roots.

Remarks on Ceratites Mandhata Diener (l. c. p. 22, Pl. XVII, fig. 1).

In my memoir on the lower Trias of the Himálayas I described a specimen of an ammonite collected by Mr. Griesbach from the horizon of *Hedenstræmia Mojsisovicsi* S. E. of Muth, Spiti, which I classed with the genus *Ceratites*.

The advisability of grouping this specimen with *Ceratites* has been questioned by E. Philippi (Die Ceratiten des oberen deutschen Muschelkalkes, Palæont. Abhandl., Dames u. Kayser, N. F. Bd. IV. 1901, p. 436). The objections raised by Philippi have induced me to re-examine my Himálayan type-specimen. On the strength of this examination I am obliged to remove *Ceratites Mandhata* from the list of independent species. My type is a fragment not very satisfactorily preserved which I classed with the genus *Ceratites* on account of its general similarity with some of the species of *circumplicati* from the Himálayan Muschelkalk. It seems probable, however, that it belongs to *Flemingites* rather than to *Ceratites*, and that it is perhaps most nearly allied to the specimen of *Flemingites sp. ind. ex aff. trilobato* found by Mr. Griesbach at the same locality and in the same beds.

In my description I stated that the siphonal area of *Ceratites Mandhata* is highly rounded and that it passes into the lateral parts without the intervention of a marginal edge. Now, however, I must concede the possibility that the oval shape of the transverse section was merely due to the effect of weathering as the external part in one place, where it is not injured by weathering, appears to be obtuse and bordered by marginal shoulders. The characters of the external part, when complete, did therefore, perhaps, not differ considerably from those in *Flemingites Griesbachi* v. Krafft. I would further draw attention to the remarkable resemblance in general shape with the specimen determined by myself as *Flem. sp. ind. ex aff. trilobato*, for which A. v. Krafft has proposed the new specific name of *Flem. Griesbachi*.

In my type-specimen I considered a considerable amount of egression from the normal spiral line in the last volution to be one of the most prominent characters; or, in other words, the rapid decrease of involution in the vicinity of the anterior termination. On re-examination of this type I convinced myself of the correctness of this statement, finding indeed that the end of the body-chamber only touches the penultimate whorl. Nevertheless, I venture to doubt whether this feature can, in a specimen of such insufficient preservation, be safely attributed to a decreasing involution It may perhaps be explained on the assumption that the body-chamber was strongly deformed and crushed near the umbilical suture, and that this crushed part was afterwards weathered away, whereas the uninjured portion remained undestroyed.

The sculpture of the inner whorls of the specimen mentioned agrees with those in *Flemingites Griesbachi*. Its close affinity or even identity with this species must consequently be taken into consideration.

Remarks on Waagen's species of Ceratites from the Salt Range.—Among the notes left by the late Dr. A. v. Krafft a few remarks on this subject have

been found. Although the advisability of grouping any of the ammonites from the Triassic beds of the Salt Range with the genus *Ceratites* has since been discussed by Philippi in his valuable memoir on the Ceratites of the German Muschelkalk (l. c. p. 435), I do not hesitate to quote A. v. Krafft's remarks *in extenso*, as they were based on a personal examination of Waagen's type-specimens.

"I am far from being convinced," he writes, "that any of the species of *Ceratites*, described by Waagen, can suitably be classed with that genus. I shall have an opportunity of showing in the description of the new species of *Sibirites* from the lower Trias of Byans, that *Ceratites inflatus* Waagen (Ceratite formation, l. c. p. 40, Pl. X, fig. 1) and *C. patella* Waagen (l. c. p. 51, Pl. IV, fig. 2) probably belong to the genus *Sibirites* Mojs.

"*Ceratites sagitta* Waagen (l. c. p. 48, Pl. IV, fig. 3) has been founded on a specimen too insignificant to allow of a definite determination. The same remark applies to *Ceratites angularis* Waagen (l. c. p. 45, Pl. V, fig. 3) and to *C. disulcus* Waagen (l. c. p. 42, Pl. XI, fig. 7).

"*Ceratites Murchisonianus* Waagen (l. c. p. 43, Pl. IV, fig. 1) should perhaps have rather been placed in *Meekoceras*, with which it agrees in its transverse section and sutures (not figured by Waagen), whereas the sculpture—indistinct folds in the lower portion of the flanks—is too weak to distinguish it sharply from *Meekoceras*.

"In *Ceratites normalis* Waagen (l. c. p. 38, Pl. VI, fig. 2) the sculpture, consisting of small marginal tubercles which are connected by straight ridges crossing the siphonal area, differs considerably from the ornamentation of any species which has been classed with *Ceratites* by E. v. Mojsisovics.

"*C. dimorphus* Waagen (l. c. p. 46, Pl. XI, fig. 6) is represented by a single chambered nucleus of very small dimensions only, the sutures of which cannot be seen distinctly. *C. Wynnei* Waag. (l. c. p. 50, Pl. XI, fig. 5), is a cast with its whorls moderately inflated and nearly devoid of any sculpture. Its sutures are but very indistinctly preserved."

As will be seen from those remarks, A. v. Krafft in the results of his examination agrees entirely with Philippi, who likewise denies the presence of true Ceratites in the Triassic beds of the Salt Range.

Genus: PRIONITES Waagen.

PRIONITES nov. sp. ind. Pl. XXVII, fig. 1.

Measurements.

Diameter of the shell	67 mm.
„ „ „ umbilicus	20 „
Height of the last volution	25 „
Thickness of the last volution	18 „

$\frac{D}{U} = 3{\cdot}35 \qquad \frac{A}{C} = 1{\cdot}39.$

In the Hedenstrœmia beds of Muth two damaged ammonites were collected by Mr. Hayden, which will probably have to be placed in the genus *Prionites* Waagen (Ceratite formation, l. c. p. 52).

They have also a certain resemblance to *Ceratites normalis* Waagen (l. c. Pl. VI, fig. 2), but can easily be distinguished from this Salt Range species by the absence of an umbilical edge and by their consequently different transverse section. It appears certain that these two specimens belong to a new species, but as there is so far no sufficient material available for a satisfactory description, I abstain from proposing a new specific name.

The general shape of the shell must have been flatly discoidal, with a moderately wide umbilicus. Transverse section of trapezoidal outlines, with a broad and flattened siphonal part, which is separated from the flanks by distinct marginal edges. Largest transverse diameter situated somewhat below the middle of the height of the sides. The lateral parts are quite flat on the outer half. Below the middle they become curved and descend gradually to the umbilicus.

The lateral parts are smooth or provided with indistinct traces of knobs along the zone of maximum thickness only. Along the external edges rows of sharp lenticular tubercles occur, which run from the uppermost parts of the sides over the external edge in a diagonal direction. This sculpture, which is only very delicate, is best seen on the chambered part of the specimen figured, but it is also seen on the body-chamber. The number of small, lenticular tubercles is approximately 30 on one-half volution. External part devoid of sculpture.

In the specimen figured three-quarters of the last volution consist of air-chambers. The second specimen in the collection is a fragment measuring one-half volution, which belongs to the body-chamber. No shell is preserved.

Sutures.—Siphonal lobe narrow, with a low median prominence. Saddles rounded. The principal lateral saddle is the largest. Lobes regularly denticulated. The denticulations of the umbilical lobe form a straight line, without the slightest differentiation into auxiliary elements.

Geological position. Locality. Number of specimens examined.—Hedenstrœmia beds, S. E. of Muth, Spiti, 2, coll. Hayden.

Remarks.—In general shape, involution, transverse section and in the arrangement of the sutural line the present species agrees so closely with *Prionites*, that there is no reason for separating it from that genus. The majority of the species, from the Salt Range described by Waagen are provided with lateral tubercles which, if present at all, have been developed only very faintly in our Himálayan form. On the other hand the latter is distinguished by the development of a delicate marginal ornamentation, which has not been noticed in any of the Salt Range species.

A transverse section similar to that of our type has been observed also in *Ceratites inflatus* Waagen (Ceratite formation, l. c. p. 40, Pl. X, fig. 1), but this species belongs most probably to *Sibirites*, as has been demonstrated by A. v. Krafft, being very similar to a type occurring in the lower Trias of Byans.

A straight umbilical lobe also occurs in certain types of *Meekoceras*, for which Waagen introduced the genus *Prionolobus*, but the transverse section is entirely different in those types, and there is no sculpture.

Genus: Tirolites Mojs.

The absence of the genus *Tirolites* from the Indian region was regarded as a well-established fact by E. v. Mojsisovics and by myself, no representative of this genus, which is spread most abundantly throughout the upper division of the Alpine Werfen beds, having been met with in the rich collections of Cephalopoda from the Salt Range and Himálayas. Its occurrence in the lower Trias of Spiti is therefore of particular interest. In the Hedenstrœmia beds of Muth Mr. H. Hayden in 1898 collected a specimen of an ammonite, which A. v. Krafft in his preliminary report on the Triassic fossils from Spiti described as a new species of the group of *Tirolites spinosi*. After a personal examination of this specimen, which was sent to me in 1899, I could only confirm A. v. Krafft's determination, the correctness of which was further acknowledged by E. v. Mojsisovics, to whose examination the specimen had also been submitted.

Mr. Hayden's discovery is especially interesting, as the genus *Tirolites* had never before been obtained from India. It is, however, necessary to state that the genus, the chief leading fossil of the lower Trias in the Mediterranean region, is certainly of the rarest occurrence in the Indian province, and that it cannot be considered as an autochthonous ancestor of the Himálayan *Trachycerata*, which make a sudden appearance in the ladinic and carnic period.

Tirolites injucundus v. Krafft. Pl. XXVI, fig. 1.

1899. *Tirolites nov. sp.*, group of *T. spinosi*, A. v. Krafft, General Report, Geological Survey of India, for 1898-99, p. 14.

1904. *Tirolites injucundus* v. Krafft in Hayden, Geology of Spiti, Memoirs, Geological Survey of India, Vol. XXXVI, Pt. 1, p. 69.

Measurements.

D	57·5 mm.	D	=2·87
U	20 „	U	
A	21 „	A	=1·31
C	eca. 16 „	C	

A. v. Krafft's diagnosis of his type-specimen runs as follows:—

"Three quarters of the last volution have been fairly well preserved. Of these one quarter only consists of air-chambers, the rest belongs to the body-chamber.

"The inner volutions have been so strongly crushed and injured by weathering that a satisfactory description is excluded. Transverse section square-shaped. Greatest transverse diameter corresponding to the marginal shoulder.

"The lateral parts are very gently arched and join the siphonal part in a distinct although not acute edge. The siphonal part is broad and flatly curved. The sides assume a strong bend in the umbilical region and are separated from the high almost vertical umbilical wall by an edge, which is sharply rounded off.

"*Sculpture.*—On the last whorl there are six main ribs terminating in high spines along the siphonal edge. The ribs rise slightly above the umbilical margin

some of them forming there protracted knobs, while others are less prominent at the beginning. Above these umbilical knobs the ribs grow weaker, to swell up for a second time into the marginal spines. The outer (siphonal) slope of these spines does not lie in a line with the curve of the siphonal part, but forms with the latter a shallow concavity.

"Besides the main ribs weaker secondary ribs occur alternating with the former. These also rise near the umbilical edge, but are never very prominent there. Instead of terminating in spines like the main ribs, they gradually die out towards the siphonal edge. These secondary ribs keep approximately to the middle of the interstices between the others and disappear soon after the body-chamber has been reached, only one pair being seen distinctly on that part of the last volution.

"The siphonal part at the anterior termination of our specimen bears very indistinct cross-folds, describing a flat semi-circle, with its convex side turned towards the aperture In one place a shallow furrow is seen, running parallel with the low, curved folds just described.

"My specimen is an inner cast, without any trace of its shelly substance preserved.

"*Sutures.*—The sutural line exhibits the primitive stage of development characteristic of *Dinarites* and *Tirolites*. It shows only two lobes and saddles outside the umbilical suture. The lobes are serrated, the saddles broad and low.

"Siphonal lobe narrow, divided by a low median prominence, each of its wings with two small indentations. The indentations of the lateral lobe are so delicate that they are barely visible to the naked eye. The inner slope of the lateral saddle reaches down to the umbilical suture, without forming a distinct lobe."

Remarks.—Since A. v. Krafft's notes were written, E. Kittl's important memoir on the Cephalopoda of the upper Werfen beds from Muć in Dalmatia (Abhandl. K. K. Geol. Reichsanst., 1903, XX, Heft 1) has been published. In this memoir the genus *Tirolites* is treated much more exhaustively than in the "Cephalopoden der Mediterranen Triasprovinz" by E. v. Mojsisovics.

E. v. Mojsisovics divided the species of *Tirolites* into the groups of *seminudi* and *spinosi*. According to his diagnosis the first is characterised by smooth inner whorls, whereas in the second the whorls are sculptured throughout, with the exception of the inner nucleus only, which is but very rarely accessible to examination. As the inner whorls are crushed and cannot be examined in the present specimen, we should be at a loss to decide to which group our species really belongs, if we had to rely only on the diagnosis given by E. v. Mojsisovics. It has, however, been demonstrated by Kittl that the two groups are also distinguished by a different development of their sutural lines. All the representatives of the *Tirolites spinosi* are provided with serrated lobes. It is, therefore, in this group of European *Tirolites* that our Himálayan form must be included.

Of the European species of *Tirolites* which may be compared with our Himálayan form, there is first *Tirolites spinosus* E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 70, Pl. 1, fig. 10,

Pl. II, figs. 1, 2, 3), which has been illustrated by Kittl on Pl. IX, fig. 7, of his above-quoted memoir. Our species closely resembles fig. 1*b* on Pl. II of Mojsisovics' memoir in transverse section, but the sculpture is different. Not only is the number of ribs greater in the European species, but this latter entirely wants the secondary ribs occurring in the chambered part, and at the commencement of the body-chamber, in the specimen from Muth. Nor are the ribs in *Tirolites spinosus* by any means so prominent in the umbilical region as they are in the Himálayan species.

A second European species comparable to the present one is *Tirolites cassianus* Quenstedt (E. v. Mojsisovics, l. c. p. 70, Pl. II, figs. 4-8, Kittl, l. c. p. 54, Pl. IX, figs. 4-6). Here we meet the same differences in ornamentation as have been pointed out above with reference to *Tirolites spinosus*, and moreover its transverse section is much more compressed than in *T. injucundus*. On the other hand it must be remarked that secondary ribs, which do not terminate in marginal spines, have been noticed occasionally in *T. cassianus*.

A third species of the group of *T. spinosi*, which might put in a claim for closer comparison with the present one, is *Tirolites Haueri* v. Mojsisovics (l. c. Pl. III, figs. 2, 3, 4), which Kittl considers to be only a local variety of *T. spinosus* (l. c. p. 56, Pl. IX, figs. 8-13). I should especially like to compare the Alpine specimen illustrated in fig. 4 by E. v. Mojsisovics, as it appears to have a high umbilical wall, similar to that of *T. injucundus*. In its transverse section our Himálayan species agrees even more nearly with *T. Haueri* than with *T. spinosus*. Yet *T. Haueri* cannot be said to agree with *T. injucundus* in its sculpture. Its ribs are more numerous, inequidistant, and marked less strongly in the umbilical region.

To *Tirolites injucundus* a second specimen has been referred by A. v. Krafft, which was collected in 1901 by H. Hayden, S. E. of Muth, Spiti, at the base of the Niti limestone, six inches above the beds with *Rhynchonella Griesbachi*. This example is more complete than the type-specimen, but has been so greatly injured by weathering that its sculpture has been almost entirely destroyed. Near the beginning of the last volution two straight ribs or pilæ are noticed crossing the lateral parts in a radial direction, but exhibiting neither umbilical nor marginal tubercles. In the last volution indistinct traces of spines occur both in the umbilical and marginal regions.

An illustration of this specimen is given on Pl. XXVI, fig. 2. Its identification with *Tirolites injucundus* is far from being established with any probability. I should rather be inclined to refer it to one of the more primitive forms of the genus *Ceratites* than to *Tirolites*. It is certainly not fit to serve as proof of a stratigraphical correlation of the Niti limestone with beds of lower Triassic age.

Genus: SIBIRITES v. Mojsisovics.

1886. *Sibirites* E. v. Mojsisovics, Arktische Triasfaunen, Mém. Acad. Impér. des sciences, St. Pétersbourg, VII, sér. T, XXXIII, no. 6, p. 58.

1893. *Sibirites* E. v. Mojsisovics, Cephalopoden der Hallstætter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 327.

1895. *Sibirites* Waagen, Fossils from the Ceratite formation, Salt Range fossils, Palæont. Indica, ser. XIII, Vol. II, p. 104.

1895. *Sibirites* Diener, Himálayan Foss., Palæont. Ind., ser. XV, Vol. II, Pt. 2, Cephalopoda of the Muschelkalk pp. 37, 101.

1896. *Sibirites* (*Anasibirites*) E. v. Mojsisovics, Beitræge zur Kenntnis der obertriadischen Cephalopodenfaunen des Himálaya, Denkschr. Kais. Akad. d. Wiss. Bd. LXIII, p. 615.

1893. *Sibirites* (*Anasibirites*) E. v. Mojsisovics, Himálayan Foss., ser XV, Palæont. Ind., vol. III, Pt. 1, upper Triassic Cephalopod faunæ, p. 49.

"The genus *Sibirites*, as proposed by E. v. Mojsisovics in 1886, was intended to accomodate types occurring in the lower Trias of the Olenek beds and in the upper Triassic beds of norio age in the Eastern Alps and Himálayas

"E. v. Mojsisovics gave the following diagnosis of the new genus, of which the Siberian species must be considered as the prototypes:—'Shells small, consisting of moderately involute whorls, with a long body-chamber (one entire volution). Sculpture consisting of numerous, strong, straight, lateral ribs, most of them bifurcating near the external margin. The secondary, divided ribs, which cross over the external part, are much thinner than the primary lateral ribs. In the geologically older species they form an angle with its apex directed towards the front. In the geologically younger species from the Hallstatt limestone they generally pass in a straight line from one side to the other. In some of the younger species, which in their sculpture recall *Coeloceras pettos*, knobs or spines rise at the points where the ribs bifurcate. Sutures very simple, with entire saddles and two lateral lobes, which are slightly denticulated. Siphonal lobe deep. No auxiliary lobes present.'

"A somewhat abnormal development of the sculpture, which has not been noticed in any of the upper Triassic species, is exhibited in *Sibirites Eichwaldi* Keys. from the Olenek beds, according to E. v. Mojsisovics. This is a bifurcation of the ribs occurring on the lateral parts of the inner volutions.

"Two species of *Sibirites* of lower Triassic age were described by E. v. Mojsisovics in 1886, namely, *Sib. Eichwaldi* Keys. and *S. pretiosus* v. Mojs., both from the Olenek beds of north-eastern Siberia. In both species the external part of the inner volutions is smooth, the sculpture consisting of lateral ribs only.

"In 1893 E. v. Mojsisovics added a few remarks to this diagnosis, chiefly with respect to the upper Triassic species of *Sibirites* from the Hallstatt limestone (type *Sibirites spinescens* v. Hauer). The body-chamber of these forms is occasionally different in sculpture from the chambered part, the spines being situated near the umbilicus. As in the Siberian species, the external part of young individuals is smooth, lateral ribs only being present.

"In 1895 Diener recorded the first Himálayan species of *Sibirites* from Triassic beds older than the norie stage. One species, *Sibirites Prahlada* Dien., was found in the earthy limestone with *Rhynchonella Griesbachi* of the Shalshal cliff. This species is richly ornamented and bears some affinity to *Sib. pretiosus* from the Olenek beds. Diener pointed out that the horizon of *Rhynchonella Griesbachi*, containing *Sibirites Prahlada*, is separated from the layer of upper Triassic representatives of *Sibirites* by a large mass of deposits, comprising the entire

middle and upper Muschelkalk and the lower stages of the upper Trias, in which *Sibirites* was not known to occur, and hinted that the disappearance of the genus during this period of intermittence was due to migration into extra-Indian regions.

"A second species of the genus, *Sibirites Pandya* Dien., was described by Diener from the red limestone of the Middlemiss crag in the Chitichun area. The fauna of this block has meanwhile been recognized as corresponding exactly with that of the beds with *Spiriferina Stracheyi* of the Central Himálayas, and *Sibirites Pandya* is consequently of nearly the same geological age as *Sibirites Prahlada*.

"In the same year Prof. Waagen described a considerable number of species of *Sibirites* from the upper Ceratite limestone of the Salt Range. To the diagnosis of the genus, as given by E. v. Mojsisovics, he adds the following remarks: 'Most of the Salt Range forms have angular ribs on the external part. The body-chamber is very long, and often differs from the chambered portion of the shell by becoming smooth. The sutural line is ceratitic. Its goniatitic or clydonitic character, which has been noticed in a minority of species, was probably merely due to the inferior state of preservation of the type-specimens'.

"The species of *Sibirites* from the Salt Range are all restricted to the same geological division, the upper Ceratite limestone. Waagen distinguishes two groups connected by transitional forms, the *curvicostati*, comprising species in which the ribs passing over the external part are bent forward more or less strongly, and the *rectecostati* characterised by straight ribs on the external area.

"In his description of the upper Triassic Cephalopoda of the Himálayas E. v. Mojsisovics enters anew into a discussion of the genus *Sibirites*. In this memoir he introduced the new subgenus *Anasibirites*, in which he included all the Salt Range types described by Waagen, remarking that those types differ in several respects from the group of *Sibirites Eichwaldi* Keys., though being nearly allied to it.

"The subgenus *Anasibirites* is defined by E. v. Mojsisovics, as follows:—'Narrow, rapidly increasing whorls, with a narrow, rounded or flattened external part. The ornamentation is closed completely over the external part, consisting either of ribs curved forward (*curvicostati*) or straight (*rectecostati*). Marginal tubercles indicated but faintly and rather rare, completely absent in the majority of the species. Lateral sculpture consisting of strong primary and weaker secondary ribs. There is a marked tendency to shift the place of division of the ribs from the marginal edges towards the umbilical region. The contrast between primary and secondary ribs is also seen in the ornamentation of the siphonal part. In some species the sculpture disappears entirely in the body-chamber'.

"E. v. Mojsisovics excludes the two Muschelkalk species described by Diener from *Anasibirites*, and leaves them in the genus *Sibirites s. s.*, remarking that they are closely allied to *S. pretiosus* from the Olenek beds and are probably descendants from the *pretiosus*-stock. Their characters are:—wide umbilici, slowly increasing whorls and a sculpture distinguished from that of *Anasibirites*. *Sibirites Prahlada* even approaches in his opinion the noric types from the Hallstatt limestone, which are elevated to the rank of a proper sub-genus *Metasibirites*. In this sub-genus

the bifurcations of the ribs coincide, as a rule, with the lateral spines, but where these are obliterated, they are situated in the middle of the sides or lower down. Such species of noric age as differ from *Metasibirites* by the marginal position of their spines, even in the adolescent stage of growth, are united in the subgenus *Thetidites* by E. v. Mojsisovics.

"The genus *Sibirites* is thus divided into :—

(*a*) *Sibirites* s. s.; Lower Trias of the Olenek region, Lower Muschelkalk of the Himálayas.
(*b*) *Anasibirites*; Lower Trias of the Salt Range.
(*c*) *Metasibirites*; Noric Hallstatt limestone of the Eastern Alps.
(*d*) *Thetidites*; Noric stage of the Himálayas.

"Although I think that a sub-division of genera should be avoided, unless justified by good reasons, I believe that the separation of *Metasibirites* and *Thetidites* from *Sibirites* s. s., as proposed by E. v. Mojsisovics in 1897, was a step in the right direction. I even venture to go still further and I propose to separate *Metasibirites* and *Thetidites* entirely from *Sibirites*.

"In referring those two upper Triassic genera in one way or another to *Sibirites* we might seem to assume that the types, met with in the lower Trias and in the Muschelkalk, persist without undergoing considerable change during a period of intermittence, which has as yet nowhere yielded representatives of this stock. This assumption is, however, improbable, there being good reason to consider the genus *Acrochordiceras* from the upper Muschelkalk as a true descendant of the genus *Sibirites*, in the interpretation which will be given of this genus below. Thus we have evidence that the genus *Sibirites* in younger geological periods actually assumes a higher stage of differentiation. Last, but not least, it can be shown that the upper Triassic types in question differ from the older ones in some important features.

"The sutural line of *Thetidites* (E. v. Mojsisovics, l. c. Pl. XI) shows only one lateral saddle, while those of the older types of *Sibirites* invariably have two. It is true that, in some of those types, as for instance in *Sib. Prahlada*, the second lateral saddle is very low, but it is certainly present, whereas in *Thetidites* the umbilical suture divides the second lateral lobe. The sub-genus *Metasibirites* from the Alpine Hallstatt limestone likewise differs from *Sibirites* in its sutures. *Metasibirites spinescens* (v. Mojsisovics, Cephalopoden der Hallstætter Kalke, Abhandl. K. K. Geol. Reichsanst. VI-2, Pl. CXXIV, fig. 1c) has a very high median prominence in the siphonal lobe, quite unlike anything known from the geologically older types. This prominence is quite as high as, if not higher than, the external saddle, and of the same shape, whereas in the older types the siphonal lobe is provided with a much lower median prominence, generally bearing a median incision on its top. If then, in accordance with these considerations, we are induced to doubt the alleged affinity between the older and younger types, we are still more justified in doing so by reason of the remarkable difference in the arrangement of their sutures.

"I therefore come to the conclusion that the generic name *Sibirites* should be restricted to the lower Triassic and Muschelkalk species, the upper Triassic type being most probably entirely independent of them.

"Now we have to consider more in detail what I take to be the only true representatives of *Sibirites*, and more particularly the lower Triassic species to be dealt with.

"From the lower Trias of the Himálayas the genus *Sibirites* had so far not been recorded. It was first discovered by Mr. F. H. Smith in 1899, at Lilinthi E. G., in Byans, near the frontier of Nepal. The specimens were obtained from the topmost bed of a chocolate limestone, which in Byans represents the entire lower Trias, including the Otoceras stage. It is approximately 150 feet in thickness and has yielded fossils in different layers. The importance of this discovery is at once evident. *Sibirites* occurs in the Salt Range exclusively in the upper Ceratite limestone, a horizon, whose presence in the Himálayas had hitherto been doubtful, since no trace of the characteristic Salt Range types had been met with. In Spiti the fossiliferous horizon of the Hedenstrœmia beds (horizon of *Flemingites Rohilla*) is overlaid by a series of limestones very poor in fossils, which on stratigraphical grounds must be considered as an equivalent of the upper Ceratite limestone of the Salt Range, but in which no characteristic fossils were found, with one single exception.* Similar conditions prevail in Painkhánda and in Johar. But in Byans this horizon is fossiliferous. The specimens collected by Mr. F. H. Smith are, unfortunately, few in number and badly preserved, but nevertheless they are sufficient to prove undeniably, that the uppermost part of the chocolate limestone in the section of Lilinthi represents the upper Ceratite limestone of the Salt Range.

"The diagnosis originally given by E. v. Mojsisovics will only have to be slightly altered to accommodate the Salt Range and Byans types. The subgeneric name of *Anasibirites* can therefore be dispensed with.

"First of all the individuals are not always of small size. Waagen has already described a species, very much larger than the largest Siberian type (*Sibirites tenuistriatus*) and a still larger type occurs in Spiti. E. v. Mojsisovics originally stated that in *Sibirites* generally the bifurcation of the ribs takes place at the siphonal margin. But this hardly applies to the Siberian types from the Olenek beds. We need only refer to his own remark on the abnormal sculpture of *Sibirites Eichwaldi* Keys. and look at his illustration of *S. pretiosus*, where the bifurcation of the ribs occurs in the upper part of the flanks. It is most decidedly not the case in the Salt Range species, where the ribs bifurcate on the lateral parts, either near the middle or somewhat above.

"E. v. Mojsisovics further states:—'The divided ribs are weaker and narrower than the primary ones.' This is the case in *Sibirites pretiosus*, but not in *S Eichwaldi*, nor in any of the Salt Range forms. Very often the divided ribs are even stronger than the primary lateral ones. Nor do the ribs always form an angle along the external part, as in *S. Eichwaldi*.

"Lateral spines, according to the original diagnosis, as given by E. v. Mojsisovics, are absent in the older types. In *Sib. pretiosus*, however, the lateral

* "For details of *Sibirites spitiensis*, possibly derived from beds higher than the fossiliferous horizon of *Flemingites Rohilla*, in the section S. E. of Muth, see below."

ribs are so high, that their strongest elevations might almost be called spines, and *S. Prahlada* Diener, which E. v. Mojsisovics himself considers to be a true representative of the genus *Sibirites s. s.*, and a descendant from the *pretiosus* stock, is provided with strong lateral spines. We are therefore justified in adding the eventual presence of lateral spines to the characters of the genus.

"The diagnosis of the genus *Sibirites* would then run as follows:—Shells of small or large size, involution and transverse section variable. Sculpture consisting of radial ribs and lateral spines. The ribs cross the external part either in a straight line or in a curve bent forward or in a sharp angle with its apex directed forward. Where lateral spines are present, they mark the point of bifurcation of the ribs. Body-chamber long (about one entire volution), sometimes devoid of sculpture. Lobes ceratitic, sometimes goniatitic (?); two lateral saddles. Siphonal lobe with a small median prominence. Vertical distribution: lower Trias, lower Muschelkalk.

"The genus *Sibirites*, as defined above, probably includes several types, which have been identified with *Acrochordiceras* by Waagen, among them being the following species:—

Acrochordiceras cf. Damesi Noetl.
„ *coronatum* Waag.
„ *distractum* Waag.
„ *compressum* Waag.
„ *dimidiatum* Waag.

"*Acrochordiceras atavum* Waag. has scarcely any sculpture on the external part, and it is rather doubtful whether it actually belongs to the same group of forms as the above species.

"All these types are fragments of body-chambers, without sutures. It is more than doubtful whether they actually belong to the genus *Acrochordiceras*, whose true representatives occur in the Muschelkalk and ladinic stage only. One of the specimens collected in Byans by F. H. Smith is very similar to one of Waagen's species of *Acrochordiceras*, as the sides bear strong spines corresponding to the place where the ribs bifurcate. In its sutures this species agrees with *Sibirites*, whereas it is decidedly distinguished in this respect from *Acrochordiceras*. It is therefore reasonable to suppose that Waagen's types, derived from beds of the same geological age as our species from Byans just referred to, agree rather with *Sibirites* than with *Acrochordiceras* in the arrangement of their sutural lines.

"The very fact that the Salt Range types in question have been looked upon as representatives of Hyatt's genus *Acrochordiceras*, gives us a hint as to the very intimate relationship of *Sibirites* and *Acrochordiceras*. I think, indeed, that there can be little doubt, but that the latter is derived from the former.

"*E. v. Mojsisovics* (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 141) points to the similarity in sculpture which connects *Acrochordiceras* with *Pericyclus princeps* de Kon. We need not, however, go back as far as the Carboniferous to find types allied as closely to *Acrochordiceras* as to *Pericyclus*.

"The difference between *Sibirites* and *Acrochordiceras* appears to lie exclusively in the sutural line, which in the latter genus is considerably more differentiated.

"The genus *Sibirites* may further include two Salt Range forms classed with *Ceratites* by Waagen, namely, *Ceratites inflatus* Waag. and *C. patella* Waag., which have been found to agree very closely with a *Sibirites* collected in Byans. It will be noticed that the genus *Sibirites*, as defined above, bears a remarkable similarity to some groups of *Ceratites* (in a wider circumscription), from which it can be distinguished by its simpler sutures and by the strong sculpture of its siphonal part.

"As regards the origin of the genus *Sibirites* we have as yet no clear evidence, but there is some probability of the *Meekoceratidæ* being the root from which *Sibirites* has branched off. E. v. Mojsisovics noticed in his Siberian types that the inner volutions are provided with smooth external parts, and the same appears to be the case in some of the specimens from Byans. On the other hand there occurs in some species of *Meekoceras* (*M. Hodgsoni*, *M. Varaha*) a faint sculpture, which crosses the external part. But there are as yet no transitional links known, which would bridge over the gap between those forms with a very faint external ornamentation, and the types with a strong external and lateral sculpture. It will therefore require more exhaustive studies to decide whether or not *Sibirites* is actually a branch of *Meekoceras*, which acquired a strong lateral and external sculpture.

"Three named species of *Sibirites* from Byans are described below. They are :—

Sibirites spiniger nov. sp.
„ *robustus* nov. sp.
„ *stephanitiformis* nov. sp.

"The two first mentioned types are probably allied to *S. ibex* Waag. Besides these there are a number of unnamed species, one of them agreeing very closely with *Ceratites inflatus* Waag. or *C. patella* Waag.

"The fauna of the uppermost beds of the chocolate limestone of Byans therefore bears marked relations to the upper Ceratite limestone, and this agreement is all the more astonishing as we have so far but a very small collection of types from either region.

"The layer containing *Sibirites* in the topmost beds of the chocolate limestone of Byans I term '*horizon of Sibirites spiniger*.' This horizon must be correlated with the upper Ceratite limestone of the Salt Range.

"A single specimen of *Sibirites*, *S. spitiensis nov. sp.*, was discovered among the collections brought by Mr. Hayden from the section S. E. of Muth. This specimen has no lateral spines and seems to represent a type allied to *S. Kingianus* Waag. and *S. chidruensis* Waag. According to Mr. Hayden it was found in the Hedenstrœmia beds. It is probable that it came from a layer corresponding in age to the horizon of *Sibirites spiniger* in Byans.

1. SIBIRITES SPINIGER v. Krafft. Pl. XXXI, figs. 2, 7 (*var.*)

Measurements.

	I.	II.
D	30 mm.	42 mm.
U	5 „	7·5 „
A	14 „	21·5 „
C	7·5 „	cca. 11 „
$\frac{D}{U}$	6	5·6
$\frac{A}{C}$	1·86	cca. 1·96

"This species represents an involute, laterally compressed type, resembling *Sibirites Eichwaldi* Keys. or *S. ibex* Waag. The greatest thickness is situated halfway up the sides. The lateral parts descend in a steep curve to the umbilical suture, no umbilical edge or wall being formed. External part flattened, with obtuse marginal edges.

"*Sculpture.*—At the beginning of the last volution occur weak radial ribs which cross over the external part; further on lateral knobs appear, which increase in height, towards the anterior termination, become more and more distant from each other, and move from the vicinity of the umbilicus to the middle of the sides. With the appearance of the lateral spines the ribs too become stronger, but only outside the lateral tubercles, the umbilical region remaining but faintly sculptured throughout. At first pairs of ribs start from each lateral spine. As these become more distant, secondary ribs are intercalated; these rise from the middle of the lateral parts. As far as can be ascertained, there appears first one secondary rib between each pair of spines and afterwards two. These ribs cross straight over the external part, the secondary, intercalated ribs being as strong as the primary ones.

"The sculpture of the external part recalls that of *Sibirites ibex* Waagen (Fossils from the Ceratite formation, l. c. Pl. IX, fig. 3), but is not so strongly pronounced as in the Salt Range species.

"The type-specimen illustrated on Pl. XXXI, fig. 2, which represents the prototype of the species, is for the greater part covered with its shell. Septa are not discernible. The length of the body-chamber is, consequently, unknown.

"The second specimen, illustrated in fig. 7, differs from the type in its more faintly developed ornamentation. The sculpture is only discernible near the beginning of the last volution. The rest of the whorl has been so greatly injured by weathering that its surface has been almost completely destroyed. The ornamentation, as far as it is visible, is chiefly conspicuous by the absence of distinct lateral spines, but to judge from some irregular knobs near the anterior termination, such spines have probably been present on the anterior portion of the cast.

"*Geological position. Locality. Number of specimens examined.*—Chocolate Limestone, horizon of *Sib. spiniger*, Lilinthi E. G., Byans, 2, coll. Smith.

"*Remarks.*—The nearest ally to this species is probably *Sibirites ibex* Waag. As the type-specimen, from which Waagen's description was taken, is a fragment

of a body-chamber, a close comparison is excluded. Nor is my material from Byans very satisfactory. *Sib. ibex* was apparently not provided with any lateral spines. The sculpture of its external part is stronger, and the ribs start lower down the sides, than in the present species."

2. Sibirites robustus v. Krafft. Pl. XXXI, fig. 1.

"The only specimen serving for description of this species is fragmentary and distorted; thus reliable measurements cannot be obtained. It is, however, evident that the umbilicus is wider, and the thickness of the whorls greater, than in the preceding species.

"The maximum thickness is situated in the middle of the lateral parts. As the specimen consists of one-half volution only, the characters of the umbilicus cannot be observed exactly. The umbilical wall was probably more distinctly marked than in *Sibirites spiniger*. External part broad and flattened, with obtuse marginal edges.

"*Sculpture.*—The lateral parts bear faint knobs, which disappear towards the anterior termination. The ornamentation consists of radial ribs, which either rise from the umbilical edge or from the upper part of the sides. They are rather delicate, but increase considerably in strength when approaching the siphonal margin. There are also faint secondary ribs, intercalated between the primary ones, and accompanying them across the siphonal area.

"The ribs are comparatively strong on the external part, especially along the marginal edges, where they occasionally even form marginal knobs. The distances between the external cross-ribs increase irregularly towards the anterior termination.

"The present fragment belongs entirely to the body-chamber. Only sma remnants of the shelly test have been preserved.

"*Sutures.*—Not known.

"*Geological position. Locality. Number of specimens examined.*—Topmost beds of Chocolate Limestone; horizon of *Sib. spiniger*, Lilinthi E. G., Byans, 1, col. Smith.

"*Remarks.*—*Sibirites robustus* is closely allied to the preceding species, but it can easily be distinguished by its thicker whorls, broader siphonal part, wider umbilicus, and less prominent sculpture. The nearest ally among the Salt Range species is probably *Sibirites ibex* Waag. This species, from the upper Ceratite limestone, has, so far as we can judge from Waagen's fragmentary type-specimen, a similar transverse section, and the umbilicus is equally wide. The sculpture, however, differs in the absence of lateral tubercles, and in the greater strength and regularity of the ribs. Intercalated ribs are known in *Sibirites perumbilicatus* Waagen (Fossils from the Ceratite formation, l. c. Pl. IX, fig. 4) and *S. hircinus* Waagen (l. c. Pl. IX, figs. 5, 6), but in these two species they occur in larger numbers between two primary ribs."

Among the American species *Sibirites Noetlingi* Hyatt et Smith (Triassic Cephalopod genera of America, l. c., p. 49, Pl. IX, figs. 1-3) belongs perhaps to the same group as *S. robustus*, but the number of ribs is considerably larger, and the continuity of the ribs along the lateral parts is not interrupted as often as in the Himálayan species.

3. SIBIRITES sp. ind. ex aff. ROBUSTO v. Krafft. Pl. XXXI, fig. 6.

This fragment of a body-chamber, measuring less than one-half volution in length, agrees with the preceding species in its shape and transverse section, but is almost without any sculpture. In the posterior part of the fragment we notice three distant broad and low folds, originating in the vicinity of the siphonal margin, which cross the external area. Otherwise the fragment is quite smooth. It is impossible to decide whether it is nearly allied to *Sib. robustus* or not.

Locality and geological position. Number of specimens examined.—Topmost beds of Chocolate Limestone; horizon of *Sib. spiniger*, Lilinthi E. G., Byans, 1, coll. Smith.

4. SIBIRITES STEPHANITIFORMIS v. Krafft. Pl. XXXI, fig. 3.

Measurements.

