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LADINIC, CARNIC, AND NORIC FAUNÆ OF SPITI.

PLATES I to XXIV.

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HIMALAYAN FOSSILS.

VOLUME V, MEMOIR No. 3.

LADINIC, CARNIC, AND NORIC FAUNÆ OF SPITI.

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INTRODUCTION.

The existence of triassic beds in Spiti was first established by the examination of Dr. Gerard's collections by H. F. Blanford in 1863, who described two species of Ammonites, *Ammonites (Ptychites) Gerardi* and *Ceratites himálayanus*, belonging to genera frequently met with in the Alpine Muschelkalk.¹

A large collection of Ammonites was brought from the triassic rocks of Spiti by the brothers von Schlagintweit in the years 1854 to 1857, and described by Oppel in 1865.² It was proved by Guembel³ and Beyrich⁴ that this fauna was also entirely of Muschelkalk age.

The presence of fossiliferous beds of upper-triassic age, younger than the Muschelkalk in Spiti, was first recorded by Stoliczka. His survey of Spiti in 1864 enabled him to give a rough outline of the stratigraphy of the Himálayas.⁵ In the triassic system he distinguished only two sub-divisions