D	. . . . .	cca. 55 mm.	$\frac{D}{U} = 3{\cdot}66$
U	. . . . .	15 „	
A	. . . . .	21 „	
C	. . . . .	cca. 17 „	

"It might be questioned whether this species should not be placed in the genus *Stephanites* Waagen (Fossils from the Ceratite formation l. c. p. 101), as the lateral tubercles are developed very strongly and regularly. I do not, however, believe that this would be justified. In *Stephanites* the external part is entirely devoid of sculpture, whereas in the present species very low cross ribs occur. The flanks descend in a very steep incline to the umbilical suture in *Stephanites*, whereas in our species the inclination is much more gradual and the umbilicus shallower.

"*Stephanites* is no doubt an offshoot from *Sibirites* in which the external ribs have been obliterated, while the lateral spines increased in size, but in the present species the characters of *Stephanites* are not yet prominent enough to warrant its being separated from *Sibirites*.

"The species is represented by a single, somewhat fragmentary specimen, whose thickness could not be measured accurately. It is uncertain whether the last volution was chambered or not. The maximum thickness is situated in the middle of the lateral parts. External part broadly rounded. No umbilical edge nor wall.

"*Sculpture.*—The sculpture of the last volution consists of high lateral spines. Their number is seven on one-half volution. The situation of those spines is at

first slightly below the middle of the lateral parts, but gradually the spines move up to the middle. Their intervals are regular.

"Where the external part has been preserved, very low cross ribs are noticed, and it appears that very faint knobs also are arranged along the rounded siphonal margin. The lateral spines appear to be connected with broad, indistinct folds, which occasionally dichotomise in the spines.

"The inner whorls are apparently smooth, but this absence of sculpture is probably due to the fact that the lateral spines correspond approximately to the line of involution, and are therefore covered by the last volution.

"Shelly test partly preserved.

"*Sutures.*—Not known.

"*Geological position. Locality. Number of specimens examined.*—Topmost beds of Chocolate Limestone, horizon of *Sib. spiniger*, Lilinthi E. G., Byans, 1, coll. Smith.

"*Remarks.*—This species bears much resemblance to *Arcochordiceras dimidiatum* Waagen (Fossils from the Ceratite formation, l. c. Pl. III, fig. 3), with which it agrees in the development of the strong lateral tubercles and low cross ribs in the marginal region."

5. SIBIRITES sp. ind. aff. INFLATO, Waag. Pl. XVII, fig. 7.

Measurements.

D	cca. 181 mm.	$\frac{D}{U}$	$=4{\cdot}22$
U	18 „		
A	35 „	$\frac{A}{C}$	$=1{\cdot}45$
C	cca. 24 „		

"There is only one specimen available for description, and this is fragmentary and without sutures. Under these circumstances I have not deemed it advisable to introduce a special denomination for the present species, which is allied to the preceding one but resembles still more strongly a species from the upper Ceratite limestone of the Salt Range.

"Owing to its fragmentary condition the present specimen cannot be accurately measured. Its maximum thickness is situated somewhat below the middle of the sides. There is no umbilical wall, but the lateral parts descend in a regular curve to the umbilical suture. Near the anterior termination the lower part of the sides forms an inclined plane which gradually passes into the curve uniting the sides with the umbilicus.

"The external part is rounded at the beginning of the last volution. In the anterior portion it is broadly flattened and bears obtuse, though very indistinct, marginal shoulders.

"*Sculpture.*—The sculpture of the present specimen is so faintly developed that it may be doubted whether the species should really be classed with the genus *Sibirites*. Yet I have done so because the characters of ornamentation agree with those exhibited in *Sib. stephanitiformis*, and because I have reason to assume that

the volution preserved belongs entirely to the body-chamber, which in *Sibirites* is often distinguished from the chambered portion of the shell by an obliteration of its sculpture.

"On the last volution we notice only short radial ribs or knobs, which are inequidistant and correspond approximately to the line of involution, so that they cannot be seen on the inner whorls. Outside the lateral knobs the sculpture is very indistinct. There are, however, faint, bifurcating ribs, which cross straight over the external part. A row of very low knobs corresponds to these cross ribs along the siphonal edge. The outline is consequently somewhat wavy.

"As no sutures can be made out, although my specimen is an internal cast, it is probable that the last volution belongs entirely to the body-chamber. This would sufficiently account for the indistinctness of the sculpture.

"*Geological position. Locality. Number of specimens examined.*—Topmost beds of Chocolate Limestone; horizon of *Sibirites spiniger;* Lilinthi E. G., Byans, 1 coll. Smith.

"*Affinities.*—I have little doubt that this species is very closely allied to *Ceratites inflatus* Waagen (Fossils from the Ceratite formation l. c. p. 40, Pl. X, fig. 1). The geological position of *Ceratites inflatus* is not certain. Waagen's type-specimen was collected by Mr. Wynne, who wrote on the label "Trias" only, without indicating the special horizon. Waagen justly remarks that in the condition of the rock and in its mode of preservation it agrees exactly with fossils from the upper Ceratite limestone.

"Waagen's illustration is far from being correct, the umbilicus being represented as too narrow. Moreover, it is greatly restored and important details have been omitted. To anyone who is not in a position to compare the type-specimen, my remarks as to the close resemblance of the two species cannot therefore be convincing.

"*Ceratites inflatus* agrees with our Himálayan species in its transverse section. Waagen's type is a fragment of body-chamber with a flattened external part and obtuse marginal edges. There is no umbilical edge, but the flanks descend gradually to the umbilical suture. Waagen described the marginal knobs and faint cross-ribs occurring on the external part correctly, but he seems to have overlooked the low lateral knobs which this species has, in common with the type from Byans. One of those knobs is clearly marked, but the others are very indistinct, and it seems that the lateral sculpture disappears entirely towards the anterior termination.

"I believe that Waagen's type agrees with our species from Byans as far as can be expected with such fragmentary specimens.

"I have further to deal with *Ceratites patella* Waagen (l. c. p. 51, Pl. IV, fig. 2), as this species is probably identical with *C. inflatus*. In this species the external part is rounded. This feature is quite in agreement with what we see at the beginning of the last volution in our species from Lilinthi. The transverse section is very similar, with the one exception, that the umbilical edge is perhaps slightly more marked. The siphonal part is not smooth, as has been stated by Waagen,

but there are low cross-ribs and marginal tubercles, especially well seen near the anterior termination and in the first section of the last volution.

"Waagen draws attention to the occurrence of bipartite ribs. This character is, indeed, well seen on his specimen, and the dividen ribs form two of the marginal knobs just alluded to. The occurrence of bifurcating ribs on the lateral parts points decidedly to the genus *Sibirites*. Faint bifid ribs also occur in the Himálayan type.

"As no trace of a sutural line is seen in Waagen's specimen, although the shell has been almost completely destroyed by weathering, it is probable that the entire last volution forms part of the body-chamber. This corroborates my view that the species should be included in the genus *Sibirites*.

"The material at hand is not sufficient to decide the question of identity, but we may consider it as very probable that *Ceratites inflatus* Wang., and *C. patella* Waagen, from the Salt Range, belong to the same group of forms with our species of *Sibirites* from Byans."

6. Sibirites spitiensis v. Krafft. Pl. XXXI, fig. 8.

Measurements.

D	135 mm.	
U	33 „	$\frac{D}{U} = 4{\cdot}09.$
A	66 „	
C	? „	

"From the Hedenstrœmia beds S. E. of Muth, Spiti, Mr. Hayden has collected a single fragmentary specimen of an ammonite, which will most suitably be classified with the genus *Sibirites*.

"In its general appearance this specimen bears a striking resemblance to *Acrochordiceras Damesi* Noetling (Zeitschr. Deutsch. Geol. Ges. 1880, Pl. XV) from the lower Muschelkalk of lower Silesia. The dimensions of the two type-specimens, the width of the umbilicus, and the sculpture are indeed strikingly similar.

"The measurements of Noetling's type are as follow:—

D	130 mm.
U	27 „
A	55 „

"It also appears that the transverse section of our specimen resembles that of *Acrochordiceras Damesi*, but this is uncertain, as the specimen from Muth is crushed and only half preserved.

"Important differences exist, however, in the arrangement of the sutural line. The specimen from Muth has ceratitic sutures, the saddles are broadly rounded and entire, while the lobes bear simple denticulations. On the other hand, we observe in *Acrochordiceras Damesi* incised saddles and lobes with much more complicated denticulations than occur in the specimen from Muth. The sculpture

of the present species is further distinguished by the complete absence of spines, one of the most characteristic sculptural elements in *Acrochordiceras*.

"Thus there can be no question but that this species is distinct from the genus *Acrochordiceras*, and there is every reason for uniting it with *Sibirites*. It closely resembles the Salt Range types of this genus in which lateral spines are absent, the sculpture being restricted to ribs, which start near the umbilicus and increase in strength towards the external part, which they cross without any interruption from one side to the other.

"Such species are for instance *Sibirites Kingianus* Waagen (Fossils from the Ceratite formation, l. c. Pl. VIII, fig. 1), and *Sibirites chidruensis* Waagen (l. c. Pl. VIII, figs. 3, 4). The sutural line agrees with that of *Sibirites* as far as it is seen on the specimen. In size the present species exceeds all others hitherto known.

"The sides are strongly arched at the beginning of the last volution, the maximum thickness being situated a little below the middle of the lateral parts. Towards the anterior termination the sides become flattened, and the umbilical edge, which at first is but vaguely indicated, becomes marked more distinctly although it remains rounded. At the same time a steep umbilical wall makes its appearance.

"*Sculpture.*—The lateral ribs start in the lower part of the sides, and it is not till they reach the middle of the flanks that they become distinct. They are broadly rounded, as are the intervals between them. Their strength varies but slightly. On the chambered part only single ribs occur, but on the body-chamber indistinct bifurcations are visible. The ribs cross over the external part, where they reach their greatest strength. No marginal tubercles are developed.

"My specimen is an internal cast, with small remnants of the shell adhering. About one quarter of the last volution belongs to the body-chamber.

"*Sutures.*—External saddle very high. Principal lateral lobe broad and deep. Second lateral lobe narrow. All the saddles are broadly rounded and entire. Umbilical lobe only partly visible and very narrow.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden.

"*Remarks.*—Mr. Hayden determined the geological position of this species as the Hedenstrœmia beds, that is to say the series of lower Triassic beds, which include the horizons of *Flemingites Rohilla* Dien. and of *Pseudomonotis himaica* Bittn. As in the Salt Range the genus *Sibirites* never been observed below the upper Ceratite limestone, and as the species of *Sibirites* collected from Byans by F. H. Smith likewise occur in the topmost beds of the lower Triassic Chocolate Limestone, it is not improbable that the present species should come from beds younger than those, in which the fauna associated with *Hedenstrœmia Mojsisovicsi* and *Flemingites Rohilla* was found in the section of Muth. If this be so, the present specimen is the only one found outside Byans which points to a representation of the upper Ceratite limestone in the lower Trias of the Himálayas."

Without directly contradicting A. v. Krafft's views as to the geological position of the present species, I think it should be borne in mind, that the restriction of *Sibirites* to the highest zone of the lower Trias, which in the Salt Range has been emphasized by A. v. Krafft, has not been observed in Western America, where, according to J. Perrin Smith, several species of this genus, nearly allied to Salt Range forms, have been met with in the Meekoceras beds *s. s.*, associated with a fauna which is probably homotaxial with the faunæ of the Indian Meekoceras and Hedenstrœmia beds.

SIBIRITES, pl. sp. ind. Pl. XXXI, figs. 4, 5, Pl. XXVIII, fig. 4.

" Among Mr. Smith's collections from Lilinthi E. G., Byans, there are besides the types described above, a number of species represented by imperfectly described examples, which do not deserve a specific denomination. But on account of the great interest connected with the discovery of *Sibirites* in the lower Trias of the Himálayas three of these types have been figured and will be briefly described below. They tend to show that the horizon of *Sibirites spiniger* includes a fairly rich fauna, which would be well worth a thorough investigation.

" The specimen illustrated on Pl. XXXI, fig. 5, belongs to a new species. On the better preserved side numerous, delicate radial ribs are seen. They become weaker towards the anterior termination and ultimately disappear, to be replaced by strong lateral spines. At the commencement of the last volution the external part is covered by ribs, which are turned forward in a strong curve, like those in the section of Waagen's *curvicostati*. At the anterior termination faint cross-ribs only are seen.

" Sutures not visible. Shelly test partly preserved.

" This species is laterally compressed and its transverse section is similar to that of *Sibirites spiniger*.

" The second specimen (Pl. XXXI, fig. 4), has a wider umbilicus and lower whorls than the preceding one. Its transverse section is almost rectangular, not unlike *Sibirites Eichwaldi* v. Mojsisovics (Arktische Triasfaunen, l. c. p. 59, Pl. X, figs. 1-9). The ribs are of very unequal strength and length, the main ribs only reaching down to the umbilical edge. The ribs describe a very flat curve on the external part.

" Similar types among the Salt Range species are *Sibirites angulosus* Waagen (Fossils from the Ceratite formation, l. c. p. 117, Pl. VIII, figs. 12, 13) and *Sib. inæquicostatus* Waag. (l. c. p. 113, Pl. VIII, figs. 7, 8), but the materials both from the Himálayas and from the Salt Range are too insignificant to allow of a closer comparison."

A third fragment, illustrated on Pl. XXVIII, fig. 4, is conspicuous by its very high and pointed spines. The siphonal ribs are stout and broader than the intercostal valleys.

The sutural line is simple, consisting of ceratitic lobes and entire saddles. The margins of the saddles are not serrated.

Genus : NANNITES v. Mojsisovics.

" The genus *Nannites* has so far been recorded only from the main layer of *Otoceras Woodwardi* Griesb. in the Himálayas and from the ladinic and carnic stage of the Eastern Alps. There appeared therefore to exist a long period of intermittence, lasting during the middle and upper divisions of the lower Trias and the Muschelkalk, which intermittence was insufficiently bridged over by an undeterminable fragment of a globose ammonite, resembling *Nannites*, noticed by Diener in Stoliczka's collections from the Muschelkalk of Spiti.

" My recent researches have led to the discovery of the genus *Nannites* in the Hedenstrœmia beds of Spiti. It has been ascertained that the species, described as *Nannites hindostanus* by Diener, extends from the Otoceras stage into the Hedenstrœmia beds without undergoing a perceptible change. This can be looked upon as supporting Diener's suggestion that the genus occurs also in the Muschelkalk, and moreover affords a satisfactory explanation of the fact that the genus ranges from the Otoceras beds into the carnic stage."

Since these notes were written *Nannites* has also been discovered in the lower Triassic Meekoceras beds of Idaho and California by J. Perrin Smith, where it occurs together with *Paranannites*, an intermediate form between *Nannites* and the true *Ptychitidæ*.

1. NANNITES HINDOSTANUS Diener. Pl. XXVIII, figs. 8, 9.

and

2. NANNITES HERBERTI Dien.

1897. *Nannites hindostanus* Diener, Himálayan Foss., Palæont. Ind. ser. XV. Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 68, Pl. VIII, figs. 3, 11, 12.

1897. *Nannites Herberti* Diener, l. c. p. 69, Pl. VIII, fig. 2.

Measurements.

NANNITES HINDOSTANUS Dien.

	Diener's type-specimen.	I	II
D	17 mm.	17·5 mm.	23 mm.
U	4 „	5 „	6 „
A	7·5 „	7 „	10 „
C	8 „	7 „	?
$\frac{D}{U}$	4·25	3·5	3·83
$\frac{A}{C}$	0·93	1	

NANNITES HERBERTI Diener.

	Diener's type specimen.
D	14 mm.
U	4 ,,
A	6 ,,
C	7·5 ,,
$\frac{D}{U}$	3·5
$\frac{A}{C}$	0·8

"Of the two species which have been distinguished by Diener, only *Nannites hindostanus* can be recognised with certainty among the recent materials collected in Spiti. *N. Herberti* will, therefore, be redescribed after Diener's type-specimen.

"Diener states that *Nannites Herberti* has a more considerable overlap and a smaller number of contractions than *N. hindostanus*. The latter difference is indeed, clearly marked, but I think that the overlap is not greater in *N. Herberti*. Accurate measurements of the overlap could only be made, it is true, by means of a cross-section, which could not be procured on account of the scarcity of the material available. The measurements given above, however, prove sufficiently clearly that *Nannites Herberti* has a slightly wider umbilicus and that the overlap should therefore be even smaller.

"(*a*) *Nannites hindostanus*.—The contractions are equally prominent on the cast and in the shell, slightly falciform and inequidistant. Their number is smaller on the chambered part of the shell than on the body-chamber. On the largest specimen figured we can count approximately twenty contractions. The contractions of the cast are sharply bordered in front only. Those of the shell, on the contrary, are bordered more sharply behind than in front, and do not show any ridges.

"Specimen I is a cast; in specimen II half of the last volution is covered with shell. The shell is thick on the external part, but thins out gradually towards the umbilicus.

"Diener believed the contractions to be absent on the shell, from which he inferred that they correspond to thickened laminæ in the interior of the shell, as in the genus *Arcestes*. On the other hand Diener described the contractions as follows (p. 68) :—'The laminæ of the shell situated behind the contractions are sharply cut off by the latter, whereas they gradually pass into the laminæ situated in front. This phenomenon has been called direct imbrication by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, p. 12).'

"I think, however, that the contractions must be visible on the external surface of the shell, and cannot therefore correspond to thickened portions in the interior of the shell, as in *Arcestes*, because the laminæ of the shell situated behind the contractions are sharply cut off by the latter.

"The actual features are as described above. I have convinced myself, by a careful examination of Diener's type-specimen, that it agrees fairly well with

my description, based on the recent materials from Spiti. I must, however, remark that the contractions become indistinct both on the cast and on the shell near the anterior termination.

"I do not believe that the features observed in *Nannites hindostanus* can be compared to what E. v. Mojsisovics calls direct imbrication. The shell is not cut off by the contractions, but it simply adapts itself to the surface of the cast.

"As an instance of direct imbrication we must take *Dinarites cuccensis* v Mojsisovics (l. c. Pl. V, fig. 7), as it is this species to which E. v. Mojsisovics himself refers on p. 12 of his memoir quoted above, when speaking of the phenomenon of direct imbrication. Now we find that in the shell of this species, the shelly crests, produced by the contractions, overlap each other on the external part, like tiles on a roof. This is not the case in *Nannites hindostanus*, but as I have stated, the shell continues across the contractions, adapting itself to the latter like a glove to the hand. So far there is no evidence that the laminæ of the shell are actually cut off by the contractions. To prove this a microscopic examination would have to be carried out, and it is doubtful whether the results would agree with Prof. Diener's suggestion or not.

"*Sutures.*—The sutures of my specimens of *Nannites hindostanus* agree with he drawing in Diener's memoir. By means of a strong lens very delicate denticulations may be seen in the lobes, both in Diener's type and in one of my own specimens. The base of the siphonal lobe could not be clearly observed.

"(*b*) *Nannites Herberti* Diener.—Diener's type of *N. Herberti* differs from *N. hindostanus* in the following features. The transverse section is broader, the umbilicus is slightly larger, and the body-chamber has distant contractions, six only being counted within the circumference of one entire volution. Their direction is strongly bent forward. As Diener's type is almost completely covered with its shelly test the contractions of the cast could not be examined. Those of the shell exhibit the same features as in *N. hindostanus*.

"What has been said regarding the direct imbrication of the shell in *Nannites hindostanus*, applies to this species likewise. The statement that no remnants of the shelly substance have been preserved, found in Diener's description, is erroneous. In reality the specimen is covered with a thin shell, except the umbilical region, where the broken edges of the test can be seen. No sutures could be observed on the small pieces of the cast laid bare. One half of the last volution at least must belong to the body-chamber.

"The delicate striæ between the contractions are less distinct than Diener's illustration would lead us to suppose. They can be seen in a few places only by means of a lens.

"*Geological position. Locality. Number of specimens examined.*—The specimens of *Nannites hindostanus* in the recent collections have all been obtained from the Hedenstrœmia beds of Spiti: S. E. of Muth, 3, coll. Hayden; Banna E. G., Thanam valley, Bashahr, 2, coll. Hayden; Kuling, 1, coll. v. Krafft.

"*Remarks.*—The specimens of *Nannites hindostanus* and *N. Herberti*, described by Diener, were extracted from a dark crystalline limestone together with

Flemingitеis Guyerdeti Diener, found by C. L. Griesbach S. E. of Muth, and designated on the original label as "bed 2." On the other hand all the specimens of *Nannites hindostanus* of Mr. Hayden's and of my own collections have been obtained from the upper division of the lower Trias (Hedenstrœmia beds).

"Leaving aside the question whether Griesbach's specimens might not have come from the Meekoceras beds, rather than from the Otoceras stage, there is no reason whatever to doubt that his specimens are in reality geologically older than those found by Mr. Hayden and by myself. The species of *Flemingites* found along with Griesbach's examples of *Nannites hindostanus* and *N. Herberti* is very different from the typical species of *Flemingites* of a younger geological age, as has been pointed out by Diener (l. c. p. 98). Its preservation is quite unlike that of fossils from the upper division of the lower Trias, and the same remark applies to the specimens of *Nannites*. On the other hand it is impossible to discover a noteworthy difference between the older and younger specimens.

"It is true that the specimens from the Hedenstrœmia beds are a little more broadly rounded on the external part, and that the sides become more nearly parallel in the vicinity of the umbilicus than in Diener's type, but otherwise they agree completely.

"We are, therefore, obliged to admit that *Nannites hindostanus* ranges from the Otoceras stage into the upper division of the lower Trias, while *Nannites Herberti* is only known from the Otoceras (or Meekoceras) beds. A younger type, similar to *N. Herberti* in some respects, can be specially distinguished from this form (see *Nannites medius* below).

"The persistence of *Nannites hindostanus* through all the stages of the lower Trias is an exceptional feature among Indian Triassic ammonites. It is of particular interest as regards the occurrence of the genus *Nannites* in ladinic and carnic beds of the Eastern Alps. Since it has been proved that a species of this genus persists from the lowest to the topmost division of the lower Trias without undergoing any noteworthy change, it is not astonishing that the genus itself has such an unusually wide range."

A species nearly allied to *Nannites hindostanus*, from the Meekoceras beds of California, has been described as *N. Dieneri* by Hyatt and Smith (Triassic Cephalopod genera of America, l. c. p. 79, Pl. VII, figs. 5-25). It differs from this Indian species only in some very subordinate details, namely in the smaller number of contractions of the shell, and by the sharper divisions of its external lobe. I think that J. Perrin Smith is perfectly right in separating the two species, according a greater importance in classification to those marks that are seen in small shells with few distinctive characters than would be attached to similar marks in shells with many such characters.

3. Nannites medius, nov. sp. Pl. XXVII, fig. 10.

One specimen in the Himálayan collection, which was united provisionally with *Nannites hindostanus* Dien. as *cf.* by A. v. Krafft, does not agree with the type in all features of importance. A new specific name is therefore introduced.

The following measurements were marked by A. v. Krafft on the label accompanying this specimen :—

D . .	15 mm.	$\frac{D}{U} = 3$
U	5 „	
A	6·5 „	$\frac{A}{C} = 0{\cdot}92.$
C	7 „	

The general shape and transverse section agree very nearly with those of *Nannites hindostanus*, but the umbilicus is wider. A further difference consists in the number of contractions being eight only in the last volution, although more than one-half of this volution belongs to the body-chamber. In this character *N. medius* resembles *N. Herberti* Dien.; but otherwise it agrees with this species less than with *N. hindostanus*. It can be distinguished from *Nannites Herberti* by its wider umbilicus, more compressed transverse section, greater number of contractions (six only are counted in my type-specimen of *N. Herberti*), and by the direction of the contractions which are less bent forward.

With *N. Dieneri* Hyatt and Smith (Triassic Cephalopod genera of America, l. c. p. 79, Pl. VII, figs. 5-25) it agrees closely in the number of contractions, but its whorls are more strongly compressed and provided with a wider umbilicus.

The specimen figured is a cast. The last septum may be distinctly observed. More than one half of the last volution belongs to the body-chamber.

Between the contractions very delicate striæ are seen, following the same direction.

Sutures.—As far as known identical with those of *Nannites hindostanus*. The base of the siphonal lobe is not accessible to examination.

Locality and geological position. Number of specimens examined.—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden.

Remarks.—Two other specimens of *Nannites* from the Hedenstrœmia beds of Banna E. G., can be referred to this species probably as *cf. medio*. In size they are very much inferior to the type described above, but otherwise agree with it in the small number of contractions. In one of those specimens the body-chamber occupies three-quarters of the entire last volution.

Genus : Episageceras Noetling.

1901. *Episageceras* Noetling, Neues Jahrb. f. Min. etc. Beilagebd., XIX. p. 363.

Episageceras Dalailamæ Diener.

1897. *Medlicottia Dalailamæ* Diener, Himálayan Foss. Palæont. Ind., ser. XV, Vol. II, Pt. I, Cephalopoda of the lower Trias, p. 58, Pl. I, fig. 6, VII, fig. 7.

1901. *Medlicottia Wynnei* A. v. Krafft (*non* Waagen), Centralblatt f. Min. etc., p. 275.

1901. *Medlicottia Dalailamæ* Diener, ibidem, p. 514.

1901. *Episageceras Dalailamæ* Noetling, Ueber Medlicottia und Episageceras aus den permischen und triadischen Schichten Indiens, Neues Jahrb. f. Min. etc. Beil. Bd. XIX, p. 369. Taf. XVII, fig. 1.

The group of *Medlicottia Wynnei* Waagen, which differs from the group of *M. primas* Waag., the prototype of the genus *Medlicottia*, in its broad siphonal area and in the development of its adventitious lobes, has been elevated to the rank of a proper genus by Noetling.

The specific independence of *Medlicottia* (*Episageceras*) *Dalailamæ* has been questioned by A. v. Krafft, who insisted on its identification with *Medlicottia Wynnei* Waagen, from the upper Productus limestone of the Salt Range. I need not enter here into a discussion of this subject, since the question has been decided in my favour by Noetling, whose decision was based on personal examination of the type-specimens of both *Episageceras Wynnei* and *E. Dalailamæ*.

The fragment of a body-chamber of this species, measuring one-half volution, was collected by Hayden from the Otoceras beds N. N. W. of Kágá, Spiti. In this fragment the flat falciform folds are developed more distinctly in the marginal than in the middle region of the lateral parts.

A second specimen from the Otoceras beds S. E. of Muth, Spiti, is too badly preserved to permit of a specific determination. But it is evident, from the deep position of its adventitious lobe, that it also belongs to *Episageceras*, and not to *Medlicottia sens. str.*

Genus : PSEUDOSAGECERAS Diener.

In my memoir on the fauna of the lower Trias of the Ussuri district in Eastern Siberia (Mémoires Com. Géol. de la Russie, XIV, No. 3, Pl. I, fig. 8, Pl. IV, fig. 6) I described a fragment of an ammonite with a very complicated sutural line, for which I introduced the new genus *Pseudosageceras*. In its general shape this genus recalls *Longobardites* and *Carnites*, but shows in its sutural line a mixture of characters peculiar to *Sageceras*, *Longobardites* and *Pinacoceras*. Notwithstanding the fragmentary state of preservation, the characters of systematic importance were so conspicuous in the Siberian type, that they seemed to justify the introduction of a new generic name.

In 1905 a new species of *Pseudosageceras* was described by Noetling (Palæontographica 51, Bd. p. 155, Pl. XIX—XXVII). A very large number of examples belonging to this species, for which the name of *P. multilobatum* was proposed by Noetling, had been collected by himself and by Prof. Koken in the Ceratite marls of the Salt Range. His studies of this beautiful material must be considered as one of the most valuable contributions to our knowledge of the development of the sutural line in Triassic ammonites with an abnormal number of lobes and saddles.

In my memoir of the Triassic Cephalopoda from the Schiechlinghoehe near Hallstatt (Beiträge zur Palæont. u. Geologie Oesterr. Ungarns, etc., XIII, p. 18), I have pointed out the near relationship which I believed to exist between *Pseudosageceras* and the Mediterranean genus *Arthaberites*, from the Alpine Muschelkalk. My statement as to this affinity, which has been questioned by Frech (Lethæa Mesozoica, I. 2, Lfg. Explanation of Pl. XXVII), has been fully confirmed by Noetling's examination of *Pseudosageceras multilobatum*.

A third species of *Pseudosageceras* was discovered by J. Perrin Smith in the lower Triassic Meekoceras beds of Idaho and California. Hyatt and Smith have published its description in their monograph of the Triassic Cephalopod genera of America (U. S. Geol. Surv. Prof. Pap. No. 40, p. 99, Pl. IV, figs. 1-3, Pl. V, figs. 1-6, Pl. LXIII, figs. 1, 2). This species, which was called *Pseudosageceras intermontanum*, is closely allied to *Ps. multilobatum* Noetl.

Among A. v. Krafft's Himálayan materials there are two specimens identical with *Pseudosageceras multilobatum* Noetl. A. v. Krafft considered them as prototypes of a new genus *Frechiceras* (General Report, Geol. Surv. of India, 1901-02, p. 5), assuming that they differed from the Siberian type of *Pseudosageceras* in the arrangement of their sutures. Noetling must have known these specimens, as is evident from his statement (l. c. p. 179) that *Ps. multilobatum* is represented both in the Salt Range and in the Himálayas. I entirely agree with him in the identification of the specimens from the Ceratite marls of the Punjab with those from the Hedenstrœmia beds of Spiti.

Since A. v. Krafft's notes on *Frechiceras* were written, Noetling's beautiful monograph on *Pseudosageceras multilobatum* has been published, giving us ample information about every detail in the development of that species. This has prevented me from leaving anything unchanged in A. v. Krafft's original description. The following diagnosis of the Himálayan specimens is therefore entirely my own work.

PSEUDOSAGECERAS MULTILOBATUM Noetling. Pl. XXI, fig. 5.

1903. *Pseudosageceras multilobatum* Noetling, Palæontographica, LI, p. 131, Pl. XIX—XXVII.

Measurements.

Diameter of the shell	123	mm.
„ „ umbilicus	2	„
Height of the last volution	76	„
Thickness of the last volution	20—25	„

This species is represented by two specimens. The larger, which has been illustrated, is entirely chambered, fairly well preserved, but slightly distorted by pressure, and partly injured on its surface by weathering. The second specimen is a fragment of the last volution, in which the umbilical region has not been preserved.

In the specimen illustrated exact measurements of the transverse section were not possible. The values of the thickness given above represent only the limits, between which this dimension may be expected to lie. But this is certain, that the shell is very strongly compressed and of discoidal shape, exactly as in Noetling's type-specimen of *Pseudosageceras multilobatum* from the Ceratite marls of the Salt Range.

The situation of the largest transverse diameter could not be ascertained in the larger specimen. In the smaller fragment, which has not been illustrated, it is situated below the middle of the height of the sides. The whorls increase

rapidly in height and are strongly involute. They are indented to less than one half their height by the inner coil.

The umbilicus is very narrow and surrounded by a vertical and high umbilical wall. The umbilical edge appears to have been rounded off, but its actual character has not been satisfactorily ascertained.

The surface of the lateral parts was probably smooth. No traces of sculpture have been discovered. The siphonal edge is acute, knife-shaped, and not bordered by marginal edges or keels.

Sutures.—The sutural lines stand so close together, that they indent each other. It is very difficult to trace one septum from the siphonal edge to the umbilical suture. The margins of the corresponding saddles can be followed along the lateral parts of the entire disc as uninterrupted concentric, spiral lines.

As there are no means of correlating this extremely complicated sutural line in detail with that of normal ammonites, I shall not apply to its elements the expressions generally used in this memoir, but shall follow Noetling in adopting the terminology proposed by him in the monograph quoted above. The terminology introduced by Noetling is the following :—

L	Corresponds	to the deepest lateral lobe.
H	,,	to all the lobes situated between this lobe and the umbilical suture.
E	,,	to the external and adventitious lobes.
a	,,	to the adventitious saddles.
e	,,	to the external saddle (situated between L and E_1).
i	,,	to all saddles between L and the umbilical suture.

Between the siphonal keel and the umbilical suture 13 lobes and an equal number of saddles are counted, besides the median prominence of the external lobe.

E is divided into five adventitious branches. All of them are bipartite, the ventral (external) digitation being the longer one. In the innermost adventitious lobe each digitation is distinctly bicuspidate. In the remaining adventitious lobes the digitations are entire.

L corresponds to Noetling's "typus V." It is tripartite, the central digitation being the largest, and all digitations are bicuspidate.

H_1—H_7 are assymmetrically bipartite. The digitations are entire, but the ventral (external) one is the longest—an exceptional character in the Salt Range specimens of *Pseudosageceras multilobatum*.

i_2—i_6 are provided with entire apices, whereas i_7 and i_8 are dimeroid.

i_2 is the highest saddle and has its apex shifted slightly towards the umbilical region of the disc, exactly as in the Salt Range specimens described by Noetling.

All the saddles are lanceolate. Those adjoining L are club-shaped. Several of the adventitious saddles are somewhat laced at their base, but i_3—i_8 are bordered by parallel or regularly diverging margins.

Geological position. Locality. Number of specimens examined.—Hedenstrœmia beds, S. E. of Muth, Spiti, 1, coll. Hayden; Lilang, Spiti, 1, coll. v. Krafft.

Remarks.—The Himálayan specimen described above agrees so closely with *Pseudosageceras multilobatum* that I do not hesitate to identify them. The acute character of the siphonal edge is also found in large examples of this species from the Ceratite marls, whereas in the majority of the specimens from the Salt Range it is sharpened into two acute carinæ, which are interrupted by a narrow median furrow. But the absence of the two external carinæ in my Himálayan specimens cannot be regarded as a distinguishing feature, because in later stages of growth in this, as in several other genera of Triassic ammonites, the two external carinæ close together entirely, with the simultaneous disappearance of the external furrow. This is the case in *Carnites* Mojs. or in *Paratibetites* Mojs., where the siphonal part is flattened and bordered by two marginal keels in the adolescent stage, but culminates externally in a blunt blade in full grown specimens of large dimensions.

A comparison of the sutural lines of *Pseudosageceras multilobatum* and of the Siberian species from the Ussuri district leads to the conclusion that the Indian species is more highly differentiated, and that the differences in the shape of lobes definitely exclude any question of identity.

Pseudosageceras intermontanum Hyatt et Smith (Triassic Cephalopod genera of America, l. c. p. 99, Pl. IV, fig. 1-3, V, figs. 1-6, LXIII, figs. 1-2) is closely allied to the present species, although probably not identical. Among the specimens illustrated by J. Perrin Smith, some are provided with a siphonal keel and some with a narrow siphonal furrow, bordered by marginal carinæ. The variability of the sutural line is rather considerable. Both *H* and the adventitious branches of *E* are more irregular than in *Ps. multilobatum*.

This American species seems to differ especially from the Indian form in its volutions, which increase more slowly, the last whorl being indented to nearly one half its height by the penultimate one, a proportion which is never reached in *Ps. multilobatum*.

Genus : Hedenstrœmia Waagen.

"*Hedenstrœmia* is one of those genera proposed by Waagen, which were based entirely on characters of the sutural line. In the general shape of the shell the genus agrees with *Meekoceras*, whereas its sutures differ in the presence of adventitious elements. This difference is, in Waagen's opinion, not only sufficient for the introduction of a new genus, but he even goes so far as to unite all genera with adventitious lobes in one family of *Pinacoceratidæ*, in spite of the fact that these genera are of very different geological age, the gaps between them not being bridged over by connecting links.

"While I do not hesitate to accept the genus *Hedenstrœmia*, whose adventitious elements allow us an easy and safe distinction from *Meekoceras*, I do not think that the genus can be classed with any family other than the *Meekoceratidæ*. On the contrary it is very probable that *Hedenstrœmia* represents a

group of forms which branched off from *Meekoceras*, *Clypites* Waag. being the connecting link between the two genera.

"Waagen proposed his genus *Clypites* for the accommodation of three species occurring in the lower Ceratite marls of the Salt Range, beds which are older than the horizon in which typical *Hedenstrœmiæ* are met with in the Himálayas. *Clypites* differs very little from *Meekoceras* (in its wider circumscription, as adopted in this memoir), together with which it is found, the adventitious elements being not very distinctly developed. This no doubt induced Hyatt (Zittel's text-book of Palæontology, English edition, Cephalopoda, p. 556) to class *Clypites* with the family of *Meekoceratidæ*.

"On the other hand Waagen strongly emphasized the near relationship between *Clypites* and *Hedenstrœmia*. The adventitious elements in the sutural line, although still in process of development, are in his opinion distinctly enough marked to characterise the genus *Clypites* as a member of his family of *Pinacoceratidæ*.

"That Waagen was right in comparing *Hedenstrœmia* with *Clypites* is proved by the occurrence of a remarkable new species in the lower Trias of Spiti. In its sutural line this species combines characters of the two genera, the adventitious saddle being as distinct as in any of the typical species of *Hedenstrœmia*, while otherwise the sutures are of the type seen in the Salt Range forms classed with *Clypites* by Waagen. This species (described as *Hedenstrœmia lilangensis* below) occurs in the horizon of *Meekoceras lilangense* and *M. Varaha*.

"Thus we come to the conclusion that *Hedenstrœmia* and *Meekoceras* are connected by *Clypites*, the latter genus therefore being the ancestor of *Hedenstrœmia*.

"The fact that *Hedenstrœmia* is derived from ancestors without adventitious elements, agrees with the results obtained by Karpinsky (Ueber die Ammoneen der Artinskstufe, Mém. Acad. Impér. des sciences, St. Pétersbourg, VII ser. Vol. XXXVII, No. 2, p. 22) and E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst. X. p. 227, 228) with regard to the ontogeny of *Medlicottia* and *Carnites*. In these two genera the adventitious elements are absent in the inner whorls and are developed in the adolescent stage of growth only, a fact which decidedly points to their ancestors having been forms with normal lobes.

"This being so, I cannot help thinking that the family of *Pinacoceratidæ*, in Waagen's interpretation, is an assemblage of very heterogeneous elements, which does not correspond to any natural group among Triassic ammonites. Without entering into a detailed discussion of this question, which lies beyond the scope of this memoir, I should like to make a few remarks on this subject.

"What we know of the genera under discussion points to adventitious lobes having been acquired by forms of very different origin at very different geological periods, in connection with flat and slightly arched whorls, which required additional inflections of the septa for the support of the fragile lateral parts of the shell. Adventitious elements therefore serve the same purpose as the auxiliary elements in the umbilical region. But I do not think that the existence of such characters, in

widely separated genera, can be looked upon as a proof that those genera belong to the same family. On the contrary I am inclined to believe that the genera with adventitious lobes are not connected phylogenetically, but that each genus with adventitious elements will be found to be nearly allied with another with normal lobes, from which it was derived. With this genus it should, consequently, be united in the same family.[1]

"In my opinion therefore, the genera, united in the family of *Pinacoceratidæ* by Waagen, are highly differentiated branches from various genera of different stratigraphical position, which probably have no phylogenetic affinity whatever.

"Of the genus *Hedenstrœmia* a few species only are known so far, and but one of them, *H. Mojsisovicsi* Dien.[2], is founded on the examination of a large number of specimens. The type, for which the genus was proposed by Waagen, is *Hedenstrœmia Hedenstrœmi* Keyserling (Beschreibung einiger von Dr. v. Middendorff mitgebrachten Ceratiten des arktischen Sibirien, Bull. phys. math. de l'Acad. Impér. des sciences, St. Pétersbourg, Vol. V, No. 11, p. 7, Pl. II, figs. 5-7, *non* Pl. III. figs. 1-6), found in a single, very badly preserved fragment at Kotelny, one of the New Siberian Islands, by Captain Hedenstrœm. Waagen further includes in his genus *Ceratites furcatus* Oeberg (E. v. Mojsisovics, Arktische Triasfaunen, Mém. Acad. Impér. des sciences, St. Pétersbourg, VII ser., Vol. XXXIII. p. 80, Pl. X, fig. 18, 19) collected in the *Posidonomya* limestone of Spitsbergen and described by Oeberg in 1877. Whether *Ceratites furcatus* actually belongs to *Hedenstrœmia* appears doubtful, for there is scarcely any median prominence to be seen in the siphonal lobe, whereas all species of *Hedenstrœmia* hitherto known are provided with a high median prominence. There are also differences in the general shape and sculpture. *Ceratites furcatus* is not compressed, but moderately inflated, and its lateral parts bear strong falciform ribs, a character unknown in typical species of *Hedenstrœmia*.

"A species nearly allied to *Hedenstrœmia Hedenstrœmi* Keyserl. from Stubendorff's collections in North-eastern Siberia, was described in 1888 by E. v. Mojsisovics (Ueber einige arktische Trias ammoniten des nœrdlichen Sibirien, Mém. Acad. Impér. des sciences, St. Pétersbourg, VII, ser. Vol. XXXVI. No. 5. p. 10, Pl. II, III. fig. 13) as *Meekoceras nov. sp. ind. ex aff. Hedenstrœmi*. It also is founded on a badly preserved fragment only. E. v. Mojsisovics considered it to be a new species, but I believe it to be most probably identical with *Hedenstrœmia Hedenstrœmi*.

"The only species of *Hedenstrœmia* known so far in large numbers is *H. Mojsisovicsi* Diener, from the horizon of *Flemingites Rohilla* of the Himálayan lower Trias, of which numerous specimens have been recently found in Spiti. This species was believed by Prof. Diener to be identical with the last mentioned form from North-eastern Siberia. The correctness of this identification is, however,

[1] This is exactly the view taken by E. v. Mojsisovics (Arktische Triasfaunen, l. c. p. 79). [C.D.]

[2] For this species the new generic name of *Anahedenstrœmia* has been proposed by Hyatt. The introduction of this new genus is, in my opinion, perfectly unnecessary. [C.D.]

doubtful, *H. Mojsisovicsi* differing from Stubendorff's fragment by being more compressed and having the adventitious saddle more distinctly individualised.

"In addition to these forms four new species from the lower Trias of the Himálayas are described in this memoir. Two of them, *Hedenstrœmia byansica* and *H. Muthiana*, have their habitat in the horizon of *Flemingites Rohilla*. While this is proved directly with respect to the latter species, it must be inferred with regard to *Hed. byansica* from its occurrence in one of the exotic blocks of Malla Johar, the fauna of which points to the horizon of *Flemingites Rohilla*. These two forms and a third one, *H. lilangensis*, which has been collected in the Meekoceras beds of Spiti, have a flattened external part, like *H. Mojsisovicsi*. A fourth new species, *H. acuta*, unfortunately represented by a fragment only, is characterised by a sharp siphonal edge. This species must therefore be considered as a representative of a special group. Among those forms, which are provided with a flattened external part, we can distinguish two subdivisions. In a geologically older one, which is nearly allied to the species of the Salt Range Ceratite marls united in the genus *Clypites* by Waagen, *H. lilangensis* must be included. The placing of this species in a special sub-division is justified by the fact that the adventitious saddle is not yet developed as distinctly as in the group of *H. Mojsisovicsi*. With the group of *Hedenstrœmia lilangensis* the genus *Clypites* Waagen should perhaps be united, its distinctive characters being too insignificant to claim sub-generic value.

"Thus we arrive at the following classification of the Indian species of *Hedenstrœmia* :—

A. Group of H. lilangensis (Clypites Waag.)

1. *Hedenstrœmia lilangensis* v. Krafft, Meekoceras beds.
2. *H. typica* Waag. } Ceratite marls.
3. „ *Kingiana* Waag. } Ceratite marls.
4. „ *evolvens* Waag. } Ceratite marls.

B. Group of H. Mojsisovicsi.

5. *Hedenstrœmia Mojsisovicsi* Dien. } All from the horizon of *Flemingites Rohilla*.
6. „ *muthiana* v. Krafft } All from the horizon of *Flemingites Rohilla*.
7. „ *byansica* v. Krafft } All from the horizon of *Flemingites Rohilla*.

C. Isolated species.

8. *Hedenstrœmia acuta* v. Krafft, probably from the horizon of *Flemingites Rohilla*."

Remarks.—Hyatt and Smith are inclined to maintain *Clypites* Waag. as an independent genus, differing from *Hedenstrœmia*, to which it is closely related, in a lesser individualisation of both its adventitious and auxiliary elements. *Clypites tenuis* Hyatt and Smith (Triassic Cephalopod genera of America, l. c. p. 103, Pl. I, figs. 4-8) differs from *Hedenstrœmia lilangensis* chiefly in its auxiliary series being much more simple. Apart from the dimeroid character of the

adventitious saddle in *H. lilangensis*, this saddle is almost equally prominent in the Indian and American species. On the other hand the Salt Range species have the adventitious saddle less distinctly developed, but the auxiliary series more complicated than in *Clypites tenuis*.

The affinities between *Clypites* and *Hedenstrœmia lilangensis* are indeed so close, that valid reasons can be urged in favour of A. v. Krafft's proposal to unite them in one genus.

A. Group of Hedenstr. lilangensis.

1. Hedenstroemia lilangensis, v. Krafft. Pl. IX, fig. 1.

Measurements.

D	. ?		
U	. 4 mm.	$\frac{A}{C}$	= 4·05
A	. cca. 44 „		
C	. . . . . 10·5 „		

"Among my collections from the topmost beds of the horizon of *Meekoceras lilangense* and *M. Varaha* near Lilang, Spiti, there is a specimen belonging to a group of forms described by Prof. Waagen under the generic name of *Clypites*.

"The general shape and transverse section are the same as in the specimens of the above mentioned group, in which respect it resembles *Hedenstrœmia*, whereas in its sutural line the characters of *Clypites* and of a typical *Hedenstrœmia* are united. The present species, which deserves a new specific name, can therefore be looked upon as a proof of the close affinity of *Clypites* and *Hedenstrœmia*, which according to my opinion, should not be generically distinguished.

"The only specimen available for examination is a cast consisting of air chambers only. The ratio $\frac{A}{C}$ is approximately 4·05 at the lower termination of the figure. The lateral parts are smooth and curved very slightly downwards to the umbilical region, where they pass into the narrow umbilicus in a strong curve. External part flattened. Siphonal area narrow, with sharp marginal edges.

"*Sutures.*—As stated above, some of the characters of the sutural line agree with those seen in *Clypites* Waagen. In my type-specimen of *Hedenstrœmia lilangensis* the external saddle is larger than the lateral saddles. This is also the case in *Clypites typicus* Waag. and in *Cl. evolvens* Waagen. The umbilical lobe resembles in its general arrangement the corresponding lobe in *Clypites Kingianus* Waag, its points being separated by double indentations. On the other hand the adventitious saddle of my Himálayan form is much more distinctly developed than in any of Waagen's Salt Range species of *Clypites*. The adventitious saddle bears a median incision, which seems to point to the adventitious elements being subject to a sub-division, exactly like that of the points of the umbilical lobe.

"The lateral lobes are deep, broad, and provided with rather coarse denticulations.

"This species, I think, should induce us to unite Waagen's genus *Clypites* with *Hedenstrœmia*. Within the latter it represents a geologically older group, whose adventitious elements are in course of rapid development, as has been pointed out by Waagen.

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Meekoceras lilangense* and *M. Varaha*, 1 mile N. of Lilang, Spiti, 1, coll. v. Kraft."

B. Group of Hedenstrœmia Mojsisovicsi.

2. Hedenstrœmia Mojsisovicsi Diener. Pl. IX, figs. 3, 4, 5, 6, X, figs. 1, 2, 3, XX, fig. 1.

1897. *Hedenstrœmia Mojsisovicsi* Dien. Himálayan Fossils, Palæont. Ind. ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 63, Pl. XX, fig. 1.
1897. *Hedenstrœmia sp. ind. ex aff. Mojsisovicsi* Diener, ibidem, p. 65, Pl. XXII, fig. 2.
1905. *Hedenstrœmia Mojsisovicsi* Frech, Lethæa Mesozoica, Vol. II, 2, Lfg. Taf. 27, fig. 4.

Measurements.

	I.	II. (Pl. X, fig. 1.)
D	63 mm.	185 mm.
U	5 „	18 „
A	35 „	92 „
C	14 „	ca. 40 „
$\frac{D}{U}$	12·6	10·27
$\frac{A}{C}$	2·5	ca. 2·3

"Thanks to the fact that this species is now available in large numbers, the description given by Prof. Diener can be added to in some points. There is, however, no specimen which promises to give a good cross-section for the study of the individual development, the mode of preservation being unfavourable for this kind of research, as in all the fossils from the horizon of *Flemingites Rohilla*.

"It is rather difficult to arrive at exact measurements, even in complete examples. The thickness especially is rarely to be measured at all, the lateral parts being nearly always either crushed or distorted. Nor can anything definite be said as to the mode of involution. It is true that from a comparison of the two specimens, the measurements and proportions of which have been given above, we might conclude that the involution is decreasing, but this suggestion would have to be proved by a larger number of measurements. I do not think it is admissible to infer from the measurements of the larger example, that the involution is decreasing, for in this specimen a part of the apertural margin of the peristome has been preserved, and this starts from the umbilicus in a direction strongly bent forward.

"For the rest of the characters of the shell I may refer to Prof. Diener's description. No trace of the shelly test has been preserved in any of my specimens.

"Length of the largest body-chamber observed, approximately 220 degrees.

"*Sutures.*—In order to show the great variability of the sutural line in *Hedenstrœmia Mojsisovicsi*, especially as regards the umbilical lobe, a number of sutures have been figured. Diener described a specimen from the horizon of *Flemingites Rohilla* S.E. of Muth, which he felt inclined to look upon as specifically different from *H. Mojsisovicsi*, because in its umbilical lobe he noticed an entire saddle, very similar in shape to the second lateral saddle. This is, however, only one of the numerous kinds of variation in this species. That this is actually so, is proved by the fact that on the reverse of the side, from which Diener took his illustration of the sutural line (l. c. Pl. XXII, fig. 2), the said point on the saddle bears a median incision (see Pl. VIII, fig. 3). This specimen can therefore safely be identified with *Hedenstrœmia Mojsisovicsi*.

"It will be seen from my illustrations that large, entire points, representing true auxiliary saddles, are not uncommonly present in the umbilical lobe of this species. In one of the large examples from Muth such a point is broadly flattened on its top (Pl. IX, fig. 4).

"This adventitious lobe is also subject to considerable variation. The differences, which Diener deemed important in the specimen alluded to above are therefore of as little weight as those seen in the umbilical lobe

"*Geological position. Locality. Number of specimens examined.*—Horizon of *Flemingites Rohilla* (Hedenstrœmia beds); S. E. of Muth, Spiti, 12, coll. Hayden, 3, coll. A. v. Krafft; 5 miles S. of Ensa, 1, coll. Hayden; 1 mile N. of Lilang, 2, coll. v. Krafft.

"Chocolate Limestone, lower Trias; Jolinka E. G., Kuti Yangti valley, Byans, 1, coll. Smith.

"*Remarks.*—Diener states in his description of *Hedenstrœmia Mojsisovicsi*, that this species is probably identical with a fragment of *Hedenstrœmia* from the lower Trias of Eastern Siberia, described by E. v. Mojsisovics as *Meekoceras nov form indet. ex aff. Hedenstrœmi* (Ueber einige Arktische Triasammoniten des noerdl. Sibirien, Mém. Acad. Imp. des sciences St. Pétersbourg, VII ser. Vol. XXXVI, No. 5, 1888, p. 10, Pl. II, III, fig. 13).

"This identification is, in my opinion, open to doubt. As far as I may venture to judge from such a badly preserved fragment as the Arctic form in question, I should rather think that it is specifically different from *H. Mojsisovicsi*. In the sutural line especially I find one considerable difference, which seems to have escaped Diener's notice. To judge from the illustration on Pl. III, fig. 13 in E. v. Mojsisovics' memoir, the first adventitious saddle is much lower on its external than on its internal slope. Were this saddle of the same shape as in *H. Mojsisovicsi*, it should, although weathered, be more strongly bent downward. As it is, this saddle appears to me to be of the same character as in *H. Hedenstrœmi* Keyserl. from Kotelny, to which it has been compared by E. v. Mojsisovics. This learned author

himself remarks (p. 11) that the siphonal lobe (external lobe in his description) was probably very short, exactly as in *H. Hedenstrœmi*. This seems to point to an identity of the two Arctic species.

"E. v. Mojsisovics separated them, chiefly on the ground that in Keyserling's figure the saddles are represented as broadly rounded, whereas they are very highly rounded in the specimen collected by Stubendorff. But this difference is probably due to incorrect drawing only. The two specimens appear to be otherwise so nearly allied that I prefer to unite them provisionally in one single species, *Hedenstrœmia Hedenstrœmi*, which must be kept separate from the Indian *H. Mojsisovicsi*."

To the above notes of A. v. Krafft I have only to add, that an identification of *Hedenstrœmia nov. sp. ind. ex aff. Hedenstrœmi* with *H. Hedenstrœmi* appears to me even more doubtful than with *H. Mojsisovicsi*. Stubendorff's fragment from North-eastern Siberia and my Himálayan species agree in all their characters available for examination. As to the difference in the shape of the adventitious saddle, suggested by A. v. Krafft, it cannot be confirmed, because the septum of the Siberian fragment is not known beyond the apex of the adventitious saddle. That it was compared to that of *H. Hedenstrœmi* by E. v. Mojsisovics is easily understood, no other species of *Hedenstrœmia* being known at that time.

Nevertheless I agree with A. v. Krafft in thinking it best to keep the two forms separate for the present, until new and better materials of the Siberian species may be found to show whether or not they actually agree in the shape of their adventitious saddles. But for the same reason the two specimens from Siberia, collected by Stubendorff and Hedenstrœm, must be kept separate. Nor will it be possible for the present to include them in the same sub-division of *Hedenstrœmia*, as has been proposed by A. v. Krafft.

An American species very closely allied to *H. Mojsisovicsi* has been described from the lower Triassic Meekoceras beds of Idaho and California by Hyatt and Smith (Triassic Cephalopod genera of America, l. c. p. 101, Pl. LXVII, figs. 3-7, LXXXIV, figs. 1-10). It seems to differ from the Indian species only in the narrowness of its umbilicus. But this is a constant feature of distinction, specimens of *H. Mojsisovicsi* equalling the largest type-specimen of *H. Kossmati* in size, being provided with twice as large an umbilicus.

Hedenstrœmia Mojsisovicsi has recently been quoted by Noetling (Lethæa Mesozoica, I, 2, Lfg. Asiatische Trias, p. 165) among the fossils from the zone of *Flemingites flemingianus* in the Ceratite sandstone of the Salt Range.

3. Hedenstrœmia byansica v. Krafft. Pl. VIII, fig. 2, XXX, figs. 8, 9.

Measurements.

D	95 mm.
U	16·5 „

A	44	mm.
C	22	„
$\frac{a}{c}$ Measured near the beginning of the last volution	31	„
	14	„
$\frac{D}{U}$	5·75	
$\frac{A}{C}$	2	
$\frac{a}{c}$	2·21	

"This interesting species is distinguished from *Hedenstræmia Mojsisovicsi* by a thicker transverse section, a wider umbilicus, a broad external part and some minor differences in the arrangement of the sutural line. The rate of involution seems to be decreasing, but having at hand only one specimen, no cross-section could be made.

"The external part is flattened, with sharp marginal edges. The siphonal area grows broader in proportion to the thickness of the volution. As the measurements given above show, the last whorl is shorter near its anterior termination (body-chamber) than near its beginning.

"On the chambered portion of my specimen the lateral parts are arched all over but they become more and more compressed in the umbilical region of the body-chamber, and thus ultimately become even slightly concave. The height of the perpendicular umbilical wall accordingly decreases on the body-chamber. The umbilical edge is acute. Near the anterior termination two radial furrows are seen, of which the one situated nearest the broken end of the specimen is the deeper.

"Length of the body-chamber approximately one-half volution. No shell is preserved.

"*Sutures.*—Siphonal lobe broad, with a moderately high median prominence. Adventitious saddle club-shaped. External saddle* agreeing in shape with the adventitious saddle, but considerably higher and larger. Second lateral lobe very shallow; second lateral saddle broad and low. Umbilical lobe with several irregular points or auxiliary saddles.

"*Geological position. Locality. Number of specimens examined.*—Chocolate Limestone, probably from the horizon of *Flemingites Rohilla*, Jolinka E. G., Byans, 1, coll. F. H. Smith.

"*Remarks.*—A species identical with or very nearly allied to *Hedenstræmia byansica* was collected in the red limestone of the exotic block No. 20, to the W. of the Kiogarh-Chirchun pass in Malla Johar. My examples from this locality are of much smaller size than the specimen from Byans, but for all that their specific identity can be established with great probability.

* "I prefer to use the term (external saddle) for the saddle which is situated between the adventitious lobe and the principal lateral lobe, instead of second adventitious saddle. This saddle is indeed no adventitious element, but corresponds to the external saddle of ammonites without adventitious lobes."

"These two specimens have been illustrated on Pl. XXX, figs. 8, 19. Their measurements are as follow—

	I.	II.
D	35 mm.	44 mm.
U	cca. 2·5 „	cca. 3·5 „
A	18·5 „	25 „
C	7 „	10·5 „
$\frac{D}{U}$	cca. 14	cca. 12·57
$\frac{A}{C}$	2·64	2·38

"A comparison of the above measurements and proportions with those of the type of the species is sufficient to show that the umbilicus in the small specimens from the exotic blocks is considerably narrower. But this is not surprising, for the shape of the umbilicus of the type distinctly points to a decrease of the ratio of involution. A narrow umbilicus is therefore *a priori* to be expected in smaller specimens.

"My examples from the exotic block are more strongly compressed than the type-specimen from Byans. But this also is in accordance with the mode of growth of our species, for it was shown in the description of the type that it is compressed more strongly at the beginning than at the end of the last volution. The smaller the specimens, the more compressed they must be, at least in the adolescent stage of growth, and this is exactly what we find in the specimens from Johar.

"There are, on the other hand, some important features which point directly to the identity of the specimens from Byans and Malla Johar. The two specimens from the exotic block No. 20 are provided with a comparatively broad siphonal area, and agree perfectly with *Hedenstræmia byansica* in their transverse sections. There can be no question of *Hedenstræmia Mojsisovicsi* Dien., young examples of this species having always a very narrow siphonal part.

"One character of distinction may be noticed. The type-specimen from Byans has compressed flanks in the umbilical region of the body-chamber. This character is not seen in the two specimens from Malla Johar. But as in none of them has a portion of the body-chamber, of any considerable length, been preserved, this differentiating feature is not opposed to a specific identity.

"*Sutures.*—I have been able to examine the sutural line in only one of my specimens. In general its sutures agree with those of the type-specimen from Byans. The differences are insignificant. The principal and second lateral saddles are higher than in the type. After the second lateral saddle several delicate denticulations follow, which are absent in the type. Otherwise the umbilical lobe, as far as it is visible, agrees with that in the specimen from Byans.

"Besides *Hedenstræmia byansica* there are several badly preserved specimens of *Hedenstræmia* in my collection from the exotic block No. 20 in Malla Johar. Some of them resemble *H. Mojsis§icsi* in their transverse sections. As the sutures could not be developed, they do not deserve a special description."

4. Hedenstrœmia Muthiana v. Krafft. Pl. IX, fig. 7.

Measurements.

D	.	cca. 110	mm.
U	.	9	„
A	.	66	„
C	.	28	„
$\frac{A}{C}$	.	2·35	

"Although there is but one fragmentary specimen of this species available I think myself justified in introducing a new specific name, as the characters of importance are all well marked.

"The external part is flattened and has somewhat obtuse marginal edges. The greatest transverse diameter is situated slightly below the middle of the lateral parts. Umbilicus narrow, with a high, perpendicular wall, bordered by an obtuse edge.

"With the exception of some indistinct folds no sculpture is seen.

"My type-specimen is a cast, consisting of air-chambers only, without any remnants of the shelly test.

"*Sutures.*—Remarkable features are seen in the umbilical and adventitious elements of the sutural line. Siphonal lobe broad, with a moderately high median prominence. Adventitious saddle very slender, angular at its top, equalling in height the median prominence of the siphonal lobe. Adventitious lobe as deep as the principal lateral lobe. Among the points of the umbilical lobe one is large and bipartite, with two finger-shaped branches. The other points are small and entire.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds (horizon of *Flemingites Rohilla*), S. E. of Muth, Spiti, 1, coll. Hayden."

c. Isolated Species.

5. Hedenstrœmia acuta v. Krafft. Pl. IX, fig. 2.

"The present species is the only representative of a group of forms which differs from typical species of *Hedenstrœmia* in its sharp external part; but in my opinion it should nevertheless be included in that genus, as the characters of the siphonal part appear to me to be generally of small systematic importance, and are therefore not sufficient to distinguish genera, unless associated with other peculiar features.

"In my collection *Hedenstrœmia acuta* is represented only by a single fragment of a cast, which is entirely chambered and consists of somewhat more than one half volution. It has a diameter of 45 mm. Its thickness is 8 mm. at the anterior termination.

"The external part is sharpened into an acute edge, which is separated from the lateral parts by very shallow and indistinct furrows. The sides are strongly curved near the external part, but are flattened on the lower half. The umbilicus, which is no doubt very narrow, has not been preserved. The largest transverse diameter is situated above the middle of the smooth lateral parts.

"*Sutures.*—The characters of the sutures are those seen in the genus *Hedenstrœmia*, although they exhibit certain peculiarities. The siphonal and principal lateral saddles are very broad and short, whereas the second lateral saddle is of small size. Siphonal lobe narrow, adventitious saddle very slender. The external saddle is, so to speak, the reflected image of the principal lateral saddle. The umbilical lobe is but partly preserved.

" *Geological position. Locality. Number of specimens examined.*—Chocolate Limestone, probably from the horizon of *Flemingites Rohilla*, Jolinka E. G., Kuti Yangti Valley, Byans, 1, coll. Smith."

Remarks.—In agreement with A. v. Krafft I have classed this species provisionally with *Hedenstrœmia*, but I am not fully convinced of the correctness of including it in that genus. It is true that in several Triassic genera of ammonites with discoform shells and adventitious lobes (*Carnites*, *Pseudosageceras*) the shape of the external part is of no systematic value, but in *Hedenstrœmia acuta* the acute character of the siphonal edge is united with some other peculiarities, which together impart to that species a shape differing rather considerably from the type of the genus *Hedenstrœmia*.

I wish to draw special attention to the remarkable similarity of the present species with *Aspenites acutus* Hyatt et Smith (Triassic Cephalopod genera of America, l. c. p. 96, Pl. II, figs. 9-13, III, figs. 1-5) from the *Meekoceras* beds of California and Idaho. In their external features the two species agree almost completely. It is only the difference in the development of their sutural lines which enables us to separate them. The sutures of *Aspenites* are less complicated than those in *Hedenstrœmia*, but are arranged in general on the same plan, although at a first glance they seem to differ widely in respect of their low and broadly vaulted saddles.

I do not propose to include our Himálayan species in the genus *Aspenites*, but I think that, with larger materials available for examination, it may perhaps turn out to connect *Aspenites* and *Hedenstrœmia* as closely as *Clypites* Waagen is linked to the latter genus by *Hedenstrœmia lilangensis*.

Nov. gen. ind. ex aff. Hedenstrœmia. Pl. XXIX, fig. 2.

This new genus is, unfortunately, represented only by a single fragment from the topmost layers of the Meekoceras beds of Lilang, where it was found by A. v. Krafft, together with a specimen of *Meekoceras Varaha* Dien.

The specimen is too badly preserved for illustration or for the introduction of a specific name. The shell is described sufficiently by saying that it closely

resembles *Pseudosageceras multilobatum* Noetl. External part acute, knife-like. Umbilicus not preserved, but apparently very narrow. No sculpture. The diameter of this fragment, which consists of air-chambers only, is about 38 mm.

Sutures.—This fragment deserves special mention, on account of the peculiar character of its sutural line, which is more complicated than in *Hedenstrœmia*, but less so than in *Pseudosageceras*. If we adopt the terminology of sutural elements which has been proposed by Noetling in his memoir on the development of septa in *Pseudosageceras multilobatum* (Palæontographica, LI, p. 155), the arrangement of the sutures corresponds to the following plan:—

L, the deepest lobe, is ceratitic, with parallel margins, and serrated along its base. The branches of *H* are either bipartite or terminate in a single point. Of the three adventitious branches of *E* the two ventral ones are bicuspidate, the third dorsal one is tripartite. The saddles, e_1 and *m*, are slender, with parallel margins and regularly rounded tops, i_2 is broad and low, i_1 is dimeroid. The following saddles are not distinctly individualised.

This sutural line marks to some extent a stage intermediate between *Hedenstrœmia* and *Pseudosageceras*, but approaches *Hedenstrœmia* more closely in the ceratitic shape of *L* and in the small number of adventitious elements.

The presence of this new genus in the horizon of *Meekoceras Varaha* and *Meek. lilangense* confirms Noetling's statement, that it is not safe to determine the geological age of a horizon according to the higher or lesser differentiation of the sutures of its ammonites. The specimen described above has more complicated sutures than *Hedenstrœmia*, although it makes its appearance in the lower division of the Himálayan lower Trias, together with *Hedenstrœmia lilangensis*, a connecting link between *Hedenstrœmia* and *Clypites*, whereas the group of *Hedenstrœmia Mojsisovicsi* is characteristic of the upper division.

Geological position. Locality. Number of specimens examined.—Meekoceras beds, Lilang, Spiti, 1, coll. v. Krafft.

Genus: Prosphingites v. Mojs.

Prosphingites Nala Diener.

1897. *Prosphingites Nala* Diener, Himálayan Foss., Palæont. Indica, ser. XV, Vol. II, Pt. 1, The Cephalopoda of the lower Trias, p. 54, Pl. I, fig. 4, Pl. VII, fig. 13.

1899. *Anotoceras Nala* Hyatt, Cephalopoda, in Zittel's Text-book of Palæontology, English ed., Vol. I, p. 553.

This species has been considered as the prototype of a proper genus *Anotoceras* by Hyatt, who unites it with *Otoceras* Griesb. in the family of *Otoceratidæ*, forming part of his section of *Nannitidæ*.

That Hyatt did not change his view before his death is evident from his remark in the monograph of the Triassic Cephalopod genera of America (l. c. p. 72), that *Prosphingites* is only known from the Arctic-Pacific region, not from India. Unfortunately he has not stated the reasons which induced him to remove *Prosphingites Nala* from the genus *Prosphingites*. In his diagnosis of the latter the

following characters are enumerated as leading ones: "Sub-globose, laterally compressed, with helmet-shaped whorls and highly arched venter; umbilicus deep and showing the inner volutions; surface smooth, except the cross-striæ of growth. Septa consisting of an external and two lateral serrated lobes, and a fourth lobe, goniatitic in character, on the umbilical border."

Now all those features are developed as distinctly in the two Indian species *Prosphingites Nala* Dien. and *P. Kama* Dien., as in the prototype of the genus *P. Czekanowskii* v. Mojsisovics (Arktische Triasfaunen, Mém. Acad. Impér. des sciences St. Pétersbourg, VII sér., T. XXXIII, No. 6, p. 64, Taf. XV, figs. 10-12). They are, indeed, marked in these Himálayan species much more clearly than in the American *Prosphingites Austini* Hyatt et Smith (Triassic Cephalopod genera of America, l. c. p. 72, Pl. VII, figs. 1-4), which is included in this genus, notwithstanding the presence of deep periodic constrictions or varices, which have never been noticed in *P. Czekanowskii*, and the absence of a distinctly helmet-shaped cross-section in the last volution.

The advisability of including *P. Austini* in the genus *Prosphingites* v. Mojs. is therefore questionable, and there are some strong reasons in favour of grouping it with the genus *Popanoceras* Hyatt.

Being at a loss to find any distinctive features of generic importance between my Himálayan species and *Prosphingites Czekanowskii*, I am obliged to leave it in that genus and to drop the new generic name of *Anotoceras*.

A specimen which belongs most probably to *P. Nala* was collected from the Otoceras beds 5 miles S. of Ensa, Spiti, by H. H. Hayden.

B. NAUTILOIDEA.

Genus: PLEURONAUTILUS v. Mojs.

PLEURONAUTILUS DIENERI v. Krafft. Pl. XXVIII, fig. 5.

1897. *Pleuronautilus sp. ind.* Diener, Himálayan Fossils, Palæont. Indica, ser. XV, Vol. II, Pt. 1, Cephalopoda of the lower Trias, p. 14, Pl. XXIII, fig. 6.

Measurements.

D	50	mm.	$\frac{D}{U} = 3{\cdot}12$
U	16	„	
A	20	„	$\frac{A}{C} = 1{\cdot}0$
C	20	„	

"The present species of *Pleuronautilus* is probably identical with *Pleuronautilus sp. ind.* described by Prof. Diener from the upper division of the lower Trias of Kiunglung E. G., in the Niti district. Diener's specimen has been unfortunately too much injured by weathering to establish the identity with full safety.

"I have grouped this species with the genus *Pleuronautilus* on account of its sculpture and sutures, but I am unable to say whether the umbilicus was perforated or not, as I did not succeed in clearing it from the tough matrix. The transverse section forms very nearly a square with rounded edges. Lateral parts arched very slightly, largest transverse diameter corresponding with the middle of the sides. Umbilical edge slightly rounded, umbilical wall high and steep. Marginal edges rounded, external part flattened on the chambered portion of the shell. On the body-chamber a shallow concavity sets in, which becomes gradually deeper towards the anterior termination.

"*Sculpture.*—The sides are covered with numerous ribs originating from indistinct, low tubercles, which are arranged along the siphonal edge. The ribs are not quite radial, but are slightly falciform on the chambered part of the shell. On the body-chamber they are nearly straight, but bent a little backwards. At the same time they seem to be grouped in pairs, each pair originating from one umbilical tubercle. Along the marginal edge the ribs terminate in low, rounded knobs, exactly as in the chambered part of the shell.

"*Body-chamber.*—The length of the body-chamber is a little less than one half a volution in the specimen illustrated. No remains of the shelly test have been preserved.

"*Siphuncle.*—In two fragmentary specimens of this species (not figured) the siphuncle can be seen to be situated a little below the centre of the volution.

"*Sutures.*—Lateral lobe very flat. The septa cannot be traced across the external part.

"*Geological position. Locality. Number of specimens examined.*—Hedenstrœmia beds, S. E. of Muth, Spiti, 3, coll. Hayden.

"*Remarks.*—As stated above, the species here described is probably identical with Diener's *Pleuronautilus sp. ind.* from Kiunglung. In sculpture, involution, and in the characters of the umbilicus the two species agree pretty well, as far as this can be made out from an example so badly weathered as Prof. Diener's type-specimen."

A. v. Krafft compared this species to *Pleuronautilus esinensis* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 276, Taf. LXXXVI, fig. 6) from the ladinic stage of the South-eastern Alps. *Pleuronautilus esinensis* resembles, it is true, *Pl. Dieneri* in its general shape, transverse section and involution, but has no dichotomising ribs on the body-chamber and its ribs are more distinctly falciform. The inner volutions of the Alpine species are smooth, which probably was not the case in the Himálayan form. To me it seems rather doubtful whether there is any close affinity between these two species.

A species which is certainly more nearly allied to the present one, is *Pleuronautilus Kokeni* Frech (in Noetling, Asiatische Trias, Lethæa Mesozoica, Part II, Vol. I, Taf. 25, fig. 4) from the main mass of the Ceratite marls in the Salt Range (zone of *Prionolobus volutus* Noetl.)

The two species agree in their sculpture, which in both of them consists of

slightly curved ribs, marking a transitional stage between the ornamentation of *Mojsvaroceras* Hyatt and *Pleuronautilus* v. Mojs. In *Pleuronautilus Kokeni* the siphonal area is provided with two distinct spiral ridges. But similar ridges are also present in *Pl. Dieneri*. Although they have been obliterated by weathering on the cast, faint traces are still visible in several places. Whether spiral striæ were developed in the Himálayan form, as in *Pl. Kokeni*, could not be ascertained.

Pleuronautilus Dieneri is the most primitive species of that genus hitherto known. It is a transitional form connecting *Pleurnoautilus* v. Mojs. and *Mojsvaroceras* Hyatt. E. v. Mojsisovics (Cephalopoden der Hallstætter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, Supplementheft., p. 233) considered the specimen from the Hedenstrœmia beds of Kiunglung, which A. v. Krafft identifies with *Pl. Dieneri*, to be a probable representative of the genus *Mojsvaroceras*. The lateral soulpture of the body-chamber is the same as is found in typical species of *Mojsvaroceras* from the Permian rocks of Russia and Armenia (*M. Verae* Arth.), and from the Bosnian Muschelkalk, as described by F. v. Hauer. But on the chambered part of the last volution the straight pilæ assume the shape of falciform ribs, as in *Pleuronautilus*.

Attributing to the latter feature a greater systematic value, I prefer to follow A. v. Krafft in including his new species in the genus *Pleuronautilus*.

Genus: Grypoceras Hyatt.

Grypoceras lilangense, nov. sp. Pl. XXVIII, fig. 1.

A large specimen of *Grypoceras*, which has been identified with *Nautilus brahmanicus* Griesb. by A. v. Krafft, differs from this species of the Otoceras beds in some characters of specific importance, which require its separation.

The present species is very closely allied to *Grypoceras brahmanicum* Griesbach (Palæontological notes on the lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, p. 107, Pl. I, figs. 1-3), from the stage of *Otoceras Woodwardi*. It is distinguished by the following features.

The volutions overlap one another to more than one half their height. In the chambered part of the shell the greatest transverse diameter coincides with the umbilical margin, as in *Grypoceras brahmanicum*, but is gradually shifted towards the middle of the lateral parts in the body-chamber. In the meantime the flanks become more flatly and regularly curved and the height of the last volution increases considerably in proportion to its thickness. Both the umbilical and siphonal margins are less distinctly marked than in *Grypoceras brahmanicum*. In the shape of its transverse section our new species holds an intermediate position between the latter form and the fragment from the Hedenstrœmia beds of the Shalshal cliff, which has been described as *Nautilus sp. ind. ex aff. Palladii* in my memoir on the Cephalopoda of the Himálayan lower Trias (Palæont. Ind., ser. XV, Vol. II, Pt. 1, p. 14, Pl. XXIII, fig. 7). In the posterior half of the last volution the siphonal

area is still evenly rounded, not flattened. It is only in the body-chamber that it becomes flat and provided with a low, median depression.

The most remarkable difference between *Grypoceras lilangense* and *G. brahmanicum* is the strongly compressed shape of the whorls in the latter species. In *G. brahmanicum* height and thickness are of nearly equal dimensions. In my type-specimen of *G. lilangense* a height of 69 mm. corresponds to a width of 50 mm. only at the beginning of the body-chamber, and near the aperture the last whorl is almost twice as high as it is broad.

Dimensions.

Diameter of the shell		cca. 212 mm.
„ „ „ umbilicus		33 „
Height	of the last volution	135 „
Thickness		cca. 72 „

My specimen is nearly complete, one half of the last volution belonging to the body-chamber.

Sutures.—Agreeing entirely with those of *Gryp. brahmanicum*, as illustrated on Pl. 1, fig. 2 of my memoir quoted above.

Siphuncle.—Not known.

Locality and geological position. Number of specimens examined.—Lilang, Spiti, Meekoceras beds, horizon of *Meekoceras lilangense* and *M. Varaha*, 1, coll. v. Krafft.

SUMMARY.

BY

C. DIENER.

The limestones and shales of lower Triassic age above the Permian Productus shales include at least four different faunæ.

Of these the lowest one is contained in the Otoceras beds of Painkhanda and Spiti. In the narrow circumscription introduced by Noetling, the *Otoceras beds s. s.* do not reach more than three feet in thickness in the Shalshal cliff and only a few inches more in Spiti, according to the observations of A. v. Krafft and Hayden. All the beds following, up to the base of the Hedenstrœmia stage (Subrobustus beds *antea*), have been separated from the Otoceras beds as an independent stratigraphical horizon by Noetling and A. v. Krafft. The separation of this horizon, which was afterwards called " Meekoceras beds " is fully justified by the discovery of the fauna of *Meekoceras Markhami* in Painkhanda by Noetling, and of *Meekoceras lilangense* and *M. Varaha* in Spiti by A. v. Krafft.

The overwhelming majority of the fossils which have been described in my memoir on the Cephalopoda from the lower Trias of the Himálayas (Himálayan Foss., l. c. Vol. II, Pt. 1, p. 167), as coming from the Otoceras beds, actually belong

to this division also, if the latter is taken in the narrower circumscription proposed by Noetling and A. v. Krafft. This remark applies particularly to those species which were collected by myself in the Otoceras beds of the Shalshal cliff, whereas the origin of a small number of specimens from Spiti and from the Lissar valley is doubtful. From the Meekoceras beds fragmentary examples only (*Meekoceras boreale*, *M. Varaha*) were known to me from the section of the Shalshal cliff. I had therefore no opportunity of recognizing the stratigraphical importance of this horizon, which was later on discovered by Noetling.

Among the Cephalopoda described by myself from the Otoceras beds of the Himálayas, the following can, according to the present state of our knowledge, be declared with full certainty to belong to this horizon in the new interpretation :—

Grypoceras brahmanicum Griesb.
Xenodiscus himalayanus Griesb.[1]
Episageceras Dalailamæ Dien.[2]
Proptychites Scheibleri Dien.
Ophiceras Sakuntala Dien.
„ *medium* Griesb.
„ *tibeticum* Griesb.
„ *gibbosum* Griesb.
„ *demissum* Oppel.
„ *ptychodes* Dien.
„ *chamunda* Dien.
„ *platyspira* Dien.
„ *serpentinum* Dien.[3]
Vishnuites Pralambha Dien.
Hungarites sp. ind.
Otoceras Woodwardi Griesb.
„ *undatum* Griesb.
„ *Clivei* Dien.
„ *Draupadi* Dien.
„ *Parbati* Dien.
„ *fissisellatum* Dien.
Meekoceras Hodgsoni Dien.
Prosphingites Kama Dien.

The rest of the species are mostly of doubtful geological position. The only type, whose horizon in the Meekoceras beds has been established with great probability, is *Meekoceras Varaha* Dien. found by Noetling in the horizon of *Meekoceras Markhami* and by A. v. Krafft in the corresponding beds at Lilang.

It is not possible to come to a decisive conclusion as to the rest of the types. The specimens from the Otoceras beds (in a wider sense) of Spiti and of the Lissar valley, which were collected by Griesbach, all bear the mark "bed 2" or "horizon of *Otoceras Woodwardi*," but we have ample proof that Griesbach included in

[1] The type of this species is imbedded in a slab of limestone, along with *Otoceras Woodwardi*.
[2] Found in the main-layer of *Otoceras Woodwardi* and in shales immediately overlying this.
[3] To these species must be added *Ophiceras stricturatum* Frech et Noetling.

"bed 2" also beds of younger age than the main layer of *Otoceras Woodwardi*. This is proved for instance with reference to a specimen of *Danubites* (*Xenodiscus*) *Purusha*, the sutures of which have been figured in my memoir, Pl. XV, fig. 15. It was collected from bed 2 at Kuling, according to Griesbach's original label, but its state of preservation as well as the great similarity with *Xenodiscus Kapila* suggest its being derived from the upper division of the lower Trias. I therefore (l. c. p. 165) mentioned this species among the types from the Hedenstrœmia beds of Spiti.

For this reason it would not be safe to attribute all the types said to be found in bed 2 (Griesbach) to the Otoceras beds, but the origin of those enumerated above has been established with complete certainty.

Among the Lamellibranchiata described by A. Bittner in Himálayan Fossils, Vol. III, Pt. 2, *Pseudomonotis Griesbachi* is the leading species of the Otoceras beds, both in Painkhanda and Spiti. In the Shalshal cliff section Noetling found its main layer on the top of the limestone bed containing *Otoceras Woodwardi*. In Spiti it is most common in the beds containing *Ophiceras* and immediately overlying the ferruginous limestone with *Otoceras*.

In the section of the Shalshal cliff near Rimkin Paiar E. G., the Otoceras beds *sens. str.* are represented by four bands of limestone and shale, measuring together 85 cm. in thickness. Three of them have yielded fossils. The lowest band is the main layer of *Otoceras Woodwardi*. In the topmost band *Ophiceras tibeticum* Griesb. predominates, whereas *Otoceras* is rare. The intermediate shales are very poor in fossils. *Proptychites Scheibleri* and *Medlicottia* (*Episageceras*) *Dalailamæ* were the only ammonites collected in these beds.

Noetling considers each of those three faunæ to represent a special zone. He therefore distinguishes (Neues Jahrb. f. Min., etc., Beilagebd., XVIII, 1904, p. 528) the following three zones among the Otoceras beds of Painkhanda :—

3. Zone of *Ophiceras tibeticum* Griesb.
2. Zone of *Episageceras Dalailamæ* Dien.
1. Zone of *Otoceras Woodwardi* Griesb.

It is worth mentioning that in 1901 (Lethæa Palæozoica, Dyas, Vol. II, p. 656) two different zones only were distinguished by Noetling, the lower of them corresponding to the main layer of *Otoceras Woodwardi*, and the upper one being characterised by the predominance of *Ophiceras*.

In my memoir on the stratigraphical position of the Otoceras beds (Centralblatt f. Min., 1905, p. 2) I have raised strong objections against this purely artificial distinction of separate palæontological zones among the uniform fauna of the Otoceras beds. There is not one faunistic element in the faunæ of the three fossiliferous bands, which could justify their separation. *Ophiceras tibeticum* is not restricted to the topmost layer, nor is *Otoceras Woodwardi* to the base, whereas *Episageceras Dalailamæ* is known both from the main layer of *Otoceras Woodwardi* and from the overlying shales. What has been termed "zone" by Noetling is a minute subdivision of the Otoceras beds of local value only, but has nothing whatever to do with true palæontological zones, as distinguished in the Liassic and Jurassic

systems by Oppel and Neumayr. In stratigraphical importance Noetling's zones scarcely equal Buckman's "hemeræ".

In Spiti the genus *Otoceras* has a smaller vertical distribution than in Painkhanda, being restricted there to the lowest bed of the Otoceras stage and completely absent in the higher beds, which are rich in *Ophiceras Sakuntala*. But this absence of *Otoceras* is the only feature of distinction between the faunæ of the lower and higher beds, which are otherwise identical. The species of *Ophiceras* are distributed throughout the Otoceras beds. Among Hayden's collections from 5 miles S. of Ensa there is a specimen of *Otoceras Woodwardi* imbedded in a slab of limestone together with a fragment of *Ophiceras Sakuntala*. A second specimen of *Otoceras sp. ind.* occurring together with *Ophiceras*, from Lilang, is marked on the label as coming from the ferruginous layer immediately above the Productus, or Kuling, shales.

he two horizons, which have been distinguished as zone of *Otoceras Woodwardi* and zone of *Ophiceras Sakuntala* by A. v. Krafft (General Report, Geol. Surv. of India for 1900-01, p. 4), are therefore most closely linked together by a uniform fauna. The absence of *Otoceras* in the higher bed is no sufficient reason for separating two palæontological zones, *Otoceras* being altogether rare in Spiti, whereas the predominating types of *Ophiceras* persist throughout the entire series of rocks included between the Kuling shales and Meekoceras beds.

Since there exist no valid reasons for a distinction of two or three separate zones in the Otoceras stage, I prefer to consider the fauna of the Otoceras beds as representing one single zone only, which, from its two most conspicuous elements, may be called "*Zone of Otoceras Woodwardi and Ophiceras Sakuntala.*"

It is only in the Meekoceras beds of Painkhanda and Spiti that we find the next distinct stratigraphical horizon containing a fauna actually differing from that of the Otoceras stage, and which must be considered as representing a special palæontological zone.

The fauna of the Meekoceras beds consists of the following species of Cephalopoda:—

Meekoceras Varaha Dien.
„ *Markhami* Dien.
„ *lilangense* v. Krafft.
„ *lingtiense* v. Krafft.
„ *shalshalense* v. Krafft.
„ *tenuistriatum* v. Krafft.
„ *rugosum* v. Krafft.
„ *jolinkense* v. Krafft.
„ *disciforme* v. Krafft.
„ *cf. discus* Waag.
Aspidites spitiensis v. Krafft.
„ *ensanus* v. Krafft.
„ *crassus* v. Krafft.
Koninckites Haydeni v. Krafft.
„ *alterammonoides* v. Krafft.

Ophiceras obtuso-angulatum Dien.
Xenodiscus lilangensis v. Krafft.
Hedenstræmia lilangensis v. Krafft.
Nov. gen. ex aff. Hedenstræmia sp. ind.
Grypoceras lilangense Dien.

It is, however, impossible to say how many among these 20 species are restricted to the Meekoceras beds and do not extend to the topmost bed of the underlying Otoceras stage. Six species, namely:—

Meekoceras Varaha Dien.
„ *Markhami* Dien.
„ *disciforme* v. Krafft
Aspidites ensanus v. Krafft
„ *spitiensis* v. Krafft
Koninckites Haydeni v. Krafft
Xenodiscus lilangensis v. Krafft

are represented, among A. v. Krafft's and Hayden's collections from localities where those authors have not succeeded in separating the fossils from the Otoceras and Meekoceras beds. We cannot therefore deny the possibility that some of them at least are common to both stages.

There is one species which certainly connects the two faunæ occurring in both of them, and this is *Xenodiscus radians* Waagen. The question is more complicated as regards *Meekoceras Varaha* Dien. In his stratigraphical notes on the Mesozoic rocks of Spiti (General Report, Geol. Surv. of India for 1899-1900, p. 200), A. v. Krafft quotes *Meekoceras Varaha*, *M. boreale* and two new species of *Meekoceras* from the grey limestone with *Ophiceras Sakuntala* and *Pseudomonotis Griesbachi* in the section of Lilang. The presence of *Meekoceras Varaha* in the bed with *Ophiceras*, underlying the Meekoceras stage, has also been emphasised by Hayden (Geology of Spiti, Mem. Geol. Surv. of India, Vol. XXXVI, Pt. 1, p. 63, 65), who expressly remarks, in contradiction to Noetling, that the genus *Meekoceras* has also been found in the *Ophiceras* zone of Spiti. On the other hand I am bound to confess that the specimens in A. v. Krafft's collection, which I have examined, are marked as having been found in the horizon of *Meekoceras lilangense* and *Meekoceras Varaha*, that is to say, in the Meekoceras beds.

Thus the question of the presence or absence of *Meekoceras Varaha* in the bed with *Ophiceras Sakuntala* in Spiti cannot be considered as beyond dispute.

Koninckites Haydeni is also probably common to the Otoceras and Meekoceras stages. The majority of the specimens were found by A. v. Krafft in the horizon of *Meekoceras lilangense*, but there is one specimen, collected by Hayden near Gaichund, which is marked on the accompanying label as coming from the *base* of the Otoceras beds.

As I remarked in my synopsis of the stratigraphy of the lower Trias of the Himálayas, in none of the collections made previously to 1899 have the fossils from the Otoceras and Meekoceras beds been kept separate. There are consequently

a considerable number of species the exact horizon of which is not known to us, although they can be referred to the lower division of the lower Trias with certainty. These species are :—

Meekoceras boreale Dien.
„ *cf. radiosum* Waag.
„ *dubium* v. Krafft.
„ *kyokticum* v. Krafft.
Aspidites Vidarbha Dien.
Proptychites typicus v. Krafft.
„ *sp. ind. ex aff. typico.*
Xenodiscus rigidus Dien.
„ *rotula* Waag.
„ *cf. plicosus* Waag.
Flemingites Guyerdeti Dien.
Nannites Herberti Dien.

I need hardly explain that, with this uncertainty about the original horizon of such a large number of species, we can scarcely say anything definite about the faunistic affinities between the Otoceras and Meekoceras beds. These two horizons are certainly more intimately connected by their faunæ than had been anticipated by Noetling. Neither is *Meekoceras* absent from the lower horizon, nor *Ophiceras* from the upper one. There is even some probability of *Ophiceras tibeticum* reaching into the topmost beds of the Meekoceras stage. One of Griesbach's specimens from the Shalshal cliff is marked "bed 70 (25 feet above the main layer of *Otoceras Woodwardi*." There is no valid reason for questioning the exactness of Griesbach's statement.

Without taking into account *Meekoceras Varaha* and *M. cf. boreale*, which were quoted by A. v. Krafft, from the beds with *Ophiceras Sakuntala* in the section of Lilang or *Koninckites Haydeni*, which is probably common to the Otoceras and Meekoceras beds of Spiti, the presence of one species of *Meekoceras* (*M. Hodgsoni* Dien.) in the Otoceras beds has been established with complete certainty.

The Meekoceras beds have been unanimously referred to the lower Trias. The Otoceras beds, which were considered as passage beds by C. L. Griesbach, and included in the lower Trias by E. v. Mojsisovics and myself, were placed in the Permian system by Noetling and Frech, whereas A. v. Krafft only correlated the lowest layer with *Otoceras*, in Spiti, with beds of Permian age, but looked upon the age of the *Ophiceras* horizon as doubtful.

The reasons in favour of a Permian age of the Otoceras beds made out by Noetling have been discussed in my paper on the stratigraphical position of the Otoceras beds of the Himálayas (Centralblatt f. Min., etc., 1905, p. 1-10, 36-45). Neither lithological nor palæontological reasons, nor the principles of historical priority are valid for a decision in favour of Noetling's opinion.

Lithologically both the Otoceras and Meekoceras beds are more intimately connected with the Productus or Kuling shales than with the overlying Hedenstrœmia beds. The boundary between the Permian and Triassic systems, in order

to correspond with the change in the character of the rocks, must therefore be drawn at the base of the Hedenstrœmia beds, not at the base of the Meekoceras beds. It is utterly impossible to separate the Otoceras beds and Meekoceras beds in the sections of Spiti on the strength of lithological differences, as is evident from the fact that such a separation was never attempted before the difference of the two faunæ contained in these groups was known. That the Ophiceras-zone in Spiti does belong lithologically to the Meekoceras beds, not to the underlying Kuling shales, has been expressly stated by H. Haydon (Geology of Spiti, l. c. p. 65).

The palæontological evidence is in favour of a correlation of the Otoceras beds with the Triassic system, since the identity of *Episageceras Wynnei* Waag. with *E. Dalailamæ* Dien., as suggested by A. v. Krafft, cannot be admitted. The general character of the Cephalopod fauna is such as we should expect to find in a Mesozoic horizon, the overwhelming majority of species being provided with ceratitic sutures. The Lamellibranchiata are of a decidedly Triassic habit, as has been demonstrated by Bittner. But the most conspicuous feature in the fauna of the Otoceras beds is *the complete absence of the numerous types of Palæozoic Brachiopoda* which are the predominating element in the Permian strata of the Salt Range and the Himálayas. This striking contrast in the fauna of the Kuling shales and the Otoceras beds should alone be sufficient to induce us to draw the boundary between the Permian and Triassic systems in the Himálayas at the top of the Kuling shales.

Among the Ammonites of the Otoceras beds some genera, as *Xenodiscus*, *Hungarites* and *Episageceras*, are common to Permian and Triassic strata, some others are known from Triassic, but not from Permian deposits of other regions, among them being *Meekoceras*, *Proptychites*, *Prosphingites* and *Ophiceras*, of which typical species have been described from the lower Trias of North America by Hyatt and Smith. In the Meekoceras beds of Idaho four species of *Ophiceras* have been discovered by those learned authors, so closely allied to *O. Sakuntala*, *O. ptychodes*, *O. gibbosum* and *O. demissum*, respectively, from the Himálayas, that their association with ammonites of undoubtedly Triassic age is a very strong argument against a reference of the Indian Otoceras beds to the Permian system.

Otoceras itself is not known outside the Himálayas, except in the Permian rocks of Julfa (Armenia), where it is extremely rare and associated with a fauna very rich in brachiopods of an eminently Palæozoic habit and with the Palæozoic genus *Gastrioceras*. This association of *Otoceras* with a fauna entirely different from that of the Indian Otoceras beds peremptorily forbids any correlation of the latter with the Julfa beds.

Both in the Alps and in the Himálayas the Permian and Triassic systems are connected by an uninterrupted sequence of beds. Within this sequence no distinct boundary can be drawn.[1] If we try to correlate the beds as developed in the Alps and in India, we find a homotaxial relation between the Hedenstrœmia and Campil

[1] E. W. Vredenburg, in his Summary of the Geology of India (Calcutta, Thacker, Spink & Co., 1907, p. 44) correlates the Otoceras beds with the lower Permian of Europe. This correlation involves the suggestion of a hiatus between the Otoceras and Meekoceras stage. "Far from there being a gradual passage from Permian to Trias, the gap between Palæozoic and Mesozoic amongst the marine strata of India is even broader than amongst those of Europe, in spite of deceptive appearances of continuity." I need hardly say that i cannot agree with this view.

or upper Werfen beds on the one hand and the Kuling shales and Bellerophon limestone on the other. As far as affinities exist between the Otoceras beds and the corresponding Alpine deposits, they point in the direction of the lower Werfen or Seis beds, not of the Bellerophonkalk. One species of *Bellerophon* (*B. Vaceki* Bittn.) is probably identical, and several species of Lamellibranchiata are allied very closely, as has been demonstrated by Bittner. Brachiopoda of a Palæozoic habit are absent both from the Otoceras and the Seis beds. The only representative of this class of invertebrate fossils in the Otoceras beds, *Norella procreatrix* Bittn., belongs to a group or subgenus which is at present known only from Triassic deposits.

From all this it is evident that the Otoceras beds must remain included in the Triassic system, where they were placed by Griesbach,[1] E. v. Mojsisovics and myself. This correlation stands firm and is not invalidated by any of Noetling's arguments to the contrary.

The zoological characters exhibited by the fauna of the Otoceras beds have been treated of in my memoir on the Cephalopoda of the Himalayan lower Trias (Himálayan Foss., Vol. II, Pt. 1, p. 168). No more complete new material having since been collected, I have nothing to add for the present.

The fauna of the Meekoceras beds not known to me in 1897 is very uniform in Painkhanda and Spiti, and extremely poor in genera. *Meekoceras*, including some of its subgenera, is the predominating element. *Xenodiscus*, *Ophiceras* and *Hedenstrœmia* are represented only by a small number of species. We must, however, be careful not to forget that a large percentage of the species, whose original horizon is as yet unknown, does probably belong to this stage. Thus *Proptychites*, *Nannites* and *Flemingites* may probably have to be included in the list.

To the cephalopod-bearing horizon of the upper Werfen (Campil) beds in the Alps this fauna shows as little affinity as to that of the underlying Otoceras stage. For a Triassic fauna of a character similar to that of the Himálayan Meekoceras beds we must look to the Proptychites beds of the Ussuri district in Eastern Siberia, to the Ceratite formation of the Salt Range, where the Otoceras stage is as yet unknown, and to the Meekoceras beds of California and Idaho.

The third fauna of lower Triassic age is included in the *Hedenstrœmia beds* (Subrobustus beds *autea*). From this horizon 20 species of Cephalopoda have been described in my memoir quoted above, but only 13 among them were sufficiently well preserved to permit of a specific determination. Their number has been enlarged to 33 by an examination of A. v. Krafft's and Hayden's new materials from Spiti.

The following species ought to be excluded from the list quoted in my previous memoir as having been based on insufficiently preserved materials:—

Ceratites Mandhata Dien.
Hedenstrœmia sp. ind. aff. Mojsisovicsi Dien.
Proptychites sp. ind. aff. obliqueplicato Waag.
Meekoceras cf. fulgurato Waag.
Lecanites sp. ind.

[1] Griesbach considered the Otoceras beds of the Shalshal cliff as passage beds between the Permian and Trias (Records, Geol Surv. of India, XXII, p. 160, Memoirs, XXIII, pp. 68, 219, 223), but assigned them to the Triassic system (Records, XIII, p. 103, Memoirs, XXIII, pp. 174, 177, 219).

Ceratites subrobustus (= *Keyserlingites Dieneri* v. Mojs., Himálayan Foss., Vol. V, Pt. 2, the fauna of the Himálayan Muschelkalk, p. 74) must also be omitted from this list, having its habitat in the lower Muschelkalk, not in the Hedenstrœmia beds.

Proper specific denominations have been introduced for *Pleuronautilus sp. ind.* (= *Pl. Dieneri*), *Flemingites sp. ind. ex aff. trilobato* Waag. (= *Fl. Griesbachi*), whereas the identification of *Aspidites superbus* var. with Waagen's species from the Ceratite sandstone of the Salt Range has been rejected by A. v. Krafft.

Thus the modified and enlarged list of Cephalopoda from the Hedenstrœmia beds of Painkhanda and Spiti now runs as follows :—

Pleuronautilus Dieneri v. Krafft.
Grypoceras sp. ind. ex aff. Palladii v. Mojs.
Orthoceras sp. ind.
Meekoceras pseudoplanulatum v. Krafft.
„ *solitarium* v. Krafft.
„ *sp. ind. ex. aff. pilato* Hyatt et Smith.
Aspidites Muthianus v. Krafft.
„ *nov. sp. ind ex aff. superbo* Waag.
„ *superbiformis* Dien.
Koninckites Yudishthira Dien.
„ *giganteus* v. Krafft.
Proavites Sisupala Dien.
Xenodiscus Kapila Dien.
„ *Purusha* Dien.
„ *cf. trapezoidalis* Waag.
„ *asiaticus* v. Krafft.
„ *nivalis* Dien.
„ *nov. sp. ex aff. nivali* Dien.
Flemingites Rohilla Dien.
„ *Griesbachi* v. Krafft.
„ *Salya* Dien.
„ *nov. sp. ex aff. Salya.*
„ *nov. sp. ind.* (Pl. XXVIII, fig. 3).
Proptychites sp. ind. aff. undato Waag.
Ceratites pumilio v. Krafft.
Prionites sp. ind.
Tirolites injucundus v. Krafft.
Sibirites spitiensis v. Krafft.
Nannites hindostanus Dien.
„ *medius* Dien.
Pseudosageceras multilobatum Noetl.
Hedenstrœmia Mojsisovicsi Dien.
„ *Muthiana* v. Krafft.

The most interesting new elements in this fauna are *Pseudosageceras multilobatum*, *Ceratites pumilio* and *Tirolites injucundus*.

The first is conspicuous by its very large number of serrated lobes with a long auxiliary and adventitious series. Among the ammonites of the lower Trias of involute, compressed, acute shape it takes an isolated position, similar to that of

Beloceras Hyatt in the Devonian, or of *Prodromites* Smith and Weller in the Carboniferous system. But notwithstanding this external similarity, any close affinity between these three genera is very improbable.

Ceratites pumilio is of particular interest, being the oldest representative of the genus *Ceratites s. s*, which can thus be traced with certainty into beds of lower age than the Muschelkalk. A near relative of this species may be found in *Xenodiscus* Waagen. One of the great phyla of Triassic ammonites certainly has its root in *Xenodiscus*. But *Xenodiscus*, *Xenaspis*, *Ophiceras* and *Meekoceras* are all so closely allied at the commencement of the Mesozoic era, that it is barely possible to point out a distinct ancestor of every Triassic genus within this stock of radicals.

Up to 1893 the genus *Tirolites* was considered to be entirely absent from the Arctic and Indian regions, whereas it is most abundantly spread throughout the upper division of the Alpine Werfen beds (Campil beds). This restriction of the *Tirolitidæ* to the Mediterranean province throughout the periods of the lower Trias and of the Muschelkalk was emphasised by E. v. Mojsisovics as one of the most important zoogeographical features of the Triassic epoch (Palæont. Indica, ser. XV, Himálayan Foss., Vol. III, Pt. 1, p. 152). It is hardly necessary to point out that his conclusions, based on negative evidence only, have been proved untenable by Hayden's discovery of a species of *Tirolites* in the Hedenstrœmia beds of Muth. But this much is true, that *Tirolites* is of the rarest occurrence in the Himálayas, for among the very rich collections obtained from beds of lower Triassic age there is only one single specimen belonging to this genus.

Tirolites is not the only faunistic element connecting the Alpine Werfen beds and the Hedenstrœmia stage. There are two more ammonites to be mentioned, *Xenodiscus asiaticus* Krafft, which shows very close affinities to the Alpine *Paraceratites prior* Kittl, and *Meekoceras pseudoplanulatum* v. Krafft, which is only distinguished from the Alpine *Meekoceras caprilense* v. Mojs. by some very subordinate details, and from this it is evident that the obstacles, preventing an exchange of Indian and Mediterranean Cephalopoda during the Otoceras and Meekoceras periods, were partly removed during the later period of the lower Trias, although there was probably no such open communication through the Tethys as in upper Triassic times, the influence of considerable isolation of the Alpine fauna becoming obvious from the scarcity of closely allied forms in the two regions. *Tirolites* took an independent line of development in the Mediterranean, *Xenodiscus* and *Meekoceras* in the Indian province. A small number of stragglers only was able to immigrate from one region into the other.

The presence of *Tirolites injucundus* in Spiti and of *Xenodiscus* (*Paraceratites*) *prior* in the South-eastern Alps further affords a safe basis for a correlation of the Hedenstrœmia beds in India with the Campil or upper Werfen beds in Europe. The lower Werfen or Seis beds must consequently be correlated with the lower division of the Himálayan lower Trias, *viz.*, with the Meekoceras and Otoceras stages, which are both lithologically and faunistically linked together more closely than the Meekoceras and Hedenstrœmia stages. The difference of the Cephalopod faunæ

of the two latter stages is very remarkable, only one single species extending from the lower into the higher stage.

A detailed study of the sections in Painkhanda and Spiti has led to the establishment of three separate subdivisions of the lower Trias, which correspond to stratigraphical horizons, each of them distinguished by a rich and peculiar Cephalopod fauna. In the sections of Johar and Byans neither C. L. Griesbach nor his successors, T. H. D. La Touche and F. H. Smith, have succeeded in subdividing the deposits of lower Triassic age. But in both districts palæontological analogies of the faunæ collected in the lower Triassic beds permit a correlation with the subdivisions as established in Painkhanda and Spiti.

In Johar one of the fossiliferous localities on the ridge between the Dharma and Lissar valleys has yielded a considerable number of ammonites of lower Triassic age, among which are the following species:—

Meekoceras boreale Dien.
„ *dubium* v. Krafft.
Aspidites Vidarbha Dien.
Proptychites typicus v. Krafft.
Ophiceras Sakuntala Dien.
„ *Dharma* Dien.
Xenodiscus himalayanus Griesb.
„ *cf. rotula* Waag.
„ *rigidus* Dien.
„ *lissarensis* Dien.
„ *Sitala* Dien.
„ *Purusha* Dien.

Ophiceras Dharma, *Xenodiscus rigidus*, *X. lissarensis*, and *X. Sitala* are not known from any other locality of the Himálayas and are therefore not fitted for establishing the homotaxis of the present fauna. *Xenodiscus Purusha* is a characteristic fossil of the Hedenstrœmia beds of Spiti. All the remaining ammonites point to the lower division of the lower Trias, *Xenodiscus himalayanus* and *Ophiceras Sakuntala* clearly proving the presence of the Otoceras stage in the sections of the Lissar valley. The horizon of *Pseudomonotis Griesbachi* Bittn. is also represented by the presence of numerous examples of this species and other types of Lamellibranchiata.

In Byans the lower Triassic faunæ are included in a lithologically uniform series of chocolate-coloured limestones, about one hundred and fifty feet in thickness, which are overlaid by a white limestone containing *Rhynchonella Griesbachi* Bittn. But from the palæontological evidence it is obvious that the two main divisions of the lower Trias in Spiti and Painkhanda are also represented in the sections of Byans.

The following species of Cephalopoda have been collected by F. H. Smith from the Chocolate Limestone near Jolinka, Lilinthi, Kalapani and Kuti:—

Meekoceras boreale Dien.
„ *Jolinkense* v. Krafft.
„ *Smithii* v. Krafft.

Meekoceras dubium v. Krafft.
Aspidites spitiensis v. Krafft.
„ *Vidarbha* Dien.
Proptychites typicus v. Krafft.
Ophiceras cf. serpentinum Dien.
Xenodiscus radians Waag.
„ *rotula* Waag.
„ *nivalis* Dien.
Flemingites cf. Griesbachi v. Krafft.
Hedenstræmia Mojsisovicsi Dien.
„ *byansica* v. Krafft.
„ *acuta* v. Krafft.
Sibirites spiniger v. Krafft.
„ *robustus* v. Krafft.
„ *sp. ind. aff. robusto.*
„ *stephanitiformis* v. Krafft.
„ *div. sp. ind.*

Meekoceras boreale, M. dubium, M. jolinkense, the two species of *Aspidites, Proptychites typicus, Xenodiscus radians, X. rotula,* and *Ophiceras cf. serpentinum* point to the lower division of the lower Trias, the last species more especially to the Otoceras stage. *Hedenstræmia Mojsisovicsi, Xenodiscus nivalis,* and *Flemingites cf. Griesbachi* are characteristic of the upper division.

There is, however, a peculiar faunistic element included among the representatives of the upper division, and this is the genus *Sibirites,* which is comparatively rich in species, some of them exhibiting well marked affinities with the species of *Sibirites* described by Waagen from the upper Ceratite limestone of the Salt Range. The discovery of this horizon of *Sibirites spiniger* in F. H. Smith's collections from Lilinthi E. G. is due to the late A. v. Krafft, who correlated it with the zone of *Stephanites superbus* in the Ceratite formation (Gen. Rep. Geol. Surv. of India for 1900-01, p. 4). If this correlation could be proved to be correct, it would justify the distinction of two separate palæontological horizons in the upper division of the lower Trias of the Himálayas, a lower horizon with *Hedenstræmia Mojsisovicsi* and *Flemingites Rohilla,* and a younger one with *Sibirites spiniger* and its allied congeneric forms.

In the Spiti sections the presence of this palæontological horizon is, perhaps, indicated in Hayden's collections by *Sibirites spitiensis* v. Krafft from the Hedenstræmia beds of Muth.

It must, however, be borne in mind, that the stratigraphical independence of this horizon has as yet not been demonstrated with complete certainty, although the fauna of *Sibirites spiniger* in Byans can very probably be attributed to a bed, stratigraphically well marked, near the top of the lithologically uniform series of the Chocolate Limestone. This much is also certain, that the fauna with *Sibirites spiniger* is older than the horizon of *Rhynchonella Griesbachi* and *Retzia himaica,* which in Byans is developed in the facies of light grey limestones, very sharply divided off from the underlying Chocolate Limestone of lower Triassic age.

In the Spiti sections we must therefore look for this zone in the upper division of the Hedenstrœmia beds, perhaps in the bivalve limestone with *Pseudomonotis himaica* Bittn. and *Ps. decidens* Bittn.

It has been demonstrated by A. v. Krafft that there are some strong reasons, in favour of considering the genus *Sibirites* as the ancestor of *Acrochordiceras* Hyatt, one of the leading types of the Himálayan and Alpine Muschelkalk, but of world-wide distribution (Germany, Eastern Siberia, Nevada).

The fauna of Cephalopoda from the exotic block No. 20 in Malla Johar contains the following species :—

Meekoceras joharense v. Krafft.
„ *infrequens* v. Krafft.
„ *jolinkense* v. Krafft.
Xenodiscus cf. nivalis Dien.
Hedenstrœmia cf. byansica v. Krafft.

As far as numbers go, *Meekoceras joharense* plays the principal part. Judging by its general character, this fauna can only be looked upon as a fauna of lower Triassic age. A. v. Krafft correlated it with the fauna of the Hedenstrœmia beds, and I agree with him in this view, which is especially supported by the presence of *Xenodiscus nivalis*. The only species pointing to the lower division of the lower Trias is *Meekoceras cf. jolinkense*, which is also known from the Chocolate Limestone of Byans and from the horizon of *Meekoceras lilangense* in Spiti. But it must be remarked, that the identity of the specimen from Lilang with the types from Byans and Malla Johar has not been established with full certainty.

There is no reason to explain further that the lower Triassic faunæ of the Himálayas described here and in my previous memoirs (Vol. II, Pt. 1), bear quite a distinct local character, which distinguishes them from the homotaxial faunæ of the Mediterranean region. It has been made evident from the presence of *Paraceratites* (*Xenodiscus*) in the upper Werfen beds of Muć and of *Tirolites* in the Hedenstrœmia beds of Spiti, that a sea connection between the two regions was probably opened across the region occupied by the present mountain ranges of Afghanistan and Northern Persia. But the affinities of the Indian and Alpine faunæ are, nevertheless, rather distant and from the lower Werfen beds (Seis beds) of the Alps no Cephalopod fauna is as yet known, which would bridge over the gap between the faunæ of the Bellerophonkalk and of the horizon of Campil.[1]

The relation which the Himálayan lower Trias bears to the Ceratite formation of the Salt Range, has already been minutely discussed in my previous memoirs, also by A. v. Krafft and Noetling, but an attempt to correlate the stratigraphical subdivisions in these two areas has left many points obscure, as may be seen from the following account.

[1] A very interesting fauna of lower Triassic age has been discovered recently (autumn 1907) in a red limestone of the Hon Bulog facies by F. Baron Nopcsa near Skutari in Albania. It contains *Pseudosageceras* and *Hedenstrœmia* (?) associated with *Tirolites seminudus* Kittl.

In 1897 I correlated the main layer of *Otoceras Woodwardi* with the unfossiliferous shales and sandstones at the base of the lower Ceratite limestone. The beds following above the Otoceras stage, from which fossils were known to me in fragments only (Meekoceras beds *postea*), I considered as an equivalent of the lower Ceratite limestone and of the Ceratite marls. The upper division, or Hedenstrœmia beds, was correlated with the Ceratite sandstone (in the circumscription of Waagen), and more especially with the two higher subdivisions of this series, *viz.*, the Stachella beds and the beds with *Flemingites Flemingianus* (l. c. p. 176). The question whether equivalents of the upper Ceratite limestone should be looked for in the unfossiliferous topmost beds of the Hedenstrœmia stage, or in the zone of *Rhynchonella Griesbachi*, referred provisionally to the lower Muschelkalk, had to be left open, the complete absence of the peculiar elements of the fauna of the upper Ceratite limestone in any of the Himálayan lower Triassic or Muschelkalk faunæ excluding the possibility of arriving at any reasonable decision.

In 1900 A. v. Krafft proclaimed it as one of the chief stratigraphical results of his palæontological researches, that the Otoceras beds of the Himálayas do not, as was hitherto believed, correspond to the beds at the base of the lower Ceratite limestone of the Salt Range, but are equivalent to the Ceratite marls and to the lower Ceratite sandstone, and very probably include also the lower Ceratite limestone, while, on the other hand, the upper division of the lower Trias of the Himálayas does not correspond to the whole of the Ceratite sandstones, but only to the two upper divisions of the latter, *viz.*, the Stachella beds and *Flemingites Flemingianus* beds (General Report, Geol. Survey of India, for 1899-1900, p. 19).

From A. v. Krafft's stratigraphical notes on the Mesozoic rocks of Spiti (*ibidem*, p. 202) it is, however, evident that it is the entire lower division of the lower Trias in Spiti, not the Otoceras stage *s. s.*, which he correlates with the Ceratite marls and lower Ceratite sandstone. The identical species enumerated in his memoir are either restricted to the Meekoceras beds, or their stratigraphical position is not known exactly (*Xenodiscus radians*, *X. rotula*), but a correlation of the Otoceras beds *s. s.* with the Ceratite marls is not indicated by any faunistic affinities.

This attempt to correlate the lower Triassic beds of the Himálayas with those of the Salt Range consequently does not mark any considerable advance on my own correlation given in 1897.

That A. v. Krafft could not have maintained his own correlation, published in 1900, any longer, is obvious from his short note in the General Report of the Geological Survey of India for 1900-1901, p. 3, in which he adopts Noetling's views with regard to the age of the Otoceras beds *s. s.* In his note on the Permian age of the Otoceras beds (Centralblatt f. Min., etc., 1901, p. 275) he consequently correlates the layer with *Otoceras Woodwardi* in Spiti with the upper Productus limestone of the Salt Range, leaving the correlation of the *Ophiceras* zone with either the topmost beds of the Productus limestone or with the lowest beds of the Ceratite formation undecided.

Another attempt to correlate the lower Triassic deposits of the Salt Range

and Himálayas has been recently made by Noetling (Palæontologia Mesozoica I, Asiatische Trias, p. 171). His correlation will be seen from the following table: —

Salt Range.			Himálayas.	
Sub-divisions Waagen.	Sub-divisions Noetling.	Zones according to Noetling.	Sub-divisions.	Zones.
Upper ceratite limestone.	Upper ceratite limestone.	Z. of *Stephanites superbus.*	Dark grey limestone of Byans.	Z. of *Stephanites* sp.
Ceratite Sandstone.	Ceratite sandstone.	Z. of *Flemingites Flemingianus.*	Hedenstrœmia beds.	Z. of *Flemingites Rohilla.*
	Ceratite Marls.	Z. of *Prionolobus volutus.*		
Ceratite Marl.		Z. of *Celtites fallax.*		
		Z. of *Prionolobus rotundatus.*	Meekoceras beds.	Z. of *Prionolobus Markhami.*
Lower Ceratite limestone.	Lower Ceratite limestone.	Z. of *Celtites radiosus.*		
Upper Productus limestone.	Upper Productus limestone.	Z. of *Euphemus indicus.*	Otoceras beds.	Z. of *Ophiceras tibeticum.* Z. of *Episageceras Dalailamæ.* Z. of *Otoceras Woodwardi.*

In this table the Otoceras stage is correlated with the upper Productus limestone (zone of *Euphemus indicus* Noetling), although not one single identical species has been found in these two horizons, both of them rich in fossils belonging to several classes of invertebrate animals. The Meekoceras beds are considered as equivalents of the lower Ceratite limestone, and of the thin bed at the base of the Ceratite marls which is characterised by the presence of *Meekoceras rotundatum* Waag. in large numbers. The main mass of the Ceratite marls, which in Noetling's interpretation include also the lower subdivisions of the Ceratite sandstone, as defined by Waagen, and the *Flemingites Flemingianus* beds, corresponds to the Hedenstrœmia stage of Spiti. With A. v. Krafft Noetling agrees in the correlation of the horizon of *Sibirites* in Byans with the upper Ceratite limestone (zone of *Stephanites superbus*) in the Salt Range.

As is evident from the different conclusions arrived at by previous authors there is still a considerable degree of uncertainty about the correlation of the lower Triassic deposits in the Himálayas and in the Salt Range. The reason of this difficulty is to be looked for in the different lithological development of the beds in the two regions, and in the absence of all characteristic types of the Otoceras bed *s. s.* in the Ceratite formation.

The following table shows those species of ammonites, which are identical or nearly identical in the lower Trias of the two areas, and which, consequently, must be accorded most weight in a determination of the horizon of the beds to which they belong.

Himálayas.		Salt Range.	
1. *Meekoceras pseudoplanulatum* v. Krafft.	Hedenstrœmia beds	*Meekoceras pseudoplanulatum* v. Krafft.	Zone of *Koninckites volutus* (topmost Ceratite marls, Noetling).
2. *Meekoceras cf. radiosum* Waag.	Lower division (probably Meekoceras beds).	*M. radiosum* Waag.	Probably zone of *Kon. volutus* ( ).
3. *Meekoceras disciforme* v. Krafft.	Meekoceras beds	*Gyronites superior* Waag.	Topmost beds of lower Ceratite limestone.
4. *Meekoceras cf. discus* Waag.	Meekoceras beds	*Meekoceras discus* Waag.	Zone of *Celtites radiosus* Noetling (lower Ceratite limestone).
5. *Koninckites Yudishthira* Dien.	Hedenstrœmia beds	*Aspidites evolvens* Waag.	Zone of *Flemingites Flemingianus*.
6. *Koninckites alterammonoides* v. Krafft.	Meekoceras beds	*Proptychites ammonoides* Waag.	Base of Ceratite marls.
7. *Flemingites Griesbachi* v. Krafft.	Hedenstrœmia beds	*Flemingites flemingianus* de Kon.	Ceratite sandstone *s. s.*
8. *Xenodiscus rotula* Waag.	Lower division, probably Otoceras and Meekoceras beds.	*X. rotula* Waag.	Unknown.
9. *Xenodiscus radians* Waag.		*X. radians* Waag.	
10. *Xenodiscus lilangensis* v. Krafft.	Meekoceras beds	*Prionolobus Buchianus* de Kon.	Lower Ceratite limestone, lower region.
11. *Xenodiscus cf. plicosus* Waag.	Lower division	*Gyronites plicosus* Waag.	Lower Ceratite limestone, lowest bed.
12. *Pseudosageceras multilobatum* Noetl.	Hedenstrœmia beds	*Ps. multilobatum* Noetl.	Ceratite marls (all zones Noetl.)
13. *Hedenstrœmia Mojsisovicsi* Dien.	Hedenstrœmia beds	*Hedenstr. Mojsisovicsi* Dien. (*teste* Noetling).	Ceratite sandstone *s. s.*
14. *Sibirites sp. ind. aff. inflato* Waag.	Topmost beds of Chocolate Limestone, Byans.	*Ceratites (?) inflatus* Waag.	Upper Ceratite limestone.

The palæontological evidence recorded in this table leads to the conclusion that the Hedenstrœmia beds, or more exactly the beds which contain the fauna of the zone of *Flemingites Rohilla*, are equivalent to the upper Ceratite marls (zone of *Koninckites volutus* Noetling), and to the Ceratite sandstone (*Flemingites Flemingianus* beds). The upper Ceratite limestone is represented in the topmost beds of the Chocolate Limestone in Byans, containing *Sibirites*, and probably also in the bivalve limestone with *Pseudomonotis himaica* of Spiti. The Meekoceras beds of the Himálayas probably correspond both to the lower Ceratite marls and to the lower Ceratite limestone. This is indicated by certain faunistic affinities recognized by Noetling. Among eight species identical or nearly identical with Salt Range forms, four occur in the Ceratite limestone, two in the Ceratite marls, whereas the stratigraphical position of two is unknown.

The main layer of *Otoceras Woodwardi* was correlated in my memoir of 1897 with the unfossiliferous shales and sandstones at the base of the lower Ceratite limestone, and I still adhere to this correlation. There is, indeed, no Salt Range fauna with which the rich fauna of the Otoceras beds *s. s.* can be directly correlated. As has been demonstrated above, it is certainly younger than the upper Productus limestone or the zone of *Euphemus indicus* Noetl. There is not one single identical species in the Otoceras beds and the Productus limestone, whereas there is at least one species, *Xenodiscus radians* Waag., common to the Otoceras beds and the Ceratite formation. But as the lower Ceratite limestone must be included among the equivalents of the Meekoceras beds (zone of *Meekoceras Markhami* in Painkhanda, of *M. lilangense* in Spiti), there is no group in the Salt Range to which it could be referred, except the unfossiliferous rocks which, in the sections of Chidru and Virgal, separate the Productus limestone from the Ceratite formation.

The following tabular statement will show the relations of the lower Himálayan Trias with the Ceratite formation of the Salt Range:

Salt Range.		Himálayas.
Upper Ceratite limestone		Zone of *Sibirites spiniger* (only known in *Byans*).
Ceratite sandstone (zone of *Flemingites Flemingianus*) .		Hedenstrœmia beds.
Ceratite marls .	Upper division	
	Lower division	Meekoceras beds.
Lower Ceratite limestone		
Unfossiliferous clay and shales		Otoceras beds.
Upper Productus limestone . . .		Kuling (Productus) shales.

The relations existing between the lower Triassic faunæ of the Himálayas and the Olenek beds of Northern Siberia appear to be less close than had been anticipated in 1897. Of the two species previously considered to be identical, *Ceratites (Keyserlingites) subrobustus* v. Mojsisovics must be eliminated, as the Himálayan representatives of *Keyserlingites* are neither identical with the Siberian forms from the mouth of the Olenek, nor do they occur in the lower Trias of Painkhanda and Spiti. The identity of the second species, *Hedenstrœmia Mojsisovicsi* Dien., with *Hedenstrœmia nov. sp. ind. ex aff. Hedenstrœmi* v. Mojsisovics has been questioned by A. v. Krafft, but the very close affinity of these two forms can scarcely be doubted.

There are also a few species of *Meekoceras* and *Xenodiscus*, related more or less intimately to forms from the Olenek beds, described by E. v. Mojsisovics (especially *Xenodiscus rotula* Waagen and *X. hyperboræus* Mojs.), but the importance of those affinities is certainly small in comparison with the marked differences between

the predominating faunistic elements in the two regions. The total absence of *Dinarites*, the leading genus of the Olenek fauna, in the Himálayas must be especially mentioned. Noetling is certainly right in assuming that there was no close connection between the Indo-Chinese and Siberian Triassic provinces, although I cannot agree with his correlation of the Olenek beds with the Himálayan Muschelkalk.

Noetling's correlation is based on the following reasons (Lethæa Mesozoica, Vol. I., Asiatische Trias, p. 200):—In the Himálayas *Ceratites subrobustus* occurs in the beds with *Spiriferina Stracheyi* of Muschelkalk age. The genus *Ceratites*, which in the Olenek fauna is represented by several groups, does not make its appearance at an earlier period than the Muschelkalk. The correlation of the Olenek beds with the lower Trias, advocated by E. v. Mojsisovics, must consequently be abandoned in favour of a correlation with the lower Muschelkalk.

The only deposits in Arctic Siberia, which Noetling is inclined to leave in the lower Trias, are the brachiopod-bearing shales and sandstones of Tumul-Kaia, although their age has been considered as very doubtful by A. Bittner (Arktische Triasfaunen, l. c. p. 138, Brachiopoden der alpinen Trias, Abhandl. K. K. Geol. Reichsanst, XIV, p. 313).[1]

As a result of my examination of the lower Triassic and Muschelkalk faunæ of the Himálayas it appears much more probable that the Olenek beds correspond in age with the upper division of the lower Trias than with the lower Muschelkalk. As has been explained in my memoir on the fauna of the Himálayan Muschelkalk (Himal. Foss., l. c. Vol. V, Pt. 2, p. 132), the Himálayan types of *Keyserlingites* (group of *Ceratites subrobustus* Mojs.) are not identical with those from Siberia, their mode of development showing differences sufficiently remarkable even to justify the introduction of a new subgenus (*Durgaites*). The stratigraphical position of the Indian *Keyserlingites Dieneri* does not, consequently, afford any clue as to the age of the Triassic beds of Siberia containing *Keys. subrobustus* and its allies. That *Ceratites* is not restricted to the Muschelkalk is evident from the discovery of *C. pumilio* in the Hedenstrœmia beds of Spiti. On the other hand the presence of *Xenodiscus*, *Meekoceras*, *Aspidites*, *Hedenstrœmia* and *Prosphingites*, which are exclusively characteristic of the lower Trias, peremptorily demands a correlation of the Olenek beds with the upper division of the Himálayan lower Trias.

A strong argument in favour of a correlation of the Olenek beds with the lower Trias rather than with the Muschelkalk, is the remarkable kinship existing between the faunæ of the Olenek beds and Columbites beds of Idaho. As has been stated by J. Perrin Smith (The Stratigraphy of the Western American Trias, Festschrift zum 70. Geburtstage von A. v. Koenen, Stuttgart, 1907, p. 400) the fauna of the Columbites beds is closely allied with the Olenek fauna, three species being identical or nearly so. "It gives us a proof of the age of the Olenek beds, for

[1] In his description of Triassic Brachiapoda and Lamellibranchiata of the Ussuri district, A. Bittner (Mém. Com. Géol. St. Pétersbourg, Vol. VII, No. 4, p. 84) hints with great reserve at the possibility of a correlation of the *Lingula* sandstones of Tumul-Kaia with the lower Triassic sandstones of Vladivostok.

the Idaho formation still contains some characteristic species, which lived in the *Meekoceras* epoch."

A Siberian fauna, more nearly allied to the fauna of the Himálayan lower Trias than the fauna of the Olenek beds, has been discovered beyond the Sea of Japan in the coast province of Eastern Siberia, near Vladivostok in the southern Ussuri district. This fauna contains representatives of the following genera of ammonites:—

Dinarites 2 sp. [1]
Xenodiscus (*Danubites* antea) 2 sp.
Xenaspis 1 sp.
Pseudosageceras 1 sp.
Ussuria 2 sp.
Ophiceras 1 sp.
Meekoceras 4 sp.
Proptychites 4 sp.

I have correlated it with the Otoceras beds (in the wider sense), and later on with the Meekoceras beds, whereas Frech (Lethæa Palæozoica, Vol. II, Pt. 2, Dyas, p. 659) has assumed that two geological horizons are represented in the Proptychites beds of the Ussuri district, that *Ussuria*, *Ophiceras* and *Pseudosageceras* came out of Permian strata, while *Meekoceras*, *Dinarites* and *Proptychites* came out of lower Triassic beds. But this view has become untenable, since all the genera referred to the Permian system by Frech have been found in beds of undoubted Triassic age in North America by Hyatt and Smith.

The association of the genera enumerated above, as exhibited in the fauna of the Ussuri district, is characteristic of the lower division of the lower Trias. Although one of the ammonites of this fauna is referable to *Ophiceras*, *Sakuntala* Dien. as *cf.*, I should prefer to assign it to the Meekoceras beds. *Meekoceras Varaha* Dien., one of the chief leading fossils of the Ussuri fauna and *Dinarites minutus* Waag. from the Ceratite marls of the Salt Range, point to this horizon.

The genus *Otoceras* is certainly absent from the Proptychites beds of Vladivostok, notwithstanding Prof. Frech's statement to the contrary. The species described in my memoir, "Triadische Cephalopodenfaunen der ostsibirischen Kuestenprovinz" (Mém. Comité géol. St. Pétersbourg, T. XIV, No. 3, p. 36, Pl. III, fig. 2) as *Proptychites otoceratoides*, cannot be united with *Otoceras*, its external part being broadly rounded, not acute, and its siphonal lobe being provided with numerous and coarse indentations.

A connecting link between the lower Triassic deposits of India and Eastern Siberia is afforded by some fossiliferous beds which have been discovered at two localities on Chinese territory. One of them, near Cha-tze-kang in Yunnan, has, according to Douvillé, yielded a small number of badly preserved gastropods and ammonites, among them a species recalling *Lecanites psilogyrus* Waagen. From the second locality in the Semenow range (N. E. Tibet) discovered by Futterer,

[1] Including *Dinarites minutus* Waagen, whose systematic position is uncertain.

Schellwien mentions *Ophiceras sp. ind.*, *Xenodiscus tanguticus nov. sp.* (very nearly allied to *X. nivalis* Dien.) and *Ambites sp. ind.* Although those scanty materials cannot yet be assigned to definite horizons, they are of great interest as indicating an extension of the ancient Tethys across the high mountains to the N. and E. of the Himálayas towards the Pacific region.

On the eastern side of the Pacific Ocean deposits of lower Triassic age are known from Idaho and California, where about 800 feet of shales and limestones contain fossils characteristic of this epoch. The following data have been obtained by A. Hyatt and J. Perrin Smith.

In south-eastern Idaho fossils were found at three localities in a bed of limestone not more than 15 feet thick. This is the fossiliferous horizon of the "Meekoceras beds," discovered by Peale, the fauna of which was described by C. A. White in 1880 and assigned to the lower Trias. A fourth locality of fossiliferous rocks was discovered by R. S. Spence and J. P. Smith near Paris (Bear lake county). In the section at Paris three fossiliferous horizons have been distinguished by J. Perrin Smith. The lowest contains the fauna of the Meekoceras beds. About 100 feet above this a band of shales has yielded three species of *Tirolites*, very nearly allied to Alpine forms from the upper Werfen (Campil) beds. A few feet above these "Tirolites beds," a third fossiliferous horizon was found, containing *Columbites parisianus*, a representative of the family of *Sibiritidæ*, associated with a few other species of ammonites, two of them identical with species from the underlying Meekoceras beds. In California a thin bed of gray limestone in the Inyo range (Owens' valley) has yielded a rich harvest of Cephalopoda, a large number of species, and most of the genera, being also common to the Meekoceras beds.

One of the results of the detailed palæontological investigation of the American Trias by A. Hyatt and J. Perrin Smith (Triassic Cephalopod genera of America, U. S. Geol. Surv. Prof. Pap. No. 40, Washington, 1905) is the intimate connection of the fauna of the Meekoceras beds of California and Idaho with the lower Triassic faunæ of India and Eastern Siberia. "This fauna contains several genera hitherto known only from the lower Trias of India and others previously found only in the Proptychites beds of Ussuri bay in Siberia."

The analogies with the Himálayan lower Trias are obvious from the following list of species of Cephalopoda, which must be considered as identical or very closely allied :—

HIMÁLAYAS.	NORTH AMERICA.
Meekoceras boreale Dien.	*Meekoceras boreale* Dien.*
„ *Varaha* Dien.	„ *gracilitatis* White.
„ *sp. ind. aff. pilato.*	„ *pilatum* Hyatt et Smith.
„ *Hodgsoni* Dien.	„ *cf. Hodgsoni* Sm.*
„ *radiosum* Waag.	„ *cf. radiosum* Wang.*
„ *Smithii* v. Krafft.	*Prionolobus Jacksoni* H. et Sm.

[1] The species marked * are quoted from the list published by J. Perrin Smith in his recent memoir, "The stratigraphy of the Western American Trias (Festschr. zum 70. Geburtstage von A. v. Koenen, Schweizerbart'scher Verlag, Stuttgart, 1907, p. 394, 397). Of these species no illustrations have been hitherto published.

HIMÁLAYAS.	NORTH AMERICA.
Ophiceras demissum Oppel.	*Ophiceras Dieneri* H. et Sm.
„ *Sakuntala* Dien.	„ *cf. Sakuntala* Sm.*[1]
„ *gibbosum* Griesb.	„ *cf. gibbosum* Sm.*
„ *ptychodes* Dien.	„ *Spencei* H. et Sm.
Xenodiscus rotula Waag.	*Xenodiscus Bittneri* H. et Sm.
„ *himalayanus* Griesb.	*Danubites aff. himalayanus* Sm.*
Nannites hindostanus Dien.	*Nannites Dieneri* H. et Sm.
Flemingites Rohilla Dien.	*Flemingites cf. Rohilla* Sm.*
„ *Salya* Dien.	„ *cirrus* White.*
Pseudosageceras multilobatum Noetl.	*Pseudos. intermontanum* H. et Sm.
Hedenstræmia Mojsisovicsi Dien.	*Hedenstræmia Kossmati* H. et Sm.

To these must be added the following American species from the Meekoceras beds, which are identical with or very closely allied to Salt Range forms from the Ceratite formation :—

Sibirites tennistriatus Waag.*
„ *aff. hircino* Waag.*
Meekoceras fulguratum Waag.*
„ *aff. radiato* Waag.*
„ *aff. falcato* Waag.*
Aspidites aff. Davidsoniano de Kon.*
Goniodiscus aff. typus Waag.*

The following genera and subgenera of ammonites are common to the lower Triassic strata of the Himálayas and of North America :—*Meekoceras*, *Aspidites*, *Koninckites*, *Flemingites*, *Tirolites*, *Ophiceras*, *Pseudosageceras*, *Xenodiscus* *Proptychites*, *Sibirites*, *Hedenstræmia*, and *Nannites*.

As regards the correlation of the three stages of the American lower Trias with the four stages we have been able to distinguish in the lower Trias of the Himálayas, it is rather difficult to arrive at a satisfactory conclusion.

J. Perrin Smith himself in his last memoir (The stratigraphy of the Western American Trias, l. c. p. 398) no longer maintains the views emphasised by him in his former publications. In his monograph of the Triassic Cephalopod genera of America (l. c. p. 19), the fauna of the Meekoceras beds of California and Idaho is referred with certainty to the Ceratite marls and to the lower part of the Ceratite sandstone of the Salt Range. The Columbites beds are correlated with the Olenek beds of Siberia and with the Hedenstræmia beds of the Himálayas. In his last memoir J. Perrin Smith claims for the Tirolites and Columbites beds an age younger than that of the Hedenstræmia stage of India. He insists on a great change in the faunal relations during the three lower Triassic stages distinguished in Western America. The fauna of the American Meekoceras beds shows an intimate relationship to that of the Ussuri district and of India, but none with those of the North Siberian and Mediterranean regions. During this epoch the open connection of the American lower Trias was with India through the Ussuri district,

[1] The species marked * are quoted from the list published by J. Perrin Smith in his recent memoir "The stratigraphy of the Western American Trias (Festschr. zum 70. Geburtstage von A. v. Koenen, Schweizerbart'scher Verlag. Stuttgart, 1907, p. 394, 397). Of these species no illustrations have been hitherto published.

China, Tongking and north-eastern Tibet, whence lower Triassic fossils have been described by Schellwien, but not through the boreal region. In sharp contrast to these Asiatic affinities of the Meekoceras beds, the fauna of the Tirolites beds is decidedly the same as that of the upper Werfen or Campil beds in the Mediterranean region. "Nothing comparable to it has been found in Asia, and it is probable that during the upper Werfen epoch there was some other connection between the American and Mediterranean regions than through India. But this incursion of Mediterranean forms was only sporadic, for in the overlying Columbites beds, 15 metres higher up [1], the fauna is no longer Mediterranean in character." J. Perrin Smith considers it to be in the main a boreal fauna closely allied with the Olenek fauna, but still containing some characteristic species which lived in the Meekoceras epoch.

From the discovery of a Mediterranean fauna in the Tirolites beds, J. Perrin Smith infers that the American Meekoceras beds must be older than the Campil beds of the Alps, and that the Hedenstrœmia beds of India, which had no faunistic relations with the Mediterranean region, must also be placed lower in the sequence and considered as equivalents of the Meekoceras beds of Idaho and of the Seis beds of the Alps.

An analysis of the Indian and American ammonites of lower Triassic age which are either identical or very closely allied, clearly shows that the fauna of the American Meekoceras beds has relations not only with both the faunæ of the Meekoceras and Hedenstrœmia beds of the Himálayas, but also contains equivalents of the *Ophiceras* zone of the Otoceras beds in Spiti, as is indicated by the presence of *Ophiceras Dieneri*, *O. Spencei*, *O. cf. Sakuntala*, *O. cf. gibbosum*, and *Meekoceras cf. Hodgsoni*. The association of these species with undoubtedly Triassic elements in North America is a very strong argument against a reference of the Indian Otoceras beds to the Permian system.

The majority of the species points to a correlation of the Meekoceras beds of Idaho with the Himálayan Meekoceras beds, including the *Ophiceras* zone of the Otoceras stage, but there are also some close relationships with the fauna of the Hedenstrœmia beds. In this respect we have to refer to the specific similarity of *Hedenstrœmia Mojsisovicsi* and *H. Kossmati*, of *Pseudosageceras multilobatum* and *Ps. intermontanum*, and of the representatives of the groups of *Flemingites Rohilla* and *Fl. Salya*, both in the Indian and American regions.

The species of *Sibirites* in the Meekoceras beds of the Inyo range, California, represent a type which, in the Salt Range, is exclusively characteristic of the highest zone of the lower Triassic (Scythian) series, *viz.* the upper Ceratite limestone.

It must be admitted that, according to the state of our knowledge at the time, J. Perrin Smith was perfectly justified in considering the Hedenstrœmia beds as older than the Tirolites beds of Idaho with their remarkable incursion of Mediterranean elements. It is, however, evident from the present memoir, that this incursion of Mediterranean forms was not restricted to America, but may also be

[1] In "Triassic Cephalopod genera of America" (l. c. p. 19) the distance between the fossiliferous layers of the Tirolites and Columbites beds in the section of Paris is estimated at a few feet only.

noticed in the Himálayan region, although in a lesser degree. We cannot therefore any longer reject a correlation of the Tirolites beds with the higher beds of the Hedenstrœmia stage. The close relationship existing between the scanty fauna of the Columbites beds, the youngest subdivision of the Scythian series in Idaho, with the lower Trias of the Himálayas, gives us ample proof of the correctness of this correlation. Among eleven species of ammonites four are closely allied to Indian species:—

Himálayas.	Idaho.
Meekoceras Smithii v. Krafft.	*Prionolobus Jacksoni* H. et S.
„ *sp. ind. aff. pilato.*	*Meekoceras pilatum* H. et S.
Ophiceras ptychodes Dien.	*Oph. Spencei* H. et S.
Pseudosageceras multilobatum Noetl.	*Ps. intermontanum* H. et S.

The Himálayan affinities decidedly predominate even over those with the Olenek fauna, the importance of which has been strongly emphasised by J. Perrin Smith.

It may therefore be assumed with tolerable certainty that the Hedenstrœmia beds of the Himálayas comprise the whole of the upper divisions of the American lower Trias, and are not inferior in age to the Tirolites beds of Idaho.

The horizon of *Rhynchonella Griesbachi* had been regarded as the base of the Muschelkalk by Griesbach, Bittner and by myself. But in 1904 H. H. Hayden (Geology of Spiti, Mem. Geol. Surv. of India, Vol. XXXVI, Pt. 1, p. 68), on the strength of A. v. Krafft's authority, correlated it with the lower Trias, in which he even included the nodular limestone (Niti limestone, Noetling) underlying the horizon of *Spiriferina Stracheyi* Stol. in the classical sections of Painkhanda and Spiti.

This correlation was based on the following reasons:—From two horizons—one of them six inches above the bed with *Rhynchonella Griesbachi*, the other about 30 feet above it in the middle of the Niti limestone—two fragments of ammonites were collected by Hayden in 1901. One of them was referred by A. v. Krafft to *Ceratites pumilio*, the other to *Tirolites injucundus*, both species characteristic of the Hedenstrœmia beds of Spiti. On the strength of these discoveries the boundary line between the lower Trias and the Muschelkalk is drawn by Hayden and A. v. Krafft at or above the middle of the nodular limestone (Niti limestone). The horizon of *Rhynchonella Griesbachi* is consequently included in the lower Trias.

My examination of the poorly preserved fossils from the Niti limestone of Muth has not confirmed A. v. Krafft's identifications. The species of *Ceratites*, badly preserved as it is, must at all events be separated from *C. pumilio*, as has been demonstrated in the description of the latter species. The second fragment cannot even be referred with any probability to the genus *Tirolites*. Its systematic position is very doubtful. The scanty fossil materials collected by Hayden are therefore not sufficient to serve as proof of a stratigraphical correlation of the Niti limestone with the lower Trias.

On the other hand the only species of ammonite known from the beds with

Rhynchonella Griesbachi, viz., Sibirites Prahlada Dien., ranges from this horizon into the beds with *Spiriferina Stracheyi*, of undoubted Muschelkalk age. This fact is decidedly in favour of grouping the beds with *Rhynchonella Griesbachi* with the Muschelkalk, not with the Scythian series.

Noetling (Lethæa Mesozoica, Vol. I. Asiatische Trias, p. 149) includes the horizon of *Rhynchonella Griesbachi* in the Hedenstrœmia beds, because lithologically it agrees better with them than with the overlying Niti limestone. But this argument is only valid for the Spiti sections, not for Byans, where a sharp lithological boundary occurs between the Chocolate Limestone with *Sibirites spiniger* and the light grey limestone containing *Rhynchonella Griesbachi*.

Special importance must be attributed to the fact that equivalents of the zone of *Stephanites superbus*, the highest lower Triassic zone of the Salt Range, have been found in the topmost beds of the Chocolate Limestone of Byans (horizon of *Sibirites spiniger*) *below* the horizon of *Rhynchonella Griesbachi*. To the latter horizon its proper place must consequently be assigned at the base of the Muschelkalk.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1 — MEEKOCERAS LILANGENSE v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 2*a*, *b*, *c* *d* — MEEKOCERAS LILANGENSE v. Krafft. S. of Po, Spiti, lower division of the lower Trias, coll. Hayden.

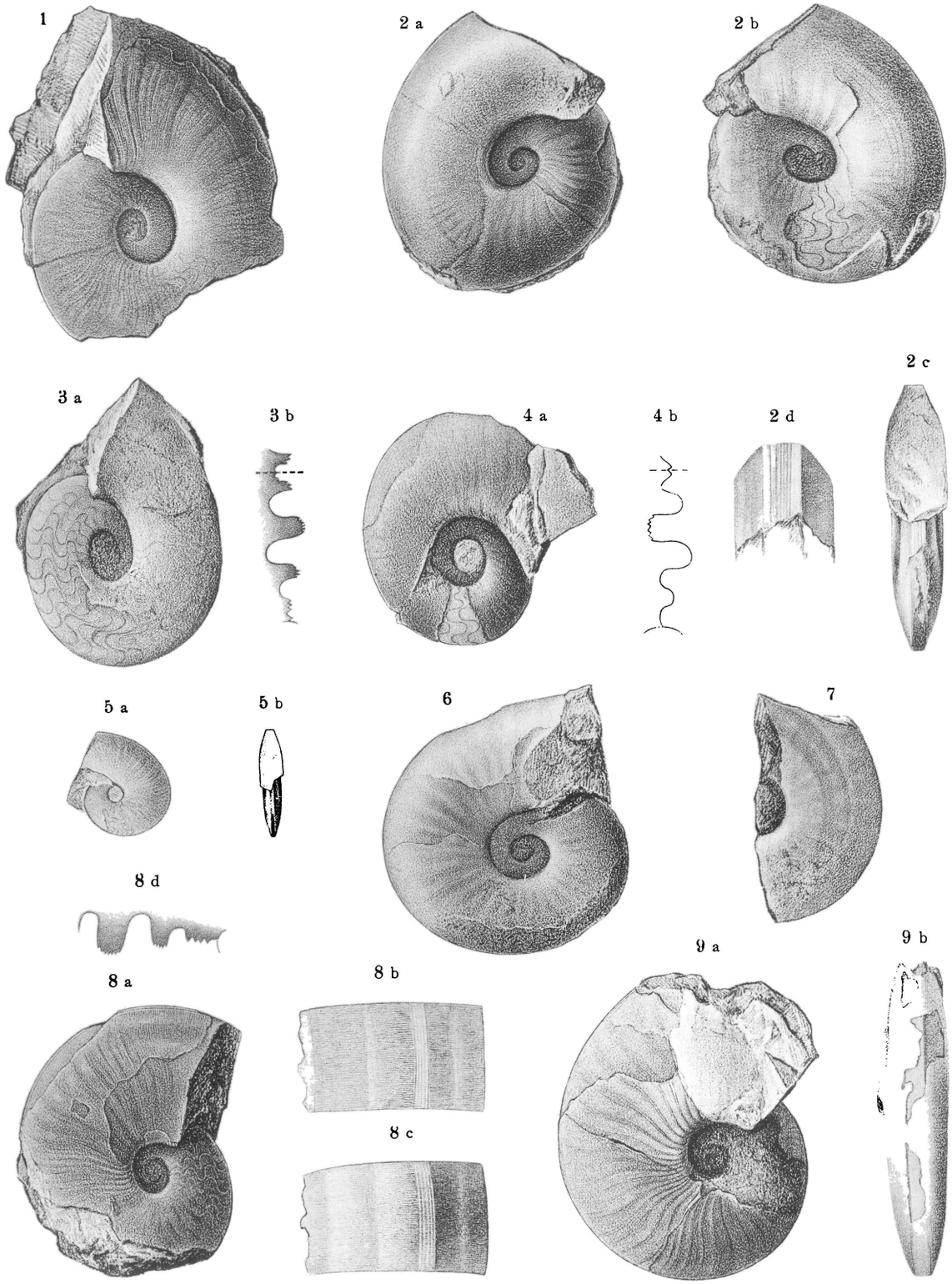
„ 3*a*, *b* — MEEKOCERAS LILANGENSE v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 4*a*, *b* — MEEKOCERAS DISCIFORME v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 5*a*, *b*
„ 6
„ 7
} MEEKOCERAS LILANGENSE v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 8*a*, *b*, *c*, *d* — MEEKOCERAS RUGOSUM v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 9*a*, *b* — MEEKOCERAS CF. RADIOSUM Waag. S. W. of Gaichund, Spiti, lower division of the lower Trias, coll. Hayden.



Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE II.

Fig. 1*a*, *b*, *c*, *d* MEEKOCERAS LINGTIENSE v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 2, „ 3*a*, *b* MEEKOCERAS VARAHA Dien. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 4*a*, *b*, *c*, *d* MEEKOCERAS VARAHA Dien. Kuling, Spiti, Meekoceras beds, coll. v. Krafft.

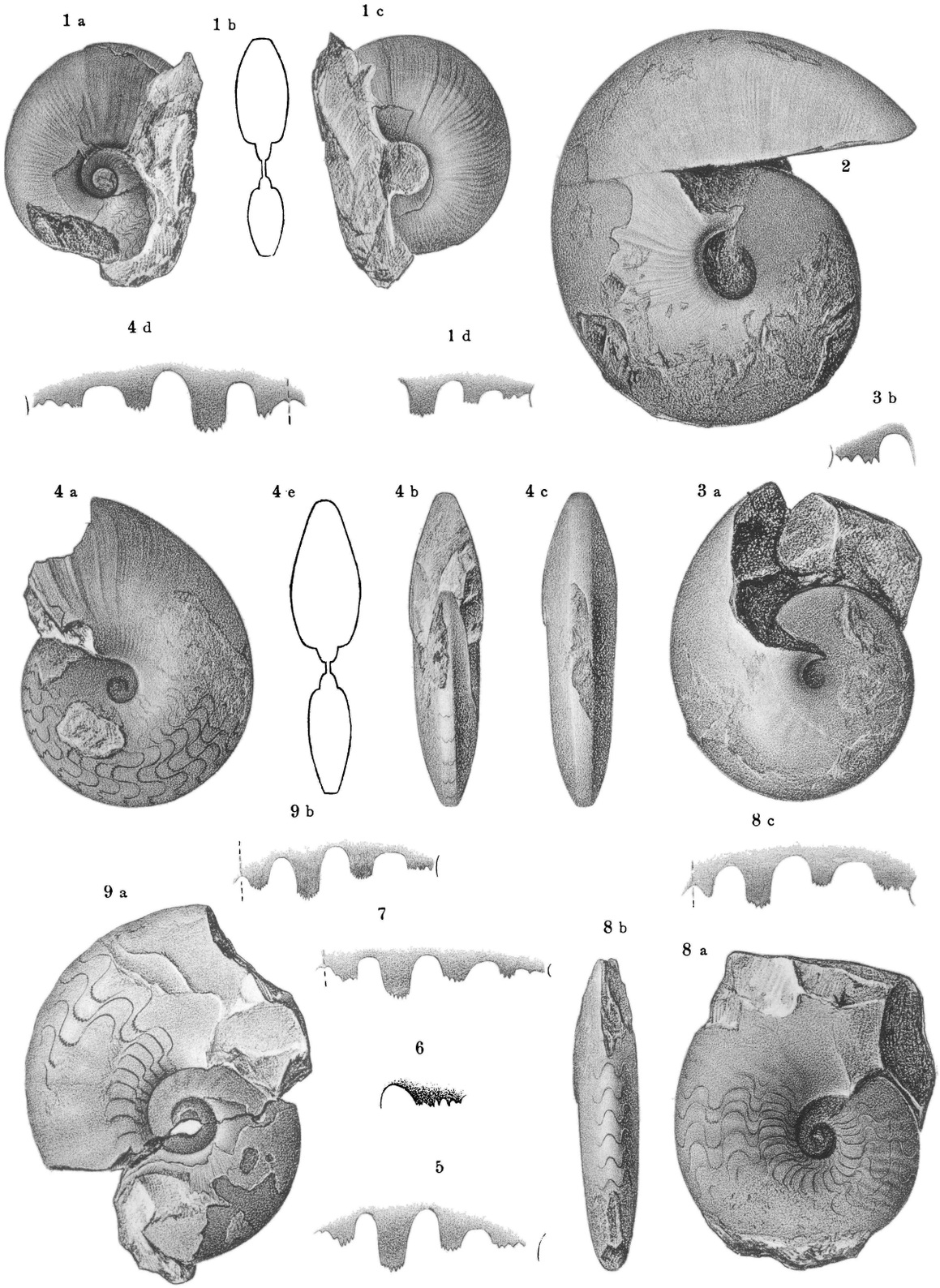
„ 5 MEEKOCERAS VARAHA Dien. Sutures of Diener's type-specimen (Pl. VI, fig. 1).

„ 6 MEEKOCERAS VARAHA Dien. Sutures of Diener's type-specimen (Pl. VII, fig. 6).

„ 7 MEEKOCERAS BOREALE Dien. Sutures of Diener's type-specimen (Pl. VII, fig. 1).

„ 8*a*, *b*, *c* MEEKOCERAS KYOKTICUM v. Krafft. 5 miles S. of Ensa, Spiti; lower division of the lower Trias, coll. Hayden.

„ 9*a*, *b* MEEKOCERAS HODGSONI Dien. Diener's type-specimen from the Shalshal Cliff. (Pl. VI, fig. 1).



Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE III.

Fig. 1*a, b, c, d, e* MEEKOCERAS SOLITARIUM v. Krafft. 5 miles S. of Ensa, Spiti, Hedenstrœmia beds, coll. Hayden.

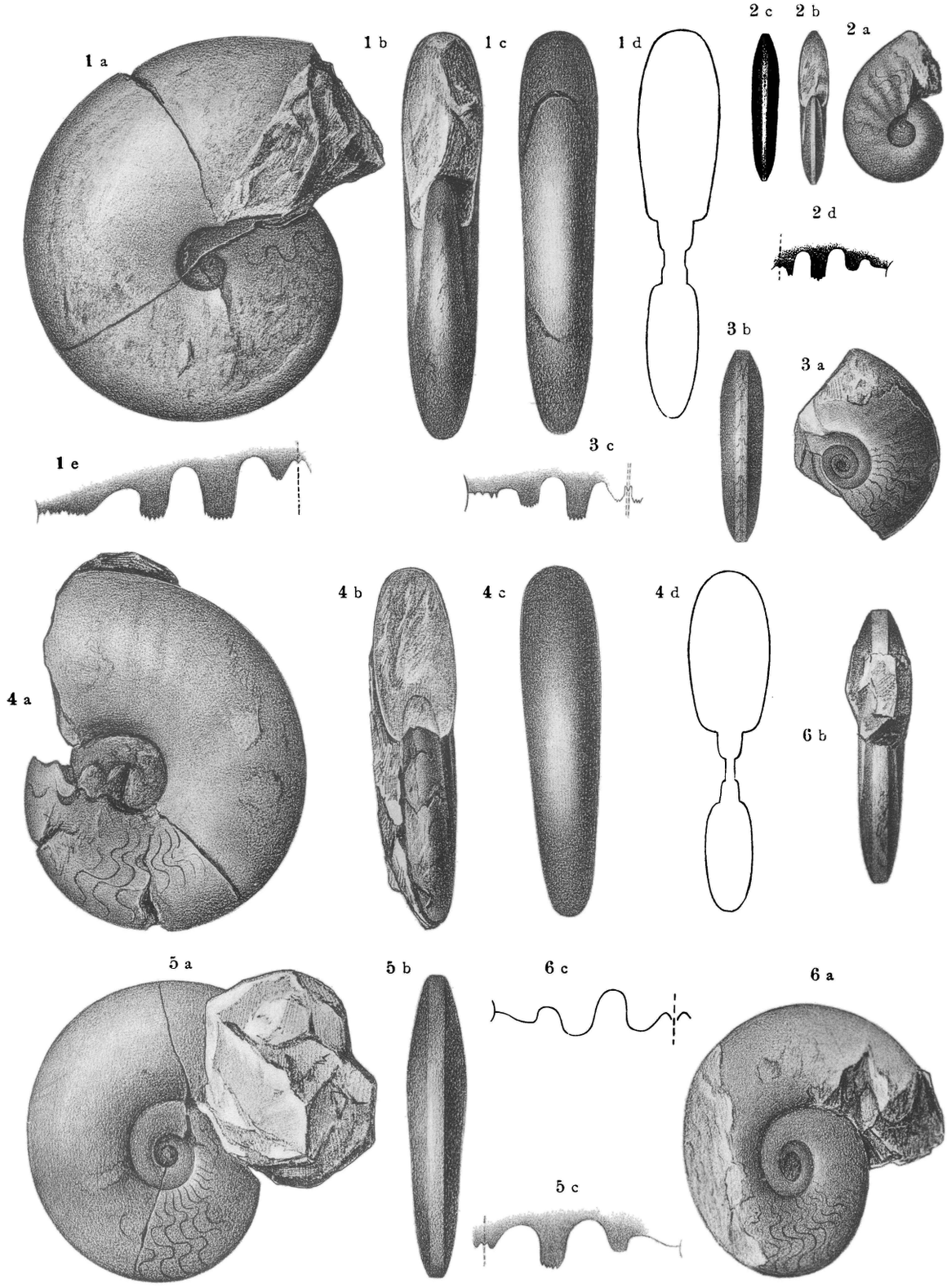
„ 2*a, b, c, d* MEEKOCERAS HODGSONI Diener. Diener's type-specimen of KONINCKITES VIDARBHA (Pl. VII, fig. 9) from the Otoceras beds of the Shalshal Cliff.

„ 3*a, b, c* MEEKOCERAS JOLINKENSE v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 4*a, b, c, d* MEEKOCERAS NOV. SP. IND. Khar, Spiti; lower division of the lower Trias, coll. Hayden.

„ 5*a, b, c, d* MEEKOCERAS DISCIFORME v. Krafft. S. E. of Muth; lower division of the lower Trias, coll. Hayden.

„ 6*a, b, c* MEEKOCERAS DISCIFORME v. Krafft. 5 miles S. of Ensa; lower divison of the lower Trias, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE IV.

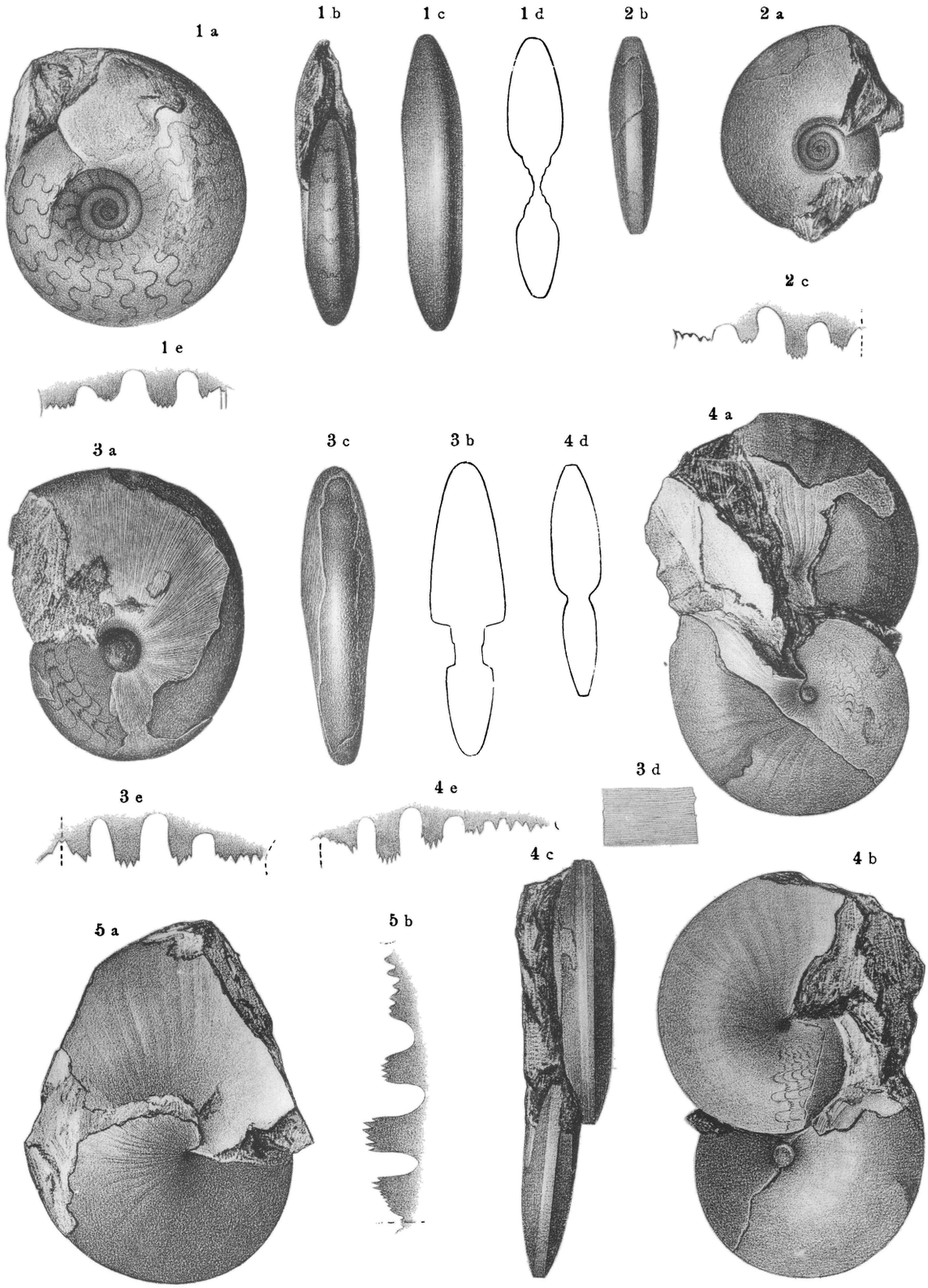
Fig. 1*a*, *b*, *c*, *d*, *e* MEEKOCERAS SMITHII **v. Krafft.** Jolinka, Kuti Yangti valley, Byans coll. Smith.

„ 2*a*, *b*, *c* MEEKOCERAS JOLINKENSE **v. Krafft.** Jolinka, Byans, coll. Smith.

„ 3*a*, *b*, *c*, *d*, *e* MEEKOCERAS TENUISTRIATUM **v. Krafft.** Meekoceras beds, Lilang, Spiti, coll. **v. Krafft.**

„ 4*a*, *b*, *c*, *d*, *e* ASPIDITES SPITIENSIS **v. Krafft.** 5 miles S. of Ensa, Spiti, Meekoceras beds, coll. Hayden.

„ 5*a*, *b* ASPIDITES SPITIENSIS **v. Krafft.** Meekoceras beds, Lilang, Spiti, coll. v. Krafft.



Phot. u. Lichtdruck v. Max Jaffé, Wien.

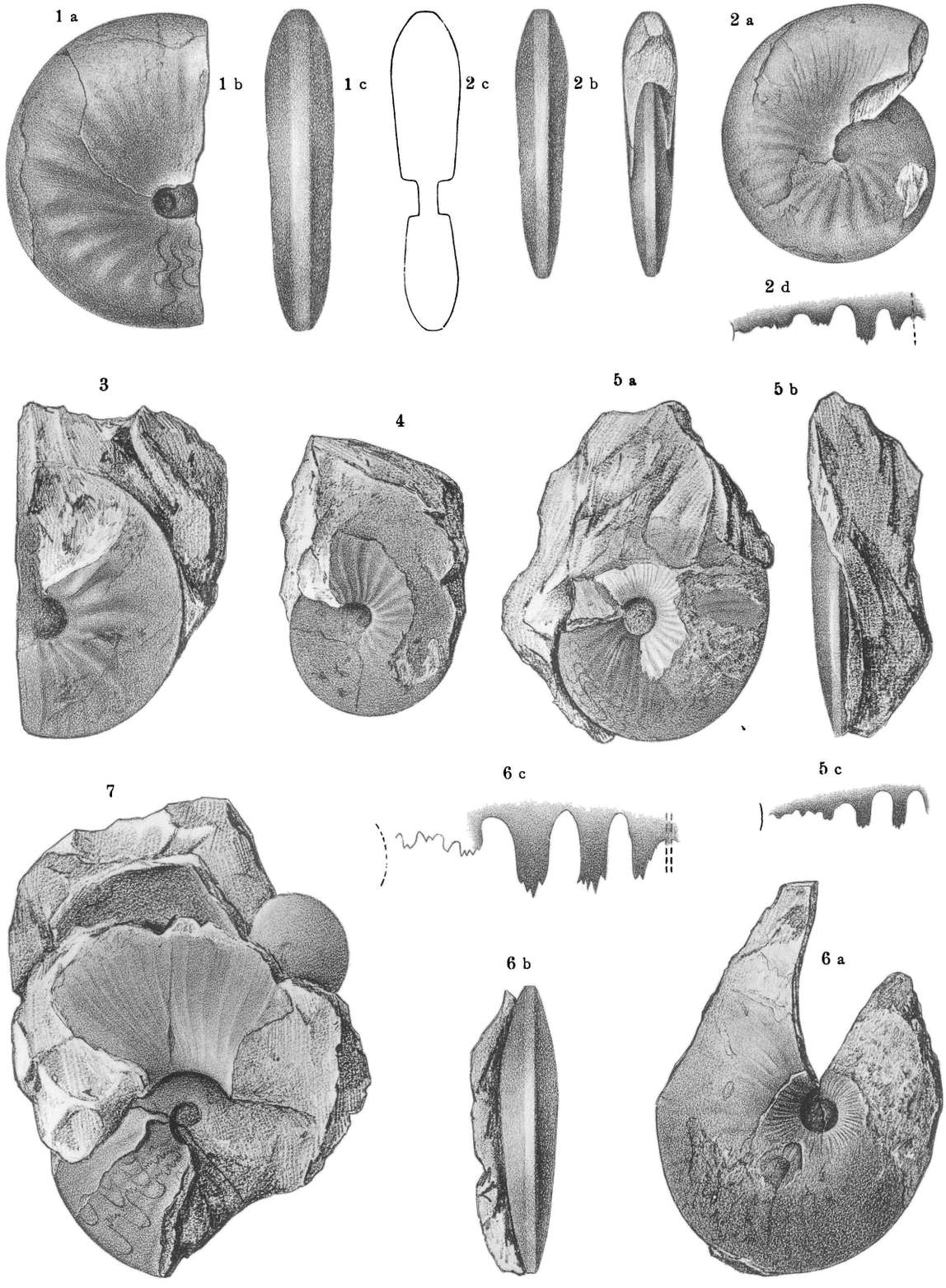
PLATE V.

Fig. 1*a*, *b*, *c* } ASPIDITES VIDARBHA Dien. 5 miles S. of Ensa, Spiti, lower division of
„ 2*a*, *b*, *c*, *d* } the lower Trias, coll. Hayden.

„ 3 } ASPIDITES ENSANUS v. Krafft. 5 miles S. of Ensa, Spiti, lower division
„ 4 } of the lower Trias, coll. Hayden.

„ 5*a*, *b*, *c* } ASPIDITES ENSANUS v. Krafft. 1 mile N. of Lilang, Spiti, Meekoceras
„ 6*a*, *b*, *c* } beds, coll. v. Krafft.

„ 7 ASPIDITES ENSANUS v. Krafft. 5 miles S. of Ensa, Spiti, lower division of the lower Trias, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE VI.

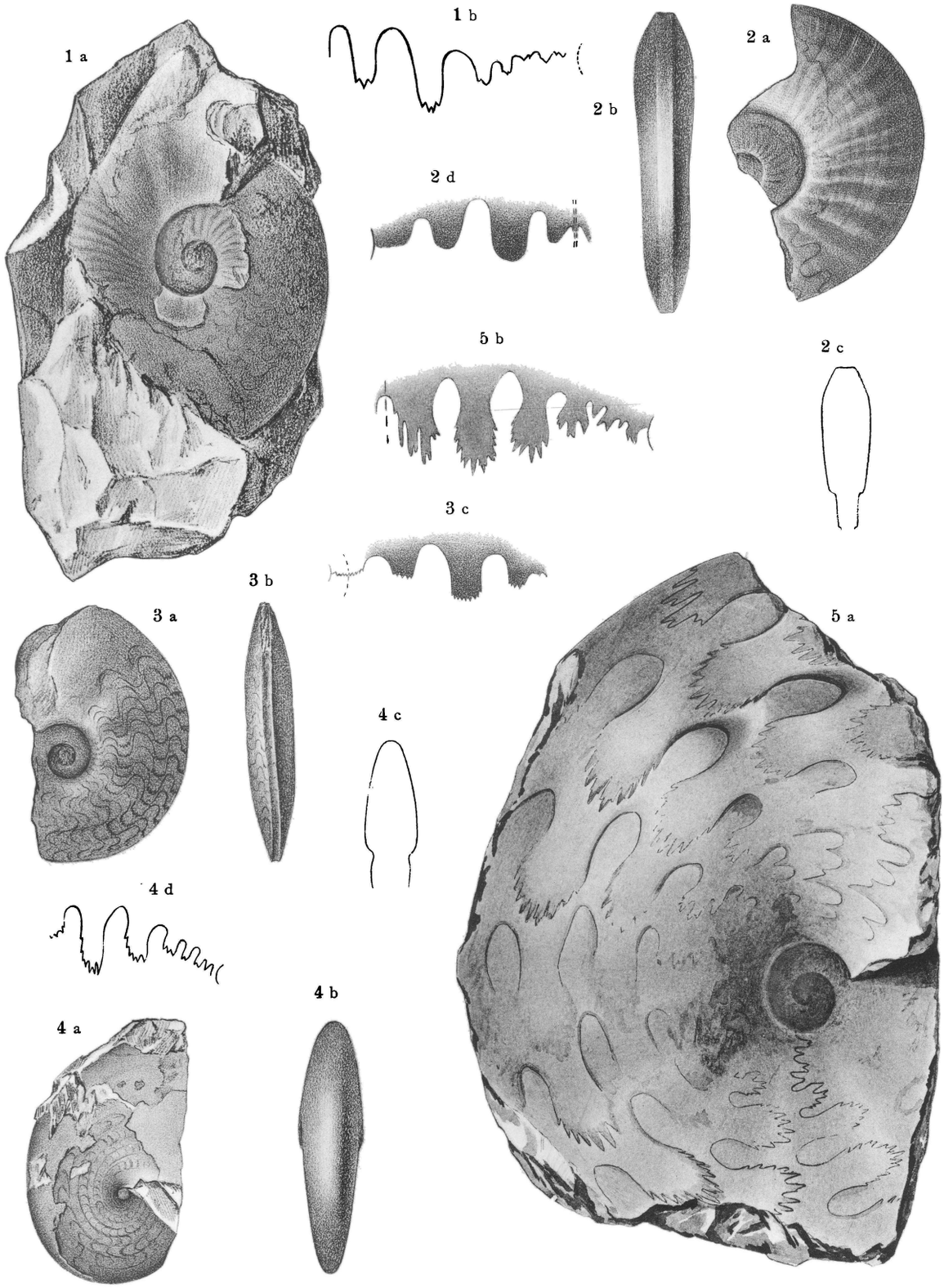
Fig. 1*a*, *b* — ASPIDITES ENSANUS v. Krafft. 1 mile N. of Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 2*a*, *b*, *c*, *d* — MEEKOCERAS NOV. SP. IND. AFF. DISCUS Waag. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 3*a*, *b*, *c* — MEEKOCERAS PSEUDOPLANULATUM v. Krafft. S. E. of Muth, Spiti, Hedenstrœmia beds, coll. Hayden.

„ 4 — ASPIDITES CRASSUS v. Krafft. Lilang, Spiti, Meekoceras beds, coll. v. Krafft.

„ 5 — ASPIDITES MUTHIANUS v. Krafft. S. E. of Muth, Spiti, Hedenstrœmia beds, coll. Hayden.

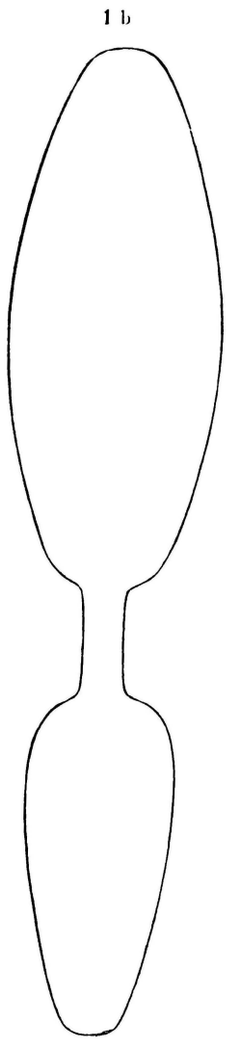


Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE VII.

Fig. 1*a*, *b*, *c* ASPIDITES CRASSUS v. Krafft. Meekoceras beds, Lilang, Spiti, coll. v. Krafft.

„ 2 ASPIDITES EVOLVENS Waagen. Sutures of Waagen's type-specimen [*Palæontologia Indica*, ser. XIII, Vol. II, Pl. XXV, fig. 1.]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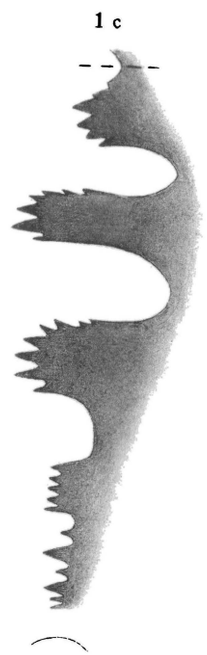
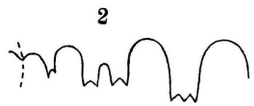

1 c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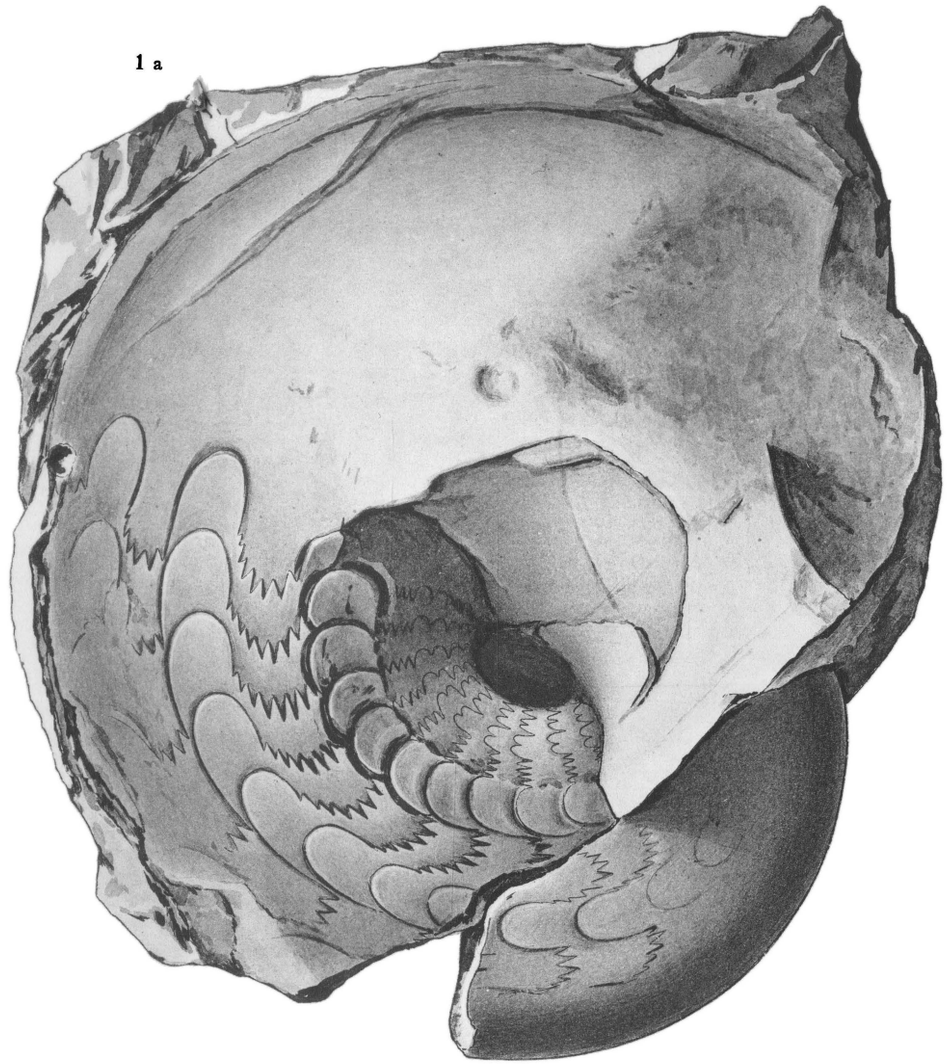
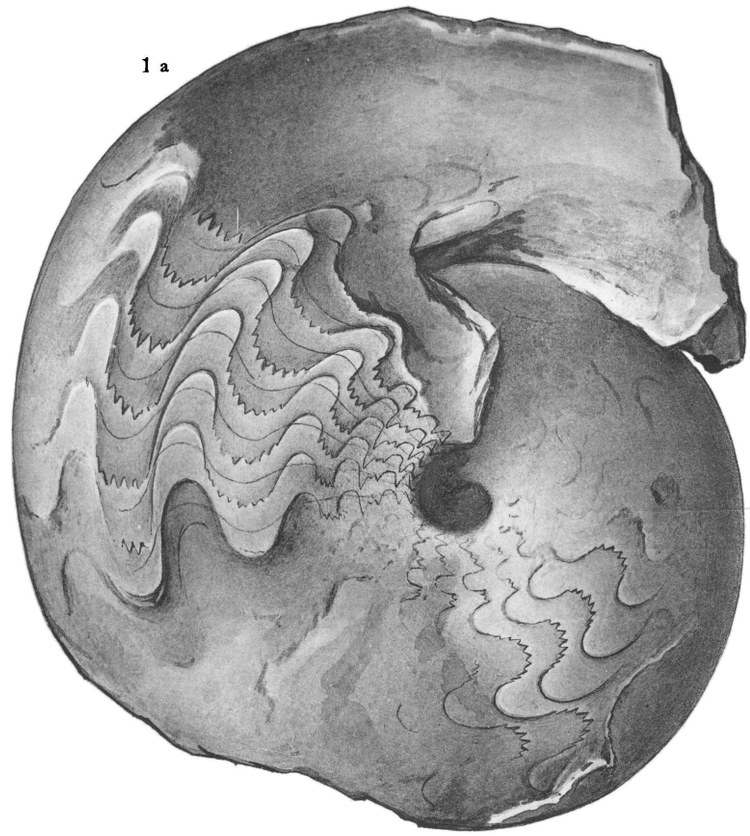

1 a

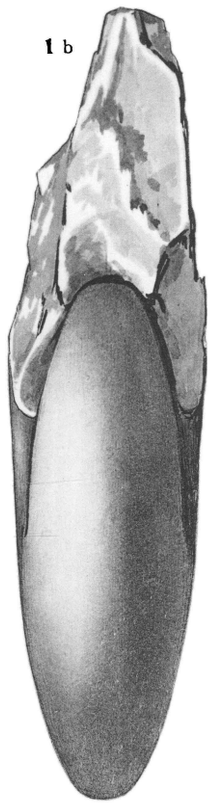
PLATE VIII.

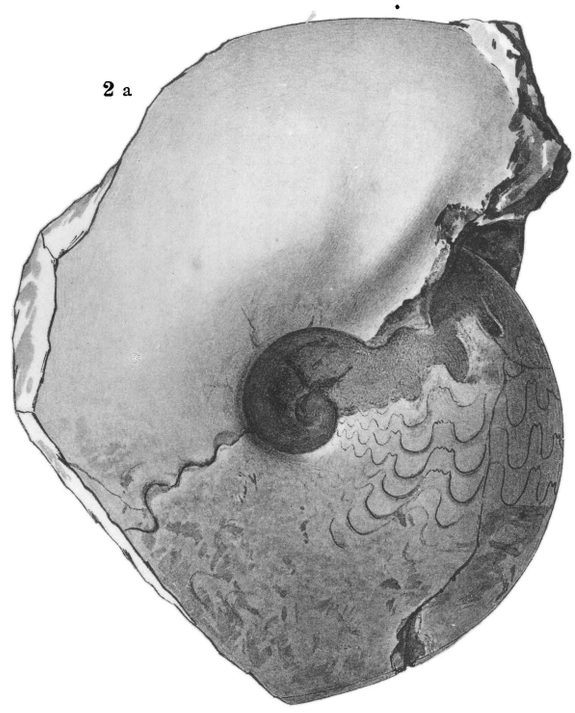
Fig. 1*a*, *b* — ASPIDITES CRASSUS v. Krafft. Meekoceras beds, Lilang, coll. v. Krafft.

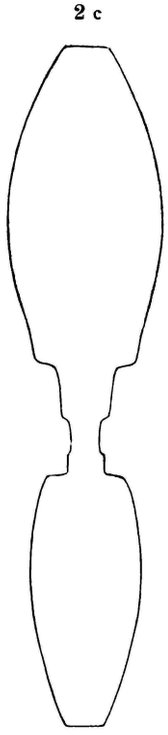
„ 2*a*, *b*, *c*, *d* — HEDENSTRŒMIA BYANSICA v. Krafft. Jolinka, Byans, coll. Smith.

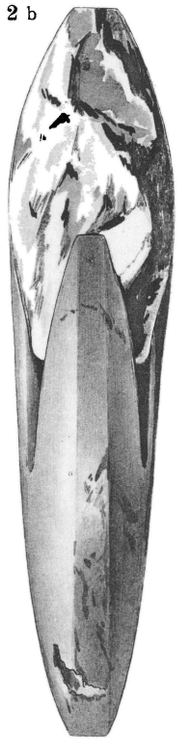
„ 3 — HEDENSTRŒMIA SP. IND. AFF. MOJSISOVICSI Dien. Sutures of Diener's type-specimen, *Pal. Ind.*, ser. XV, Vol. II, Pt. 1, Pl. XXII, fig. 2.











Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE IX.

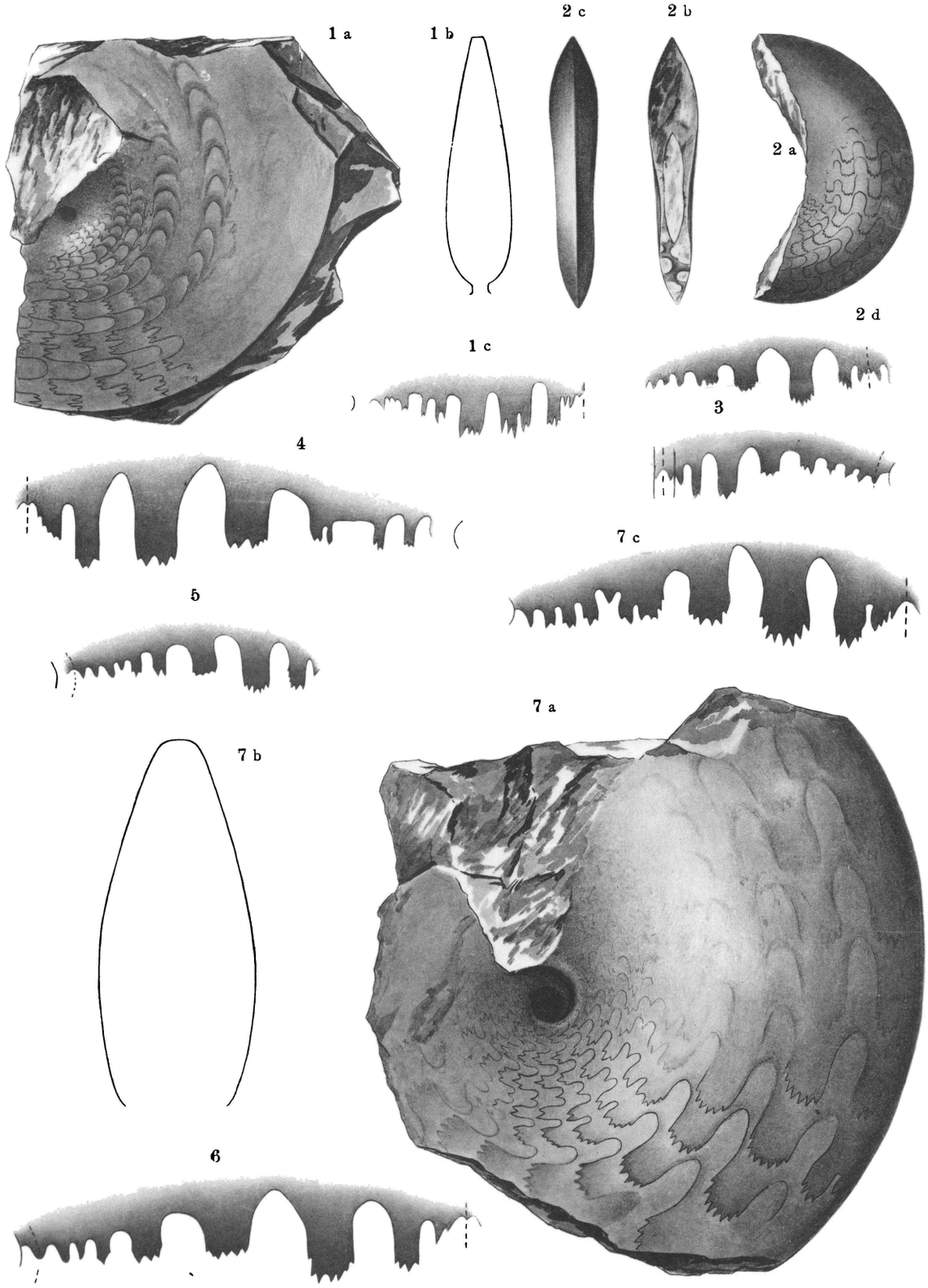
Fig. 1*a*, *b*, *c* HEDENSTRŒMIA LILANGENSIS v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 2*a*, *b*, *c*, *d* HEDENSTRŒMIA ACUTA v. Krafft. Jolinka, Byans, coll. Smith.

„ 3
„ 4
„ 5 } HEDENSTRŒMIA MOJSISOVICSI Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden. Sutures.

„ 6 HEDENSTRŒMIA MOJSISOVICSI Dien. 5 miles S. of Ensa, Hedenstrœmia beds, coll. Hayden.

„ 7*a*, *b*, *c* HEDENSTRŒMIA MUTHIANA v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

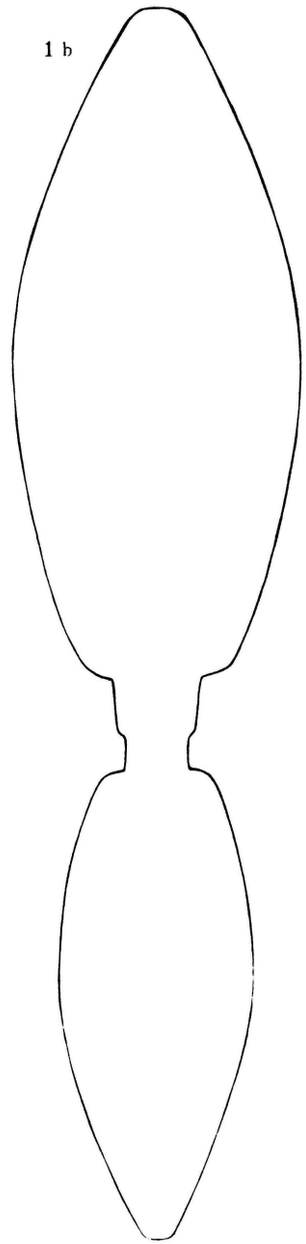


Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE X.

Fig. 1*a*, *b* HEDENSTRŒMIA MOJSISOVICSI Dien. S. E. of Muth, Spiti, Hedenstrœmia beds, coll. Hayden.

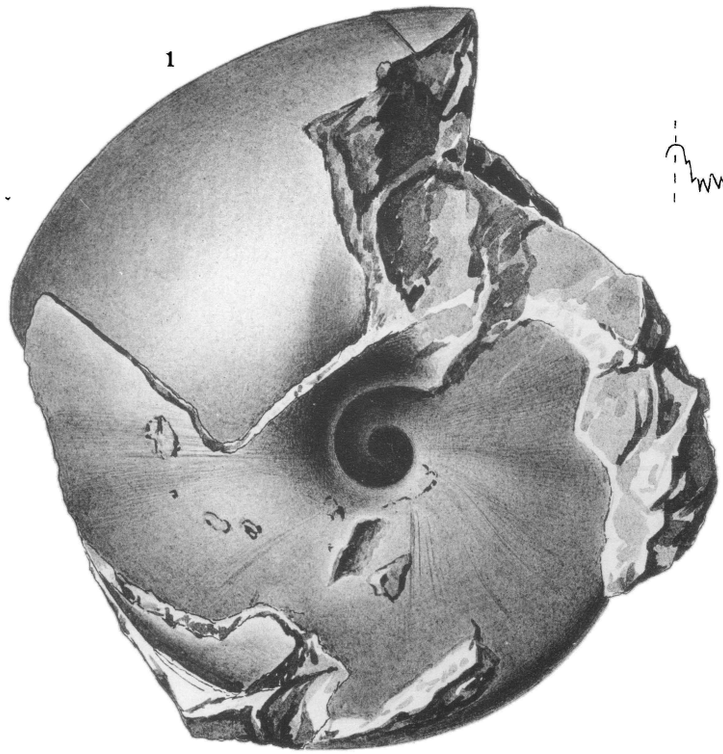
„ 2, „ 3 HEDENSTRŒMIA MOJSISOVICSI Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden. Sutures.

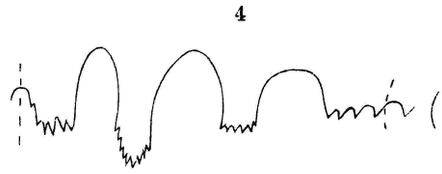


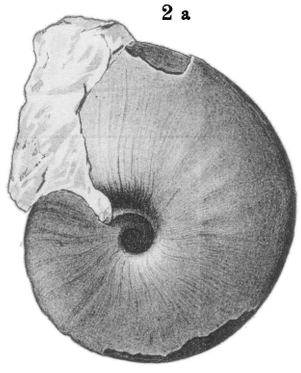
Phot. u. Lichtdruck v. Max Jaffé, Wien.

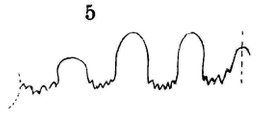
PLATE XI.

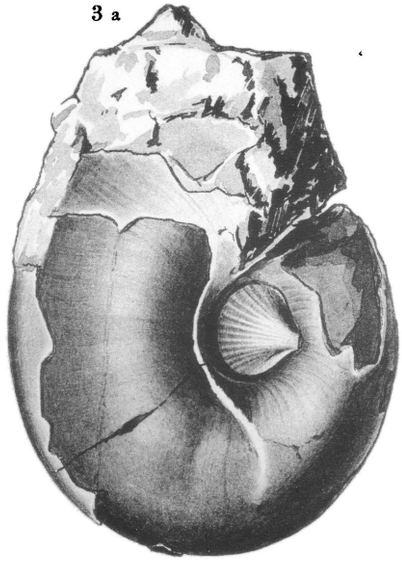
MEEKOCERAS MARKHAMI Dien. All specimens from the Meekoceras beds of the Shalshal Cliff, Painkhanda, coll. Noetling.

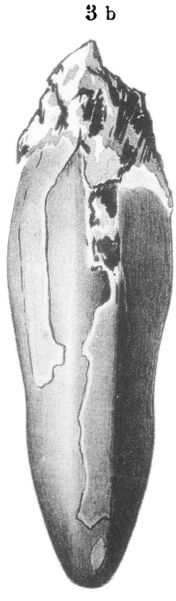


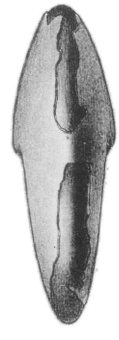








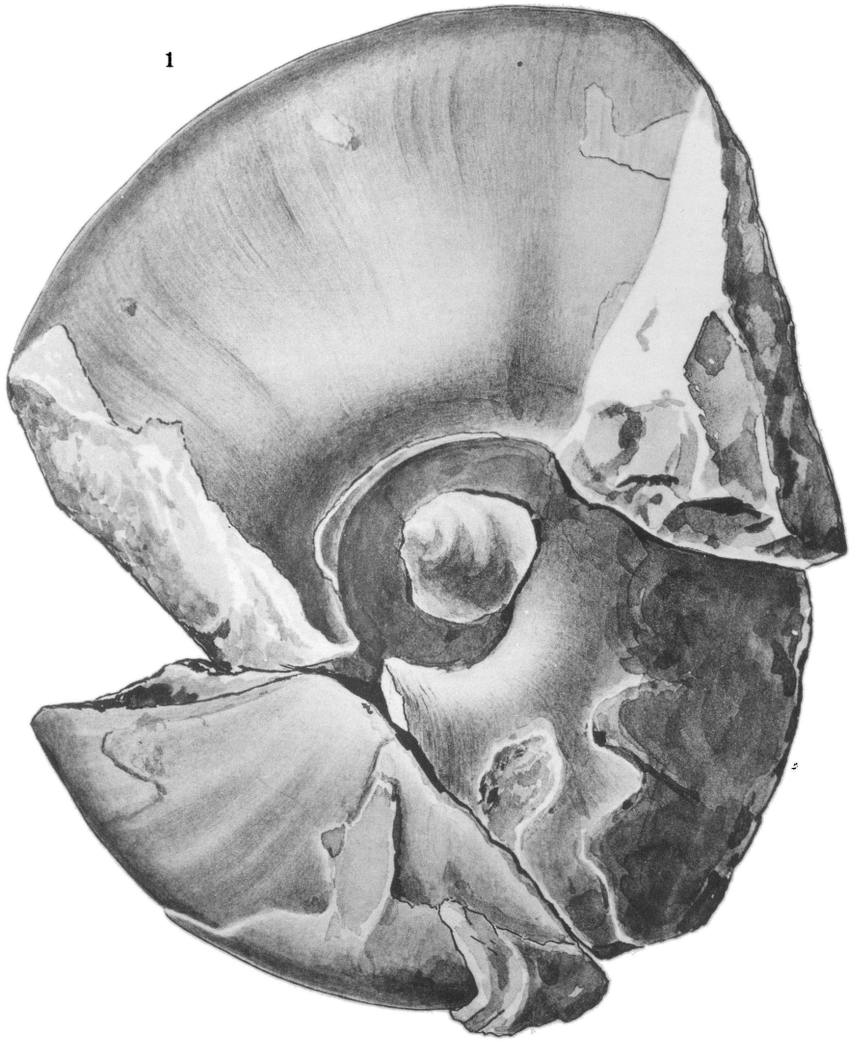


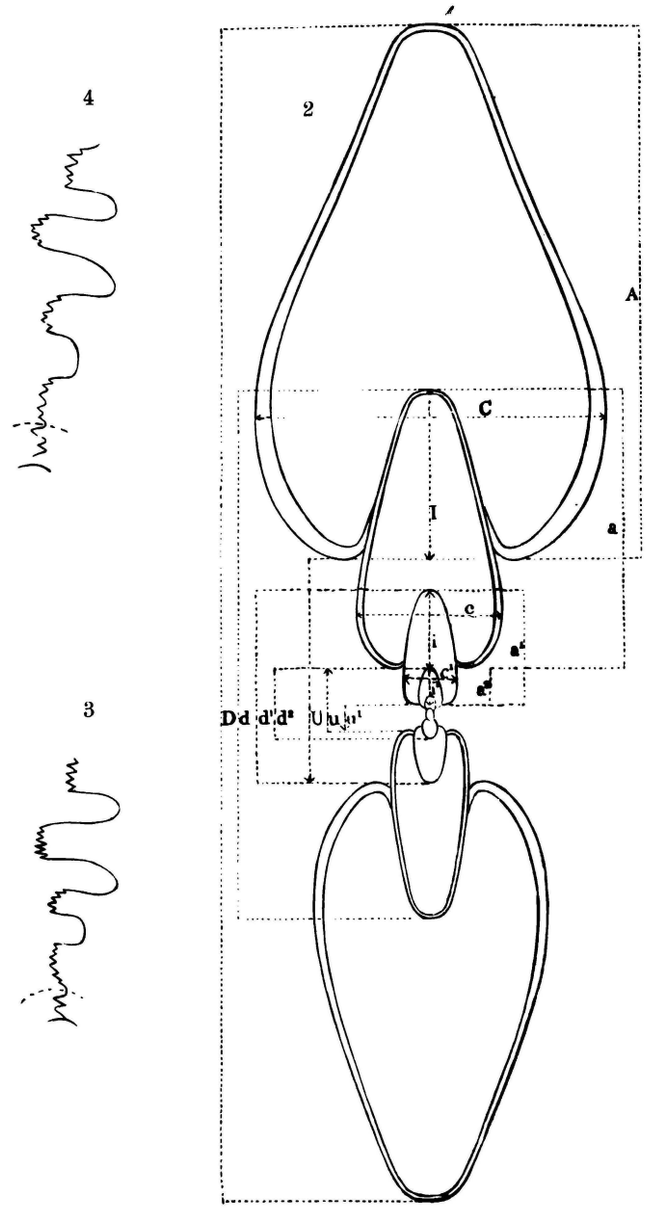


Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XII.

MEEKOCERAS MARKHAMI Dien. All specimens from the Meekoceras beds of the Shalshal Cliff, coll. Noetling.

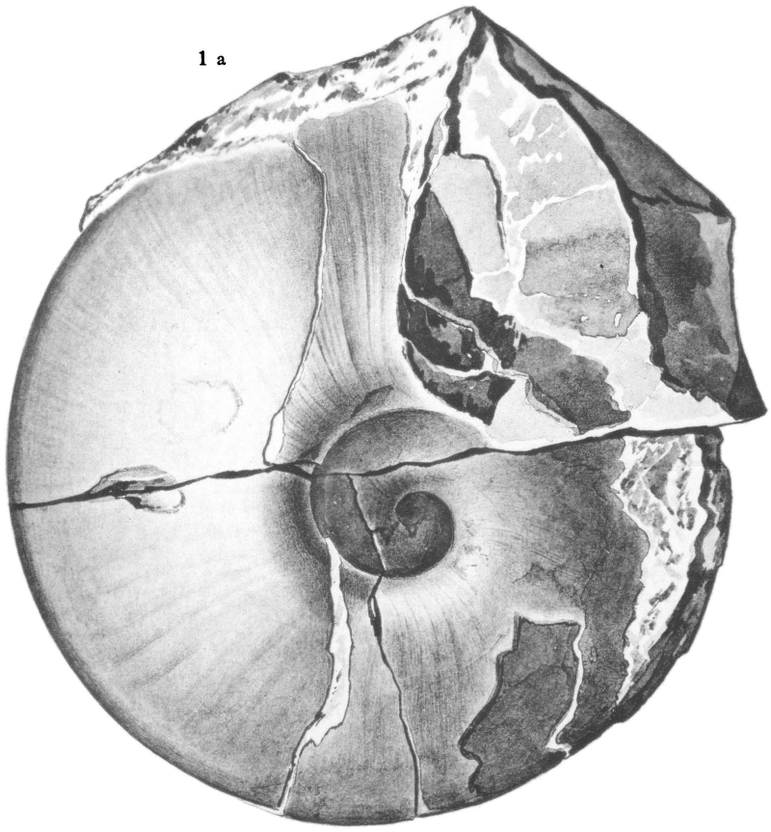


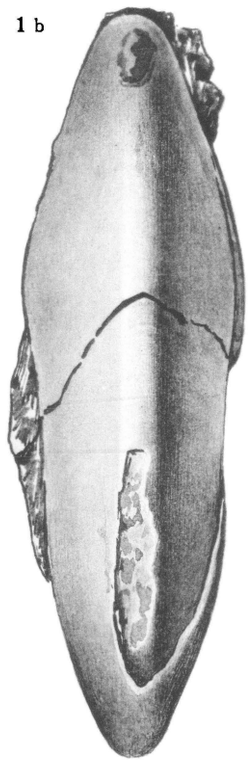


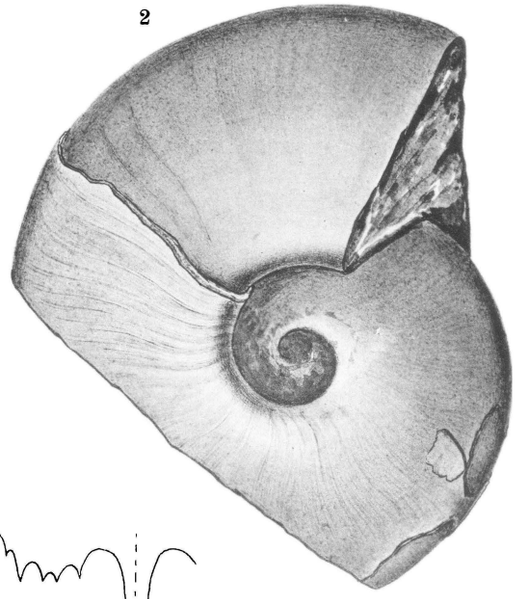
Phot. u. Lichtdruck v. Max Jaffé, Wien.

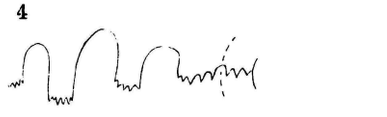
PLATE XIII.

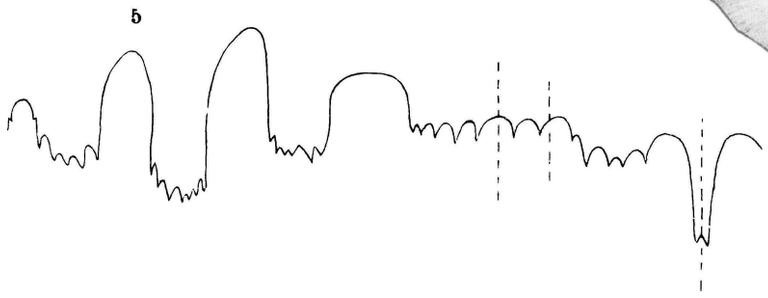
MEEKOCERAS MARKHAMI Dien. All specimens from the Meekoceras beds of the Shalshal Cliff, coll. Noetling.











Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XIV.

Fig. 1*a*, *b*, *c*, *d* MEEKOCERAS LILANGENSE v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 2 MEEKOCERAS LILANGENSE v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 3 KONINCKITES YUDISHTHIRA Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden. Sutures.

„ 4 MEEKOCERAS MARKHAMI Dien. Shalshal Cliff, Meekoceras beds, coll. Noetling. Sutures.

„ 5 MEEKOCERAS MARKHAMI Dien. Shalshal Cliff, Meekoceras beds, coll. Noetling. Sutures.

„ 6 ASPIDITES ENSANUS v. Krafft. 4 miles W. of Po, lower division, coll. Hayden.

„ 7 MEEKOCERAS VARAHA Dien. Shalshal Cliff, Meekoceras beds, coll. Noetling. Cross-section.

„ 8 MEEKOCERAS VARAHA Dien. Shalshal Cliff, Meekoceras beds, coll. Noetling. Sutures.

„ 9 MEEKOCERAS DISCIFORME v. Krafft. Lilang, Meekoceras beds, coll. v. Krafft.

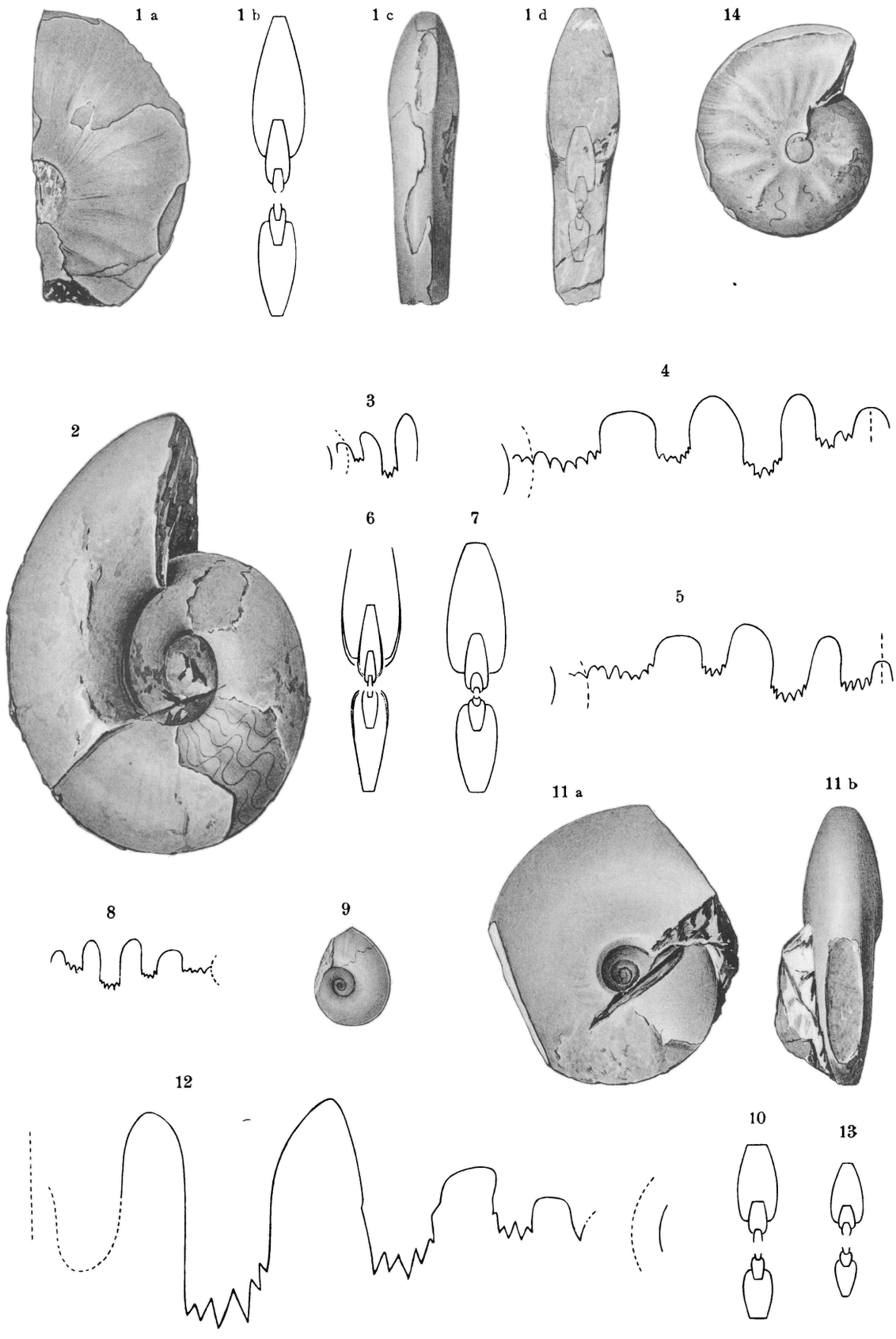
„ 10 MEEKOCERAS DISCIFORME v. Krafft. Lilang, Meekoceras beds, coll. v. Krafft.

„ 11*a*, *b* MEEKOCERAS BOREALE Dien. Crest of ridge between Dharma and Lissar valleys, lower division (Otoceras beds ?), coll. La Touche.

„ 12 KONINCKITES GIGANTEUS v. Krafft. Hedenstrœmia beds, S. E. of Muth, coll. Hayden. Sutures.

„ 13 MEEKOCERAS JOLINKENSE v. Krafft. Jolinka, Kuti Yangti valley, Byans, coll. Smith.

„ 14 ASPIDITES VIDARBHA Dien. Jolinka, Byans, coll. Smith.



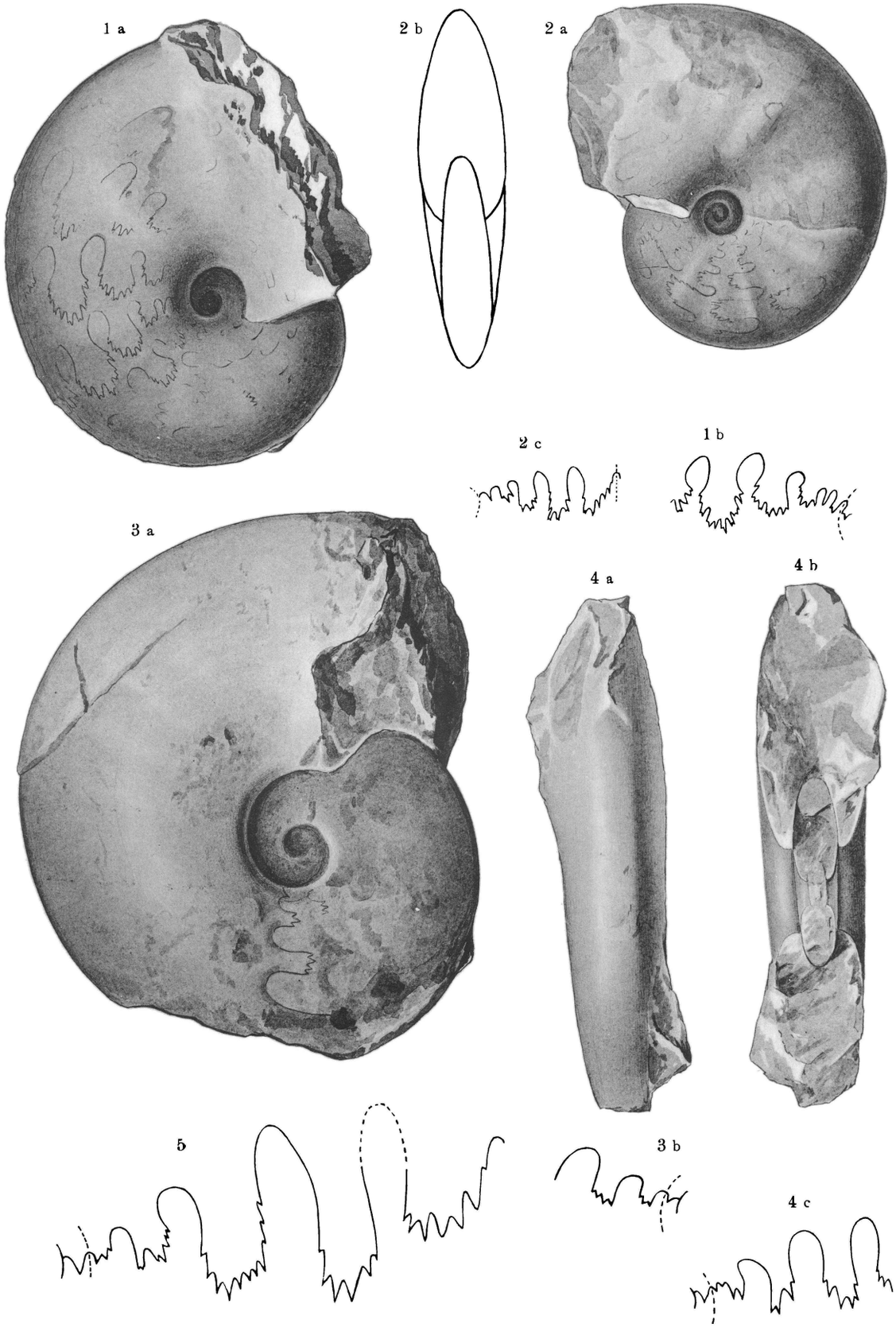
Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XV.

Fig. *a, b* — Aspidites Muthianus v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 2*a, b, c* — Aspidites Muthianus v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 3*a, b*
„ 4*a, b, c*
„ 5
} Koninckites Yudishthira Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

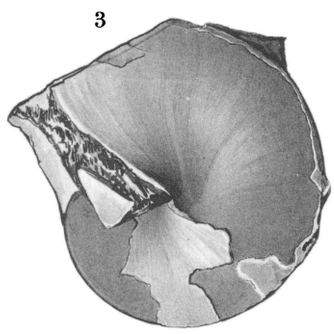
PLATE XVI.

Fig. 1*a*, *b*, „ 2*a*, *b*, *c* } KONINCKITES ALTERAMMONOIDES v. Krafft. 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.

„ 3, „ 4 } ASPIDITES SPITIENSIS v. Krafft. Shalshal Cliff, Meekoceras beds, coll. Noetling.

„ 5 ASPIDITES SPITIENSIS v. Krafft. Shalshal Cliff, Meekoceras beds, coll. Noetling. Cross-section.

„ 6, „ 7, „ 8 } ASPIDITES SPITIENSIS v. Krafft. Shalshal Cliff, Meekoceras beds, coll. Noetling. Sutures.



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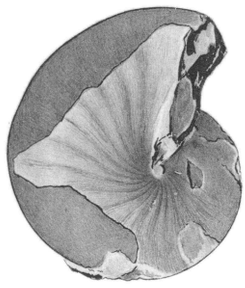
1 a



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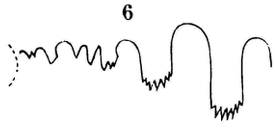

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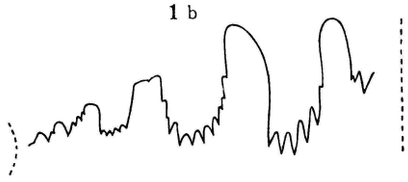
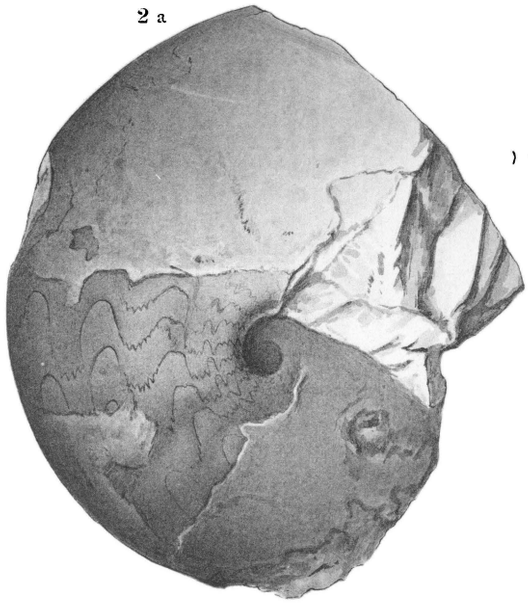


1 b



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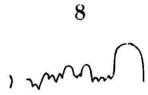
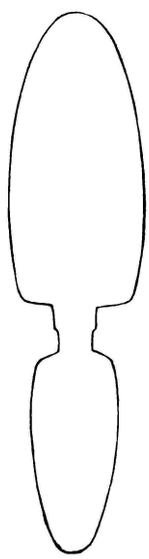


8

5



2 b

2 c

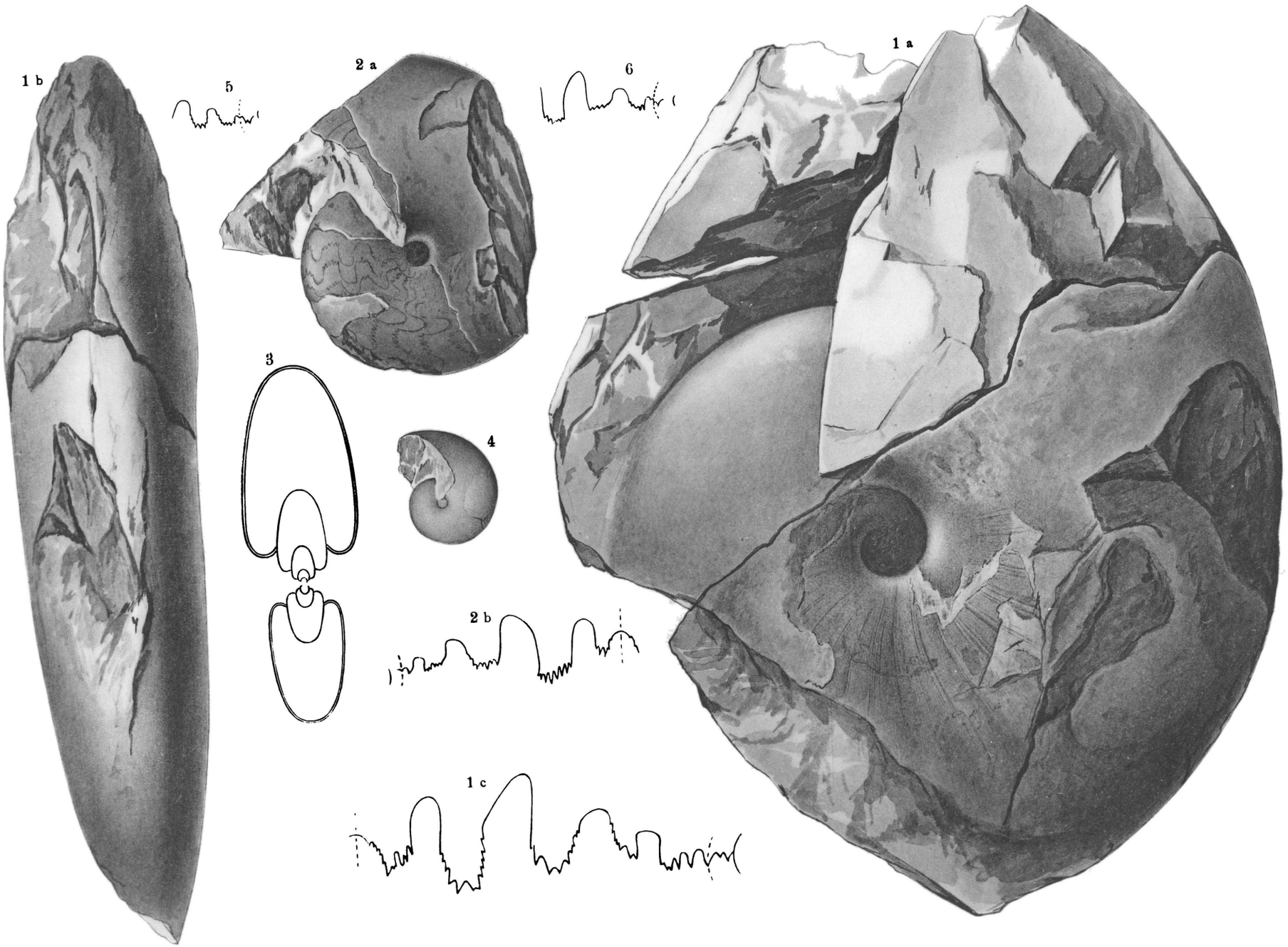
Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XVII.

KONINCKITES HAYDENI v. Krafft.

Fig. 1*a*, *b*, *c* } 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft.
„ 2*a*, *b* }
„ 3 S. W. of Gaichund, "Otoceras beds," (base) coll. Hayden.
„ 4 S. W. of Gaichund, lower division, coll. Hayden.
„ 5 S. W. of Gaichund, lower division, coll. Hayden. Sutures.
„ 1 1 mile N. of Lilang, Meekoceras beds, coll. v. Krafft. Sutures.

Geol. Surv. of India.



Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XVIII.

ASPIDITES NOV. SP. IND. AFF. SUPERBO Waag. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

Reduced to $\frac{3}{4}$ of its original size.

Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XIX.

Fig. 1 — ASPIDITES SUPERBIFORMIS Dien. S. E. of Muth, Hedenstrœmia beds, coll. Griesbach. Front view of Diener's type-specimen.

„ 2 — ASPIDITES SUPERBUS Waagen. Front view of Waagen's type-specimen from the Flemingites beds (Ceratite sandstone) of Chidru.

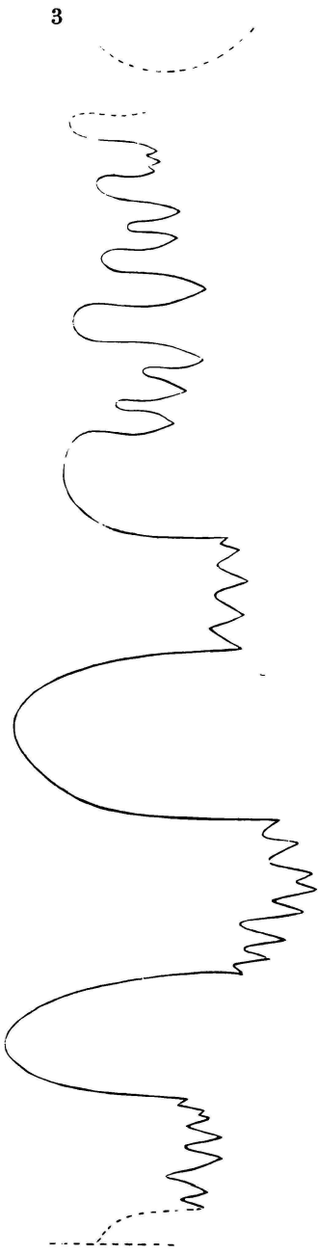
„ 3 — ASPIDITES NOV. SP. IND. AFF. SUPERBO Waag. S. E. of Muth, Hedenstrœmia beds, coll. Hayden. Sutures.

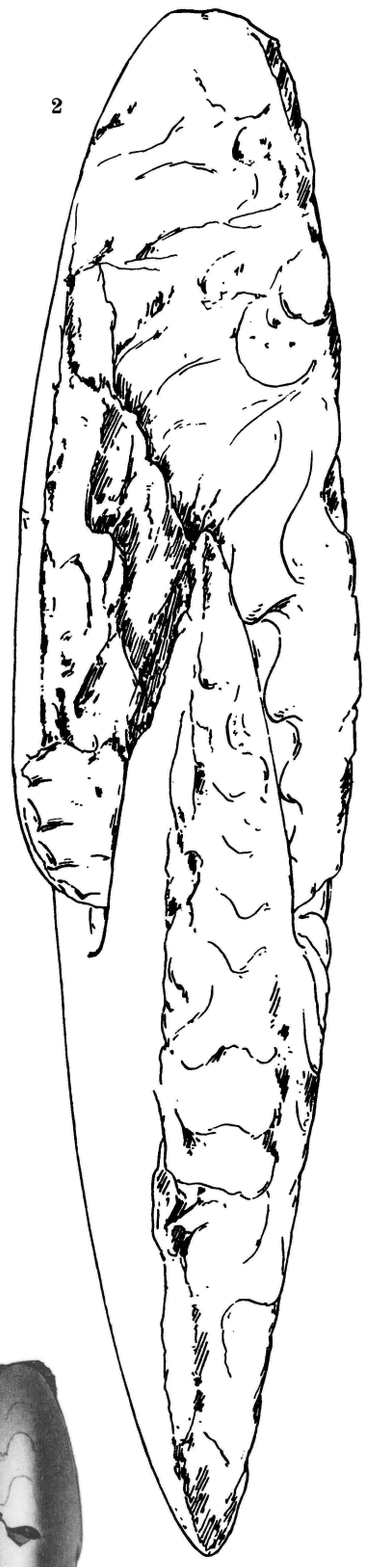
„ 4*a*, *b* — PROPTYCHITES TYPICUS v. Krafft. Kuling, Lower division, coll. v. Krafft.

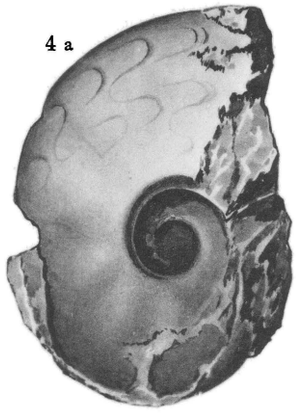
„ 5 — PROPTYCHITES TYPICUS v. Krafft. Ridge between Dharma and Lissar valleys, lower division, coll. La Touche.

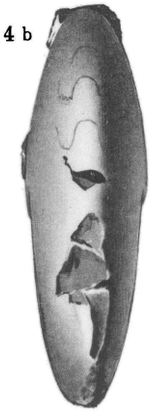
Geol. Surv. of India.

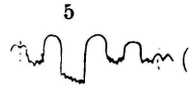
Pl. XIX.











Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XX.

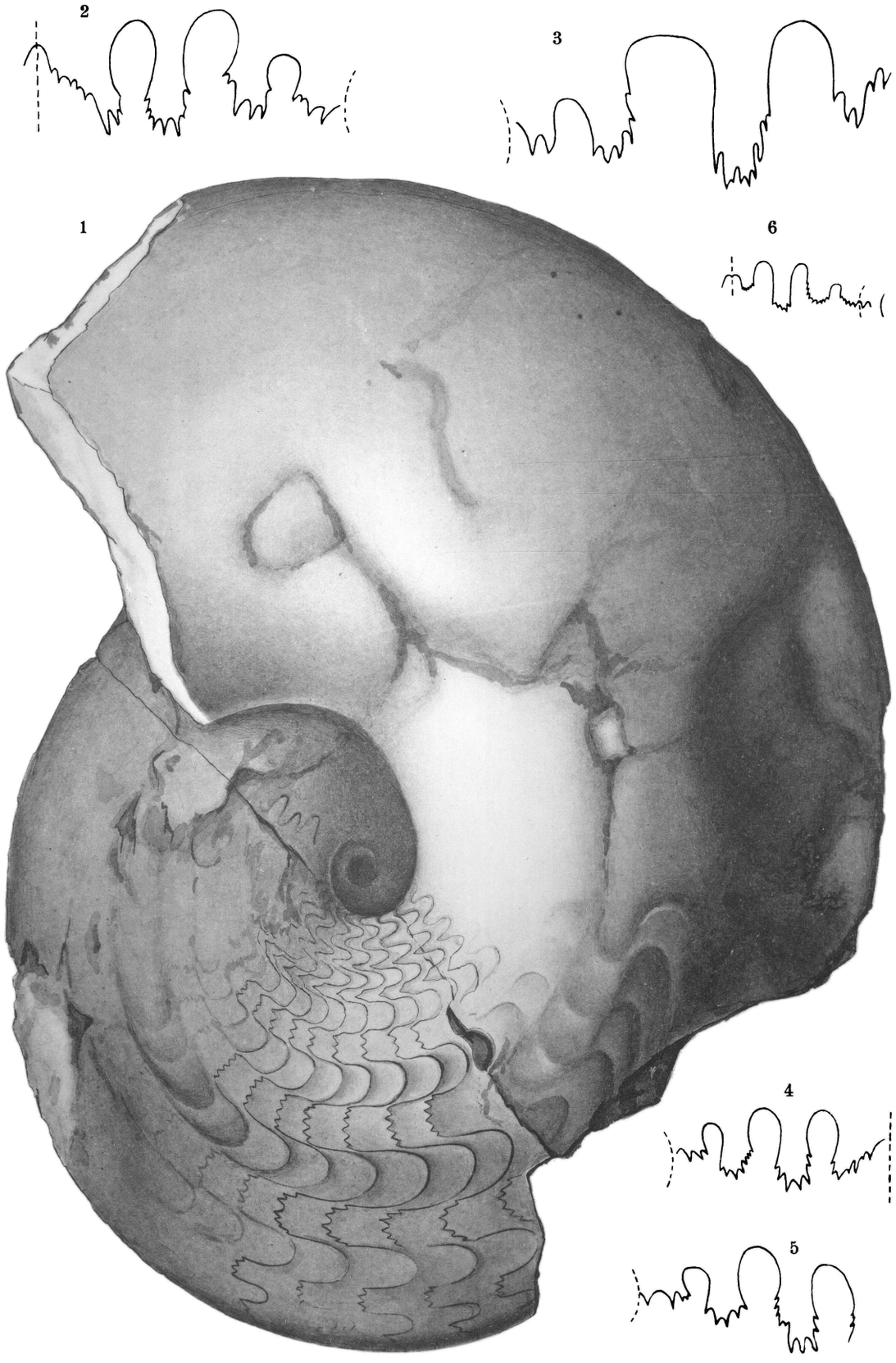
Fig. 1 HEDENSTRŒMIA MOJSISOVICSI Dien. S. E. of Muth, Hedenstrœmia beds, coll. v. Krafft.

„ 2 FLEMINGITES GRIESBACHI v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. v. Krafft. Sutures.

„ 3 } FLEMINGITES GRIESBACHI v. Krafft. 5 miles S. of Ensa, Hedenstrœmia beds,
„ 4 } coll. Hayden. Sutures.

„ 5 FLEMINGITES GRIESBACHI v. Krafft. Muth, Hedenstrœmia beds, coll. Hayden.

„ 6 PROPTYCHITES TYPICUS v. Krafft. Kuling, lower division, coll. Hayden. Sutures.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XXI.

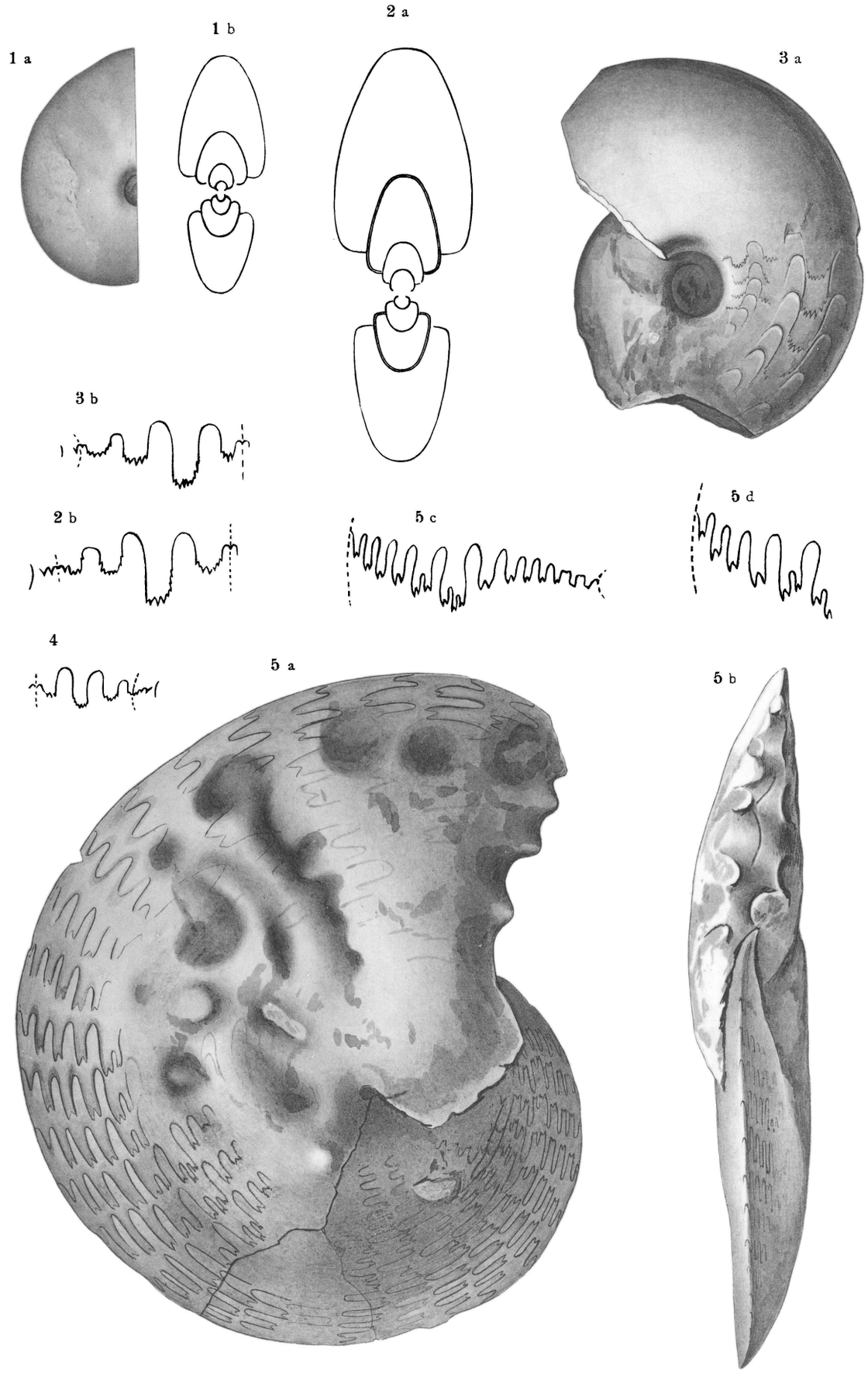
Fig. 1*a*, *b* PROPTYCHITES SP. IND. aff. TYPICO v. Krafft. 5 miles S. of Ensa, lower division, coll. Hayden.

„ 2*a*, *b* PROPTYCHITES TYPICUS v. Krafft. 5 miles S. of Ensa, lower division, coll. Hayden. Cross-section and sutures.

„ 3*a*, *b* PROPTYCHITES TYPICUS v. Krafft. N. N. W. of Kágá, lower division, coll. Hayden.

„ 4 PROPTYCHITES TYPICUS v. Krafft. S. E. of Muth, lower division, coll. Hayden.

„ 5*a*, *b*, *c*, *d* PSEUDOSAGECERAS MULTILOBATUM Noetl. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

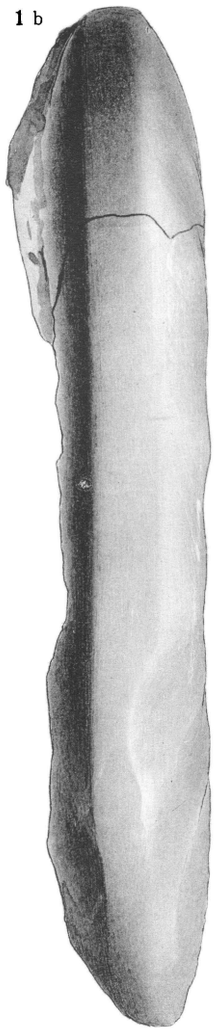
PLATE XXII.

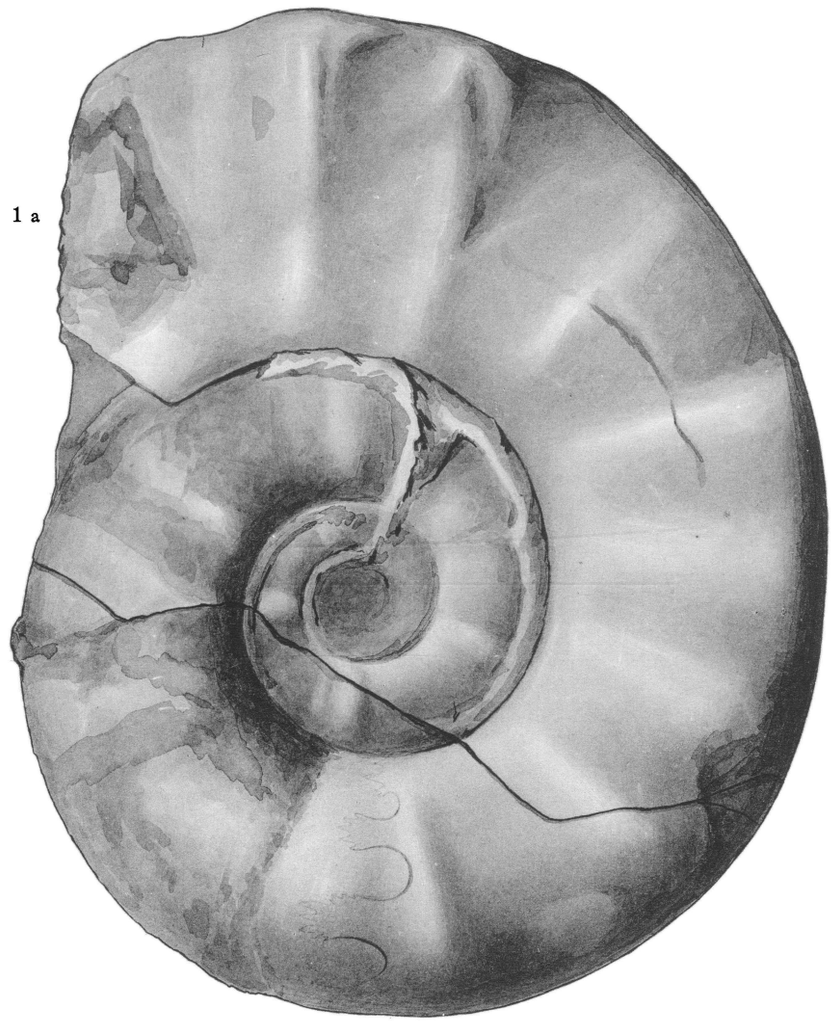
Fig. 1*a*, *b* — Flemingites Griesbachi v. Krafft. 5 miles S. of Ensa, Hedenstrœmia beds, coll. Hayden.

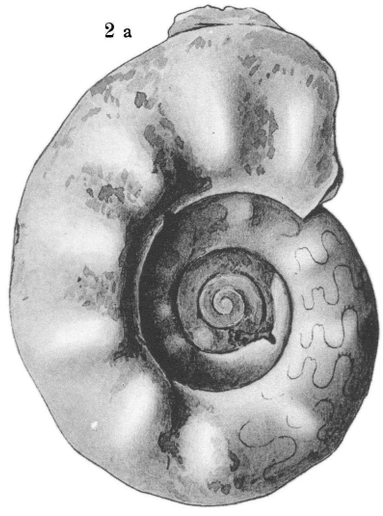
„ 2*a*, *b*, *c* — Flemingites Muthianus v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

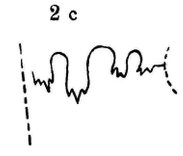
„ 3 — Flemingites Rohilla Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden. Sutures.

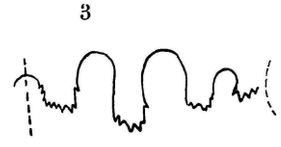
„ 4 — Flemingites sp. ind. ex aff. Salya Dien. 5 miles S. of Ensa, Hedenstrœmia beds, coll. Hayden. Sutures.

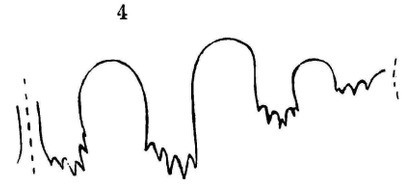


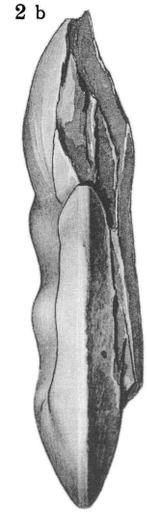












Phot u. Lichtdruck v. M. Jaffé, Wien.

PLATE XXIII.

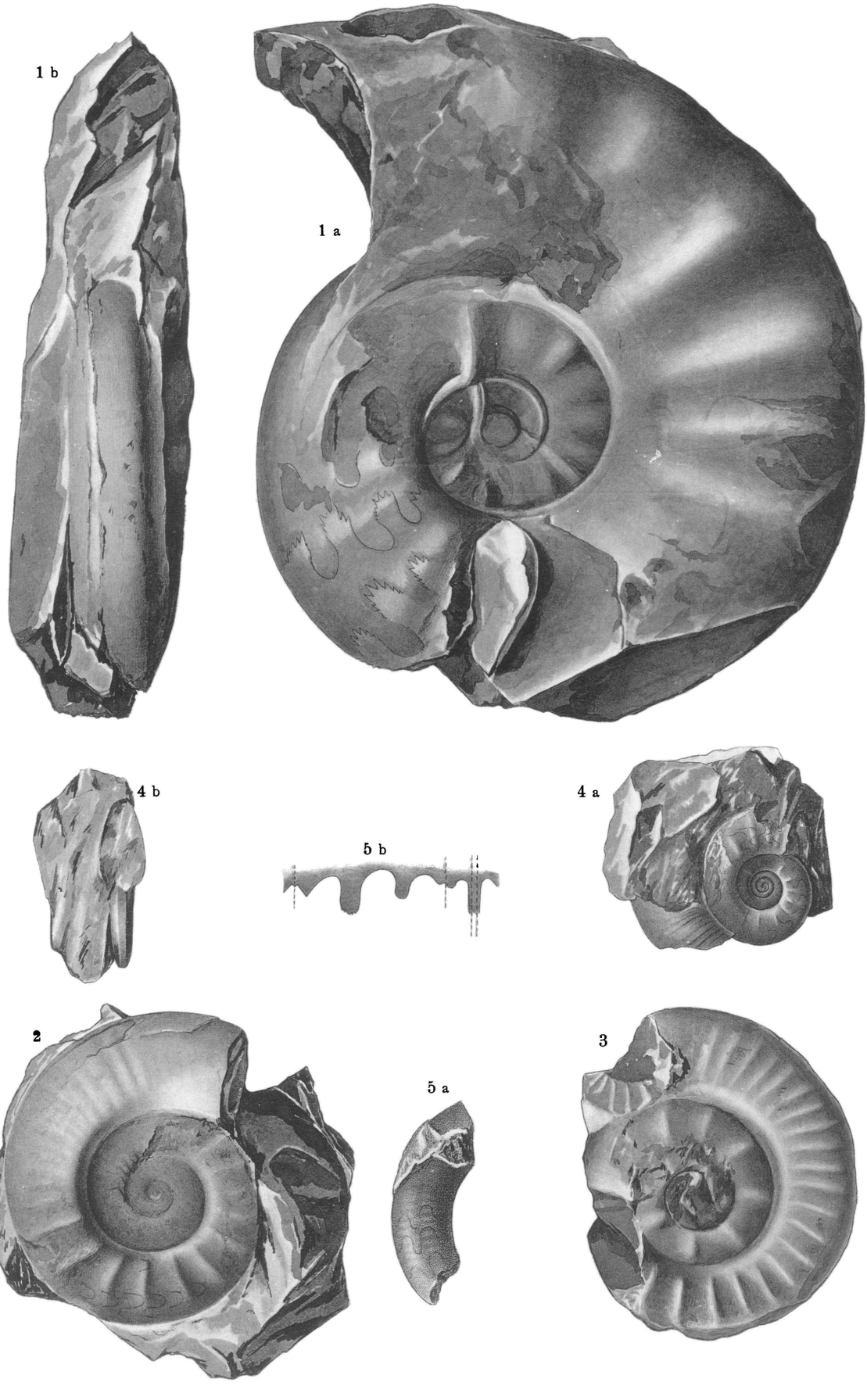
Fig. 1*a*, *b* FLEMINGITES GRIESBACHI v. Krafft. 5 miles S. of Ensa, Hedenstrœmia beds, coll. Hayden.

„ 2 XENODISCUS HIMALAYANUS Griesb. Crest of ridge between Dharma and Lissar valleys, Otoceras beds, coll. La Touche.

„ 3 XENODISCUS KAPILA Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 4*a*, *b* XENODISCUS ROTULA Waag. 5 miles S. of Ensa, lower division, coll. Hayden.

„ *a*, *b* XENODISCUS ROTULA Waag. Jolinka, Byans, coll. Smith.



Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XXIV.

Fig. 1, 2, 3*a*, *b* } XENODISCUS NIVALIS Dien. Jolinka, Byans, coll. Smith.

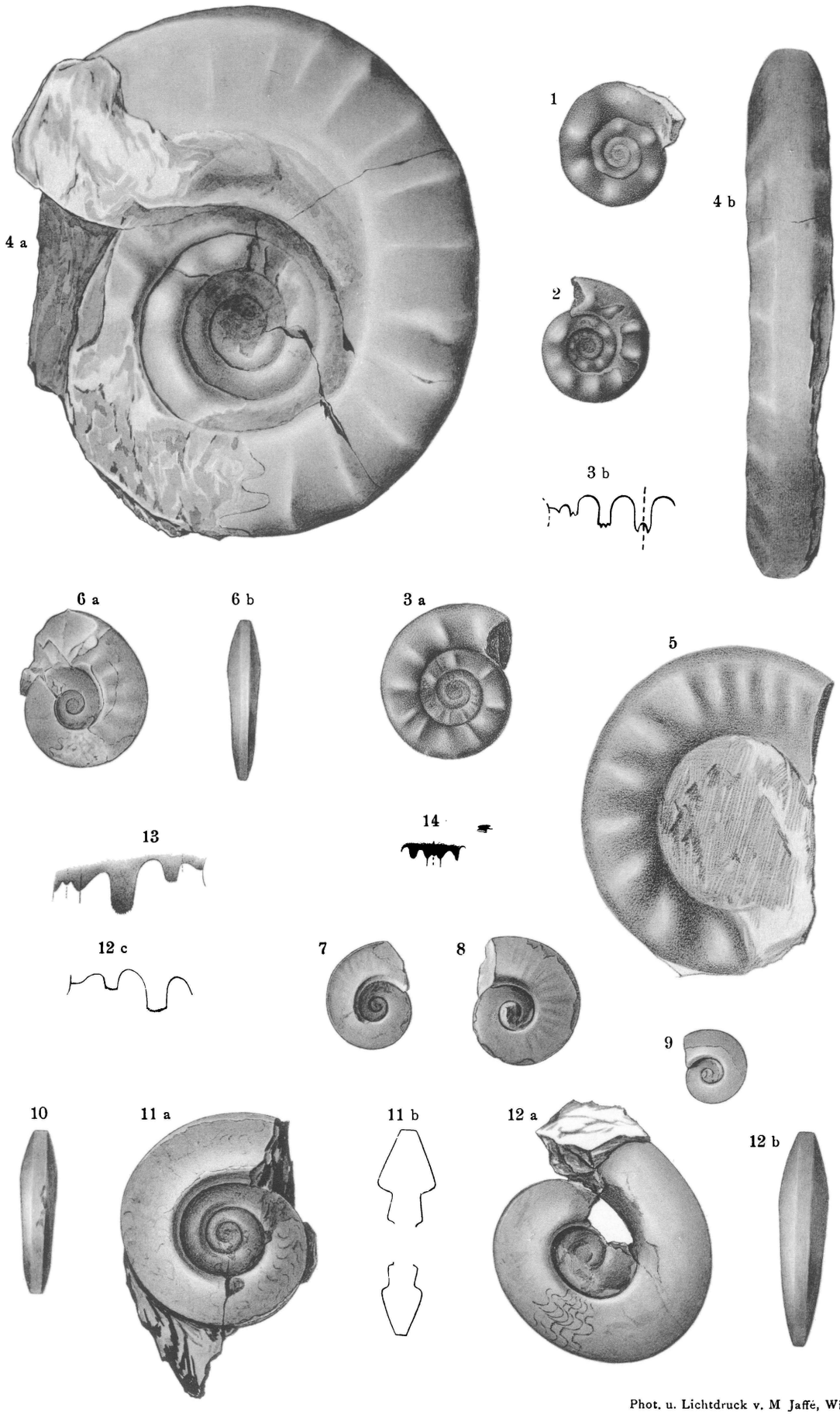
Fig. 4*a*, *b* XENODISCUS, NOV. SP. IND. AFF. NIVALIS Dien. 5 miles S. of Ensa, Spiti, Hedenstrœmia beds, coll. Hayden.

Fig. 6*a*, *b*, 7, 8, 9, 10 } MEEKOCERAS DUBIUM v. Krafft. Jolinka, Byans, coll. Smith.

Fig. 11*a*, *b* MEEKOCERAS DUBIUM v. Krafft. Lower division, crest of ridge between Dharma and Lissar valleys, coll. La Touche.

Fig. 12*a*, *b*, *c*, 13 } MEEKOCERAS DUBIUM v. Krafft. Lower division, 5 miles S. of Ensa, coll. Hayden.

Fig. 14 MEEKOCERAS DUBIUM v. Krafft. Lower division, S. E. of Muth, coll. Hayden. Suture.



Phot. u. Lichtdruck v. M Jaffé, Wien.

PLATE XXV.

Fig. 1*a*, *b* XENODISCUS RADIANS Waag. Lower division, S. E. of Muth, coll. Hayden.

„ 2*a*, *b*, *c* XENODISCUS RADIANS Waag. Otoceras beds, horizon of OPHICERAS SAKUNTALA, Lilang, Spiti, coll. Krafft.

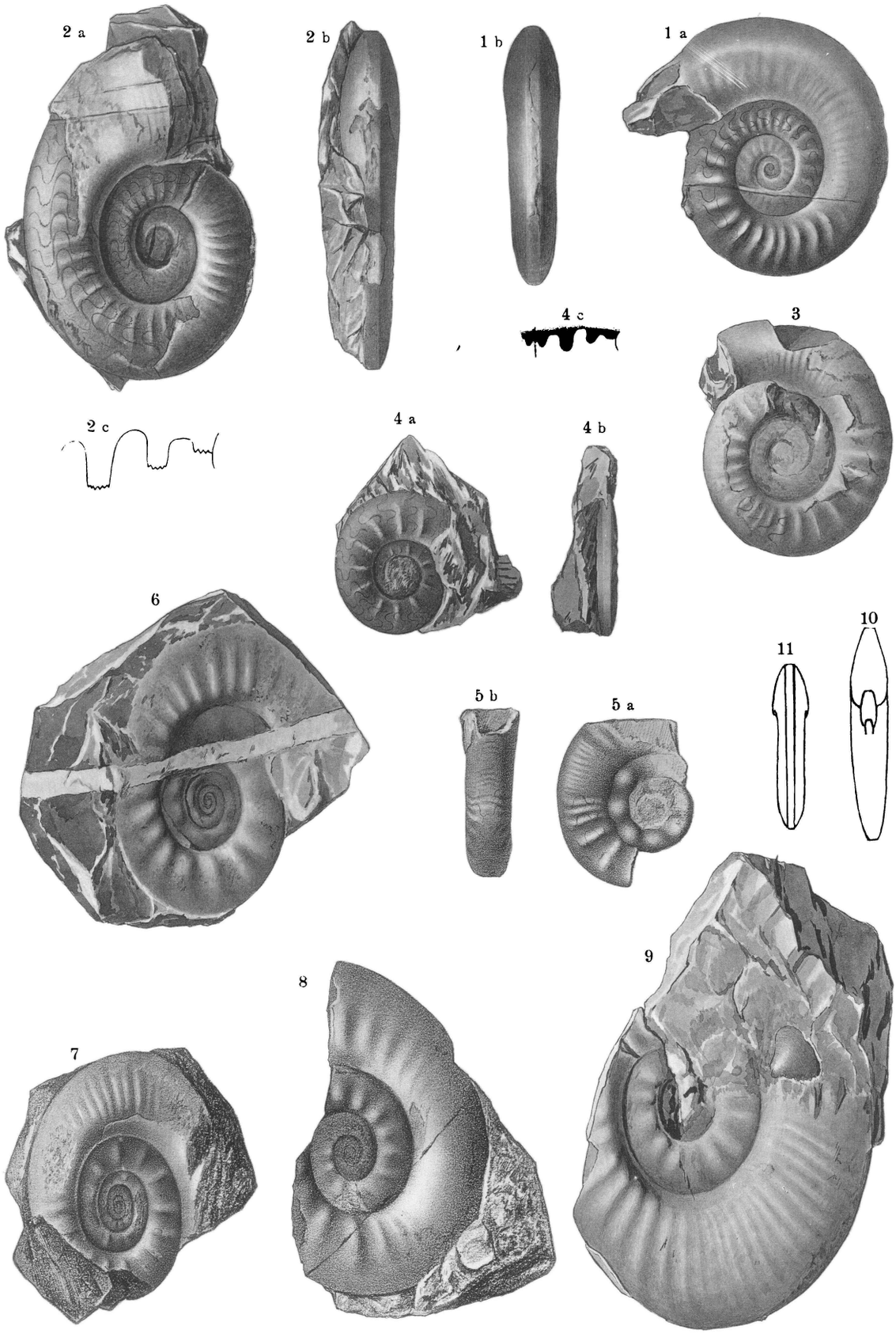
„ 3 XENODISCUS RADIANS Waag. Lower division, S. E. of Muth, coll. Hayden.

„ 4*a*, *b*, *c* XENODISCUS CF. PLICOSUS Waag. Lower division, S. E. of Muth, coll. Hayden.

„ 5*a*, *b* XENODISCUS NIVALIS Dien. Jolinka, Byans, coll. Smith.

„ 6, „ 7, „ 8 XENODISCUS LILANGENSIS v. Krafft. Meekoceras beds, lowest bed, Lilang, Spiti, coll. v. Krafft.

„ 9, „ 10, „ 11 XENODISCUS LILANGENSIS v. Krafft. Meekoceras beds, Lilang, coll. v. Krafft.



Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XXVI.

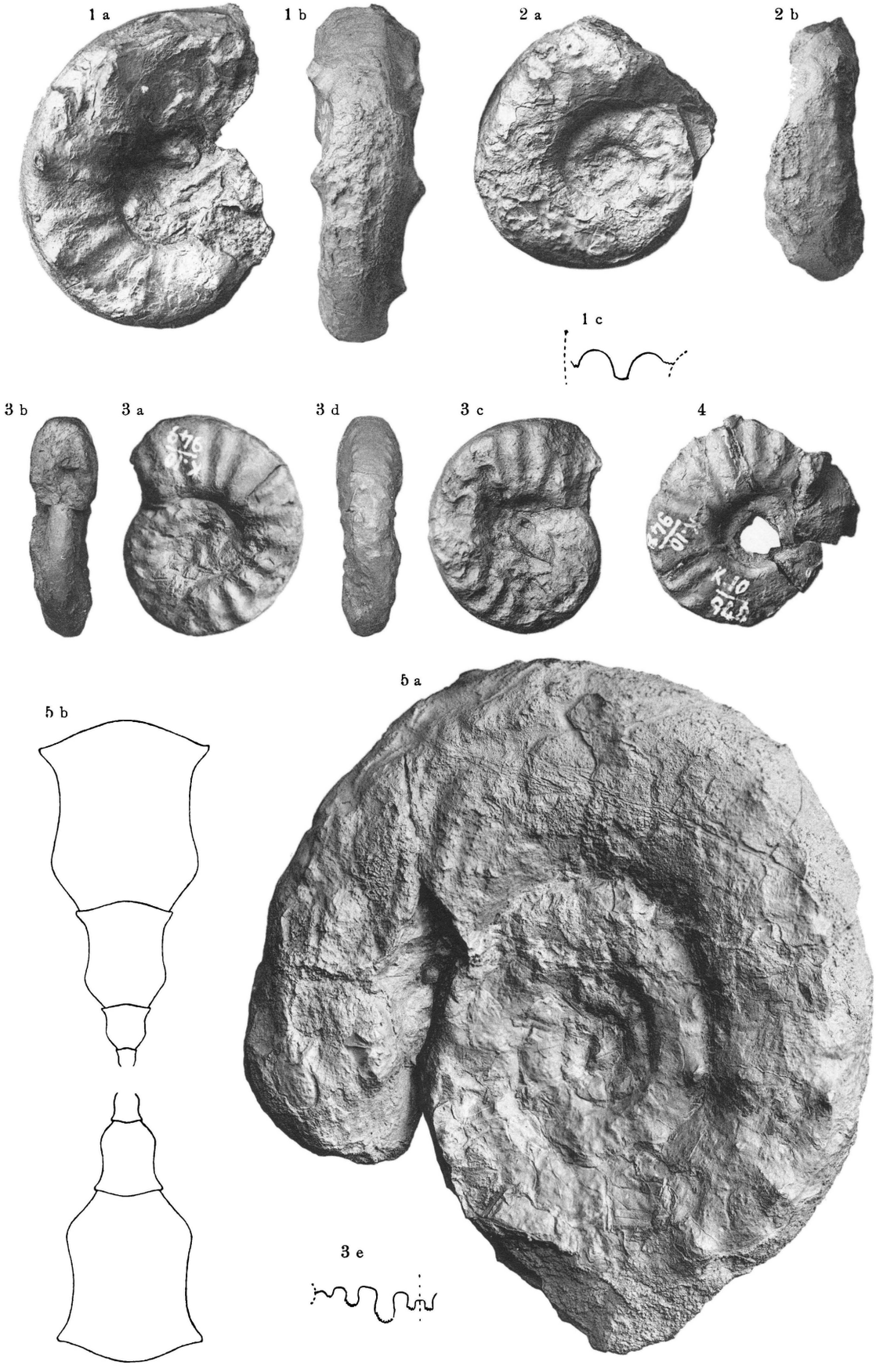
Fig. 1*a*, *b* TIROLITES INJUCUNDUS v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 2*a*, *b* TIROLITES *an* CERATITES SP. IND. ? 6 inches above the horizon of RHYNCHONELLA GRIESBACHI ; S. E. of Muth, coll. Hayden.

„ 3*a*, *b*, *c*, *d* CERATITES PUMILIO v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 4 CERATITES SP. IND. Limestone above the horizon of RHYNCHONELLA GRIESBACHI, Muth, coll. Hayden.

„ 5*a*, *b* XENODISCUS ASIATICUS v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XXVII.

Fig. 1*a*, *b*, *c* PRIONITES SP. IND. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

„ 2*a*, *b* } XENODISCUS KAPILA Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.
„ 3 }

„ 4*a*, *b* XENODISCUS ROTULA Waag. Lower division (Otoceras beds ?), 5 miles S. of Ensa, coll. Hayden.

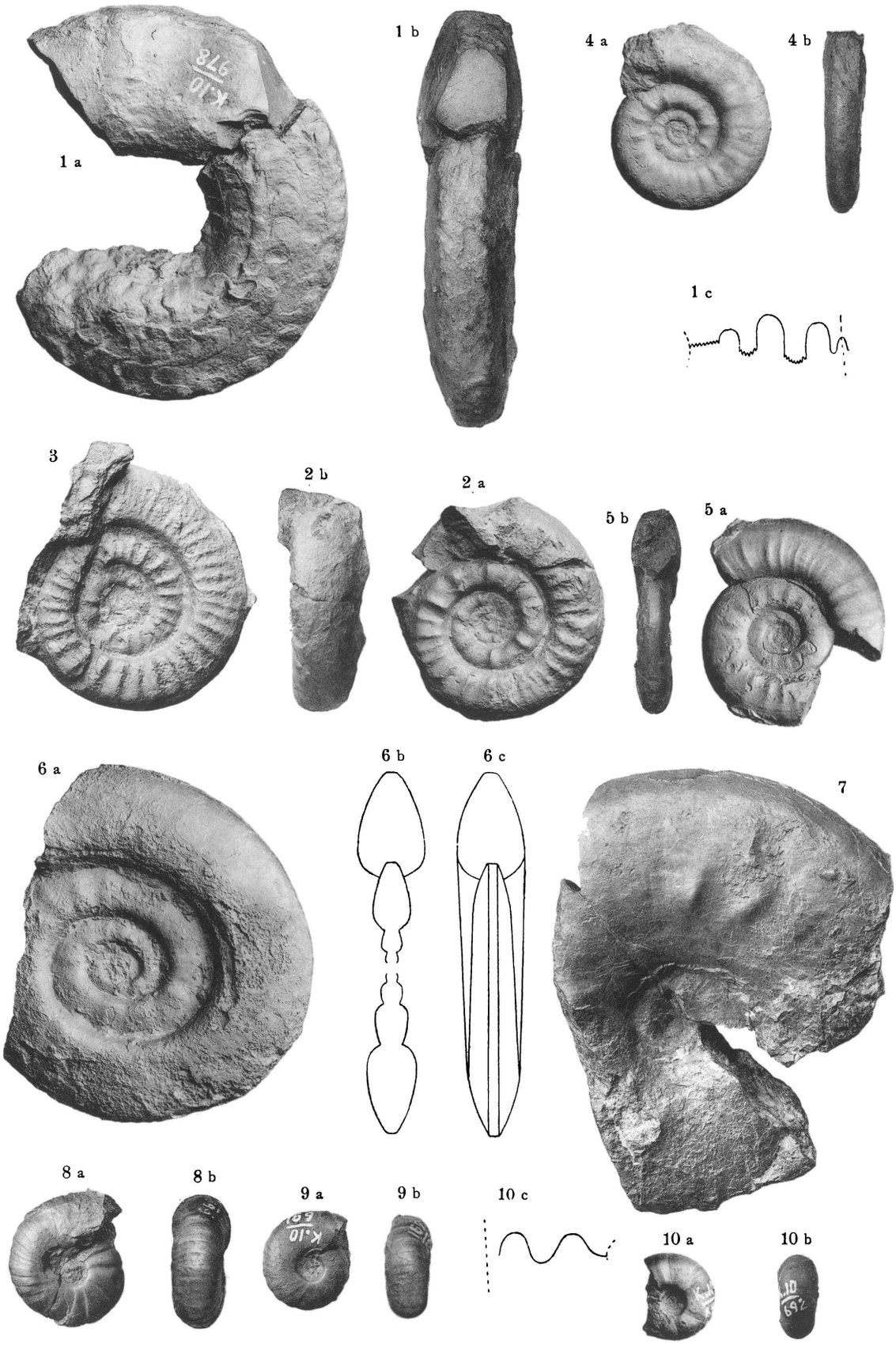
„ 5*a*, *b* XENODISCUS ROTULA Waag. Jolinka, Byans, coll. Smith.

„ 6*a*, *b*, *c* OPHICERAS OBTUSO-ANGULATUM Dien. Lilang, Meekoceras beds, coll. v. Krafft.

„ 7 SIBIRITES SP. IND. AFF. INFLATO Waag. Lilinthi, Byans, coll. Smith.

„ 8*a*, *b* } NANNITES HINDOSTANUS Dien. S. E. of Muth, Hedenstrœmia beds, coll.
„ 9*a*, *b* } Hayden.

„ 10*a*, *b*, *c* NANNITES MEDIUS Dien. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.



Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XXVIII.

Fig. 1*a*, *b* GRYPOCERAS LILANGENSE Dien. Lilang, Meekoceras beds, coll. v. Krafft, reduced to ⅔ of its original size.

„ 2*a*, *b*, *c* PROPTYCHITES SP. IND. AFF. UNDATO Waag. Banna E. G., Thanam valley, Hedenstrœmia beds, coll. Hayden.

„ 3 FLEMINGITES NOV. SP. IND. Lilang, Hedenstrœmia beds, coll. v. Krafft.

„ 4*a*, *b*, *c* SIBIRITES NOV. SP. IND. Lilinthi, Byans, coll. Smith.

„ 5*a*, *b* PLEURONAUTILUS DIENERI v. Krafft. S. E. of Muth, Hedenstrœmia beds, coll. Hayden.

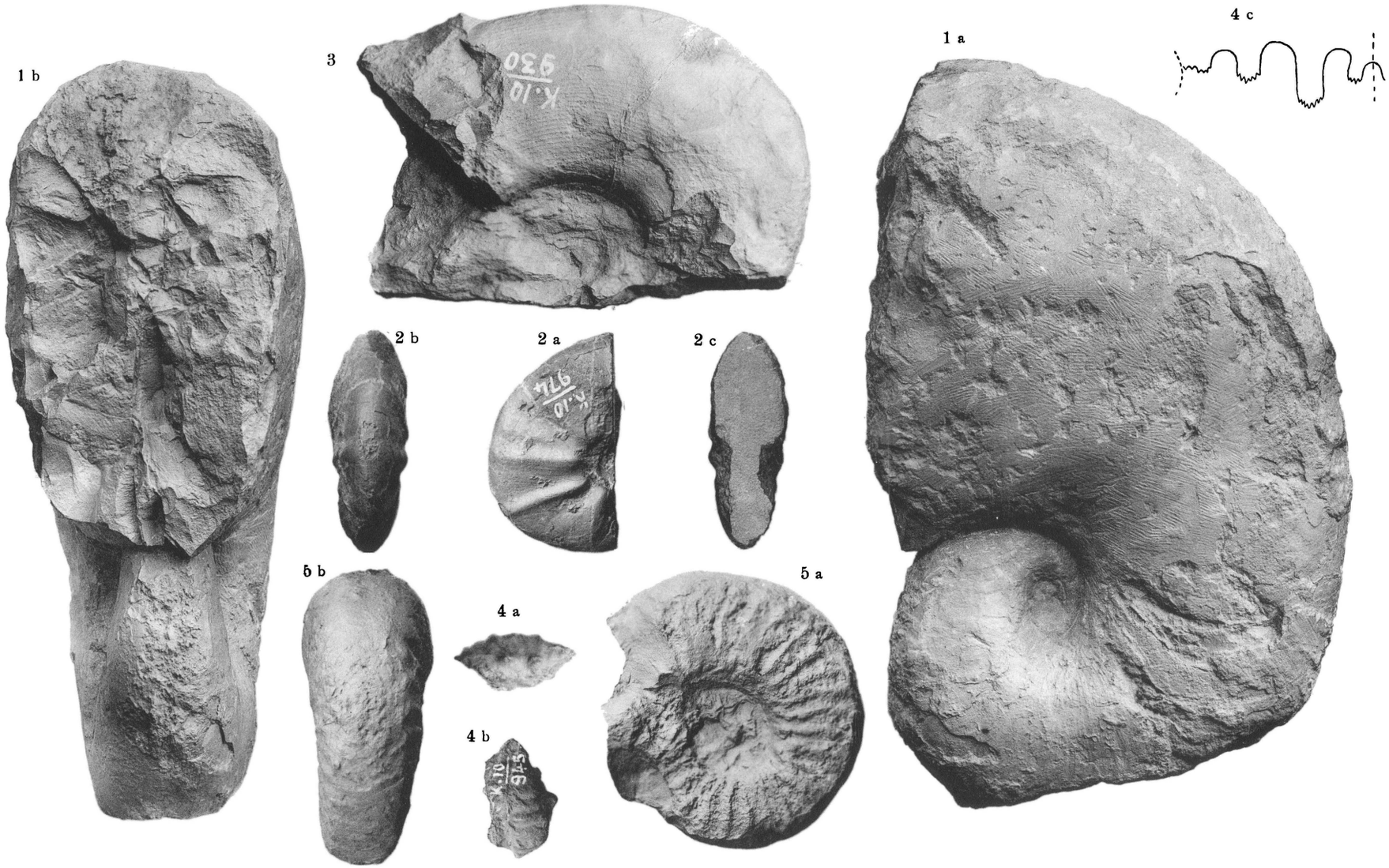

1 b
3
K.10
930
4 c
1 a
2 b
2 a
K.10
924
2 c
5 b
4 a
5 a
4 b
K.10
915

PLATE XXIX.

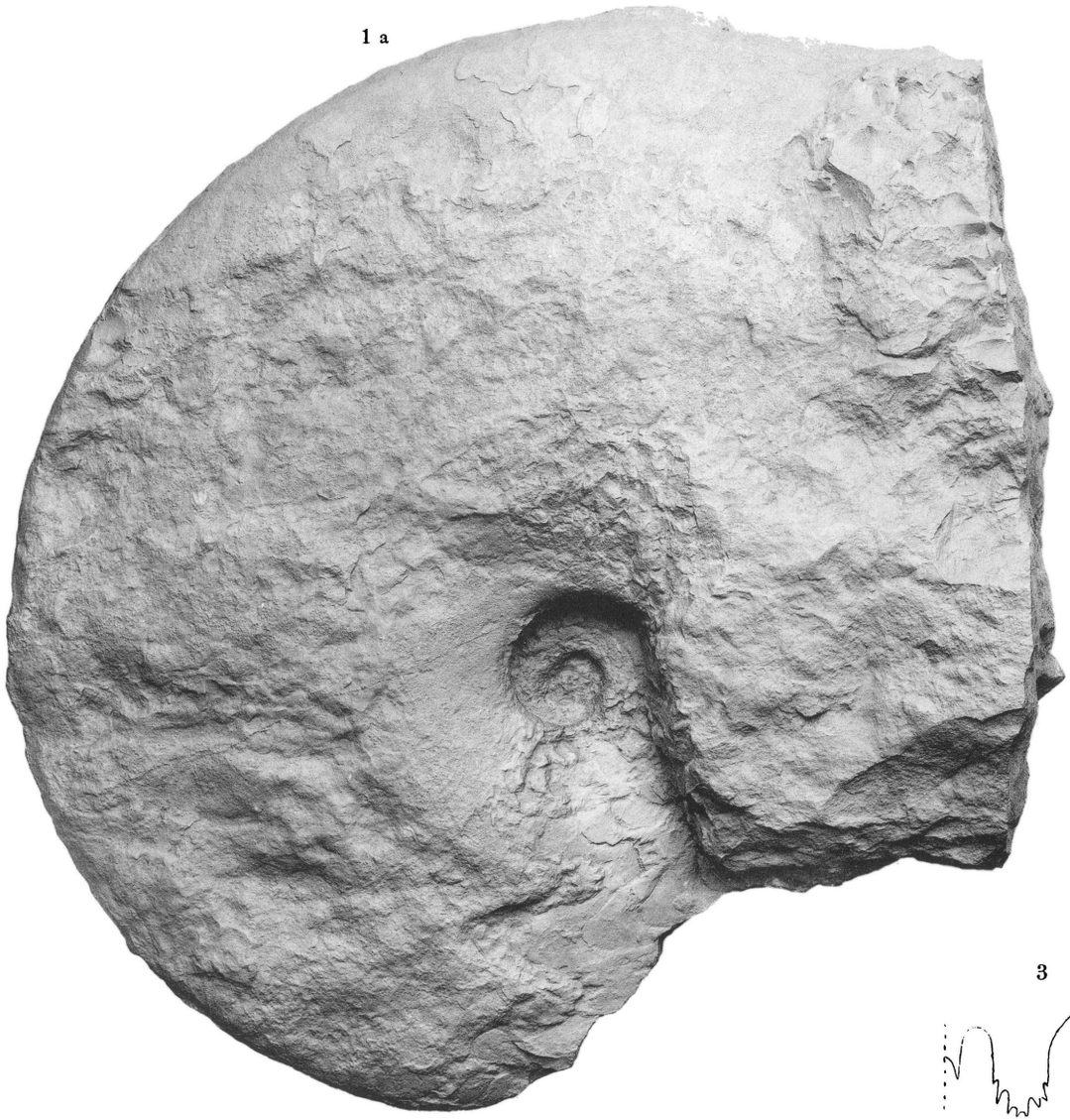
Fig. 1*a*, *b* KONINCKITES GIGANTEUS v. Krafft. S. E. of Muth, Spiti, Hedenstrœmia beds, coll. Hayden, reduced to ½ of its original size.

„ 2 NOV. GEN. IND. EX AFF. HEDENSTRŒMIA SP. IND. Lilang, Meekoceras beds, coll. v. Krafft. Sutures.

„ 3 OTOCERAS SP. IND. AFF. CLIVEI Dien. S. W. of Gaichund, Otoceras beds, coll. Hayden. Sutures.

„ 4 PROAVITES SISUPALA Dien. Shalshal Cliff, Hedenstrœmia beds, coll. Griesbach. Sutures of Diener's type-specimen.

1 a



2

4

3

1 b

Phot. u. Lichtdruck v. Max Jaffé, Wien.

PLATE XXX.

Fig. 1*a*, *b* MEEKOCERAS HODGSONI Dien. Otoceras beds, Shalshal Cliff, coll. v. Krafft.

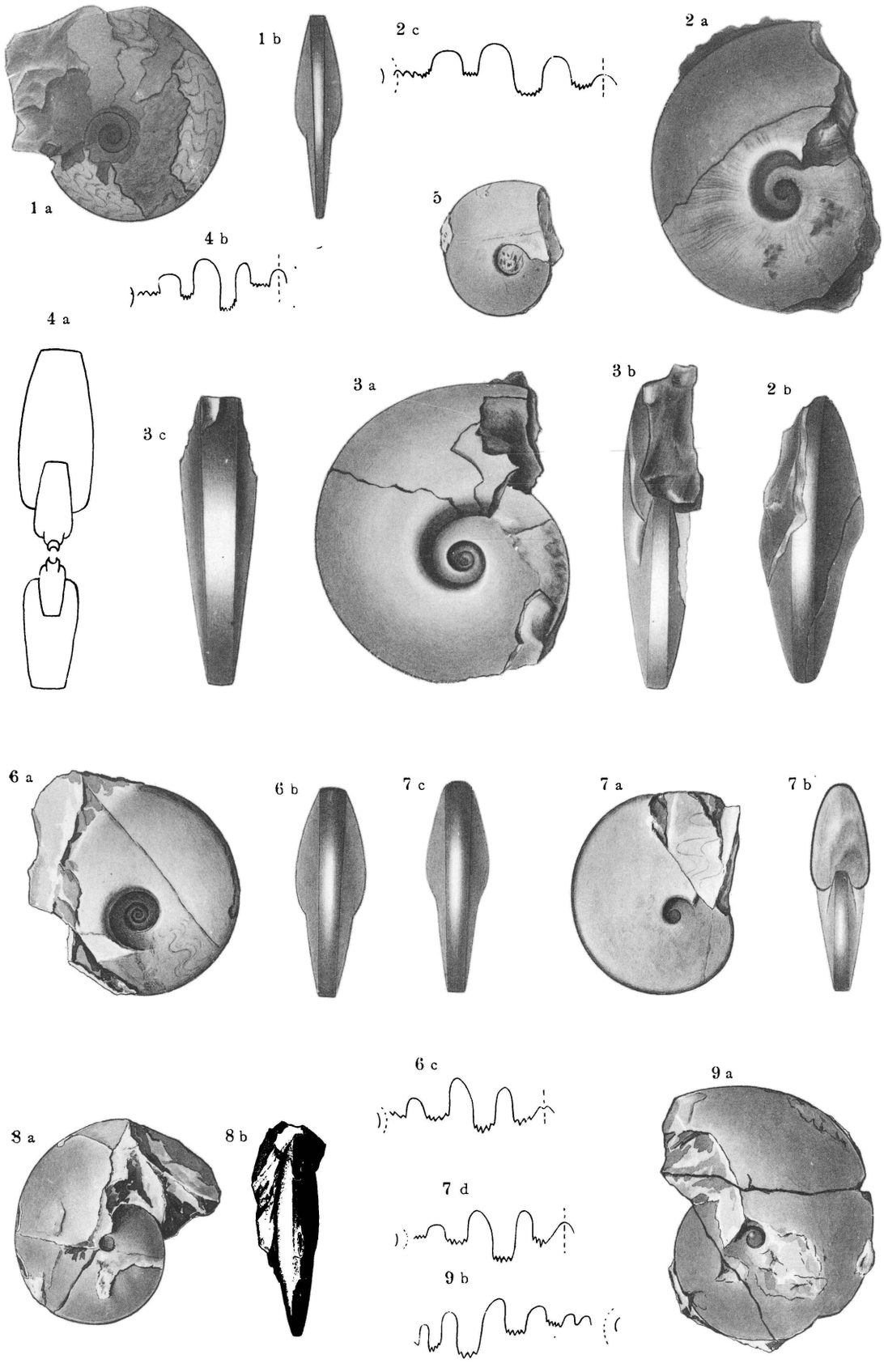
„ 2*a*, *b*, *c* MEEKOCERAS SHALSHALENSE v. Krafft. Meekoceras beds, Shalshal Cliff, coll. Noetling.

„ 3*a*, *b*, *c*
„ 4*a*, *b*
„ 5
} MEEKOCERAS JOHARENSE v. Krafft. Exotic block No. 20, Malla Johar, coll. v. Krafft.

„ 6*a*, *b*, *c* MEEKOCERAS JOLINKENSE v. Krafft. Jolinka, Byans, coll. Smith.

„ 7*a*, *b*, *c*, *d* MEEKOCERAS INFREQUENS v. Krafft. Exotic block No. 20, Malla Johar, coll. v. Krafft.

„ 8*a*, *b*
„ 9*a*, *b*
} HEDENSTRŒMIA BYANSICA v. Krafft. Exotic block No. 20, Malla Johar, coll. v. Krafft.



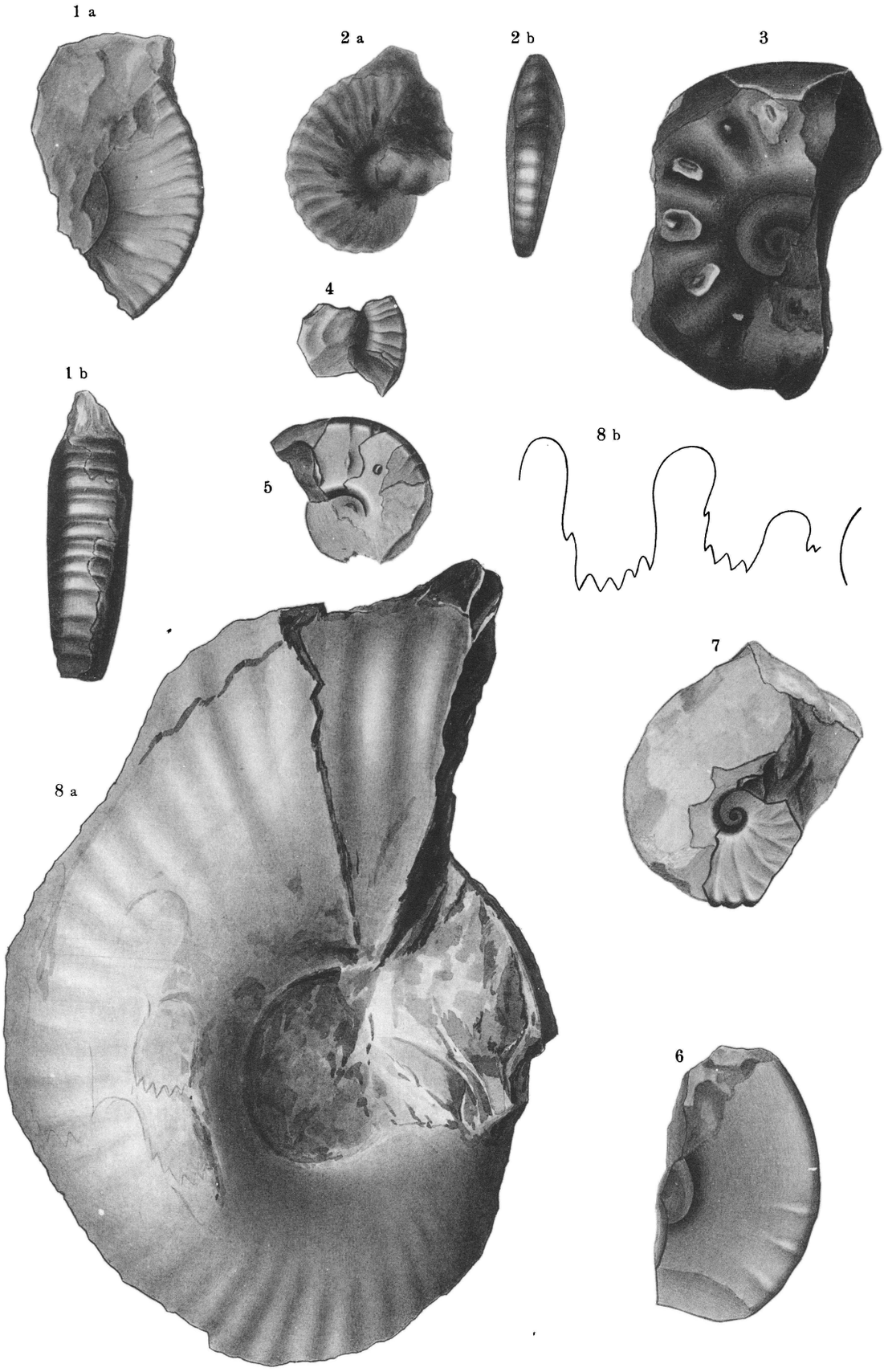
Phot. u. Lichtdruck v. M. Jaffé, Wien.

PLATE XXXI.

Fig. 1*a*, *b* SIBIRITES ROBUSTUS v. Krafft.
„ 2*a*, *b* SIBIRITES SPINIGER v. Krafft.
„ 3 SIBIRITES STEPHANITIFORMIS v. Krafft.
„ 4 SIBIRITES sp. ind.
„ 5 SIBIRITES sp. ind.
„ 6 SIBIRITES sp. ind. ex aff. robusto v. Krafft.
„ 7 SIBIRITES SPINIGER v. Krafft. var.

All these specimens from the topmost bed of the lower Triassic Chocolate Limestone, Lilinthi E. G., Byans, coll. Smith.

Fig. 8*a*, *b* SIBIRITES SPITIENSIS v. Krafft. Hedenstrœmia beds, S. E. of Muth, Spiti, coll. Hayden.



Phot. u. Lichtdruck v. Max Jaffé, Wien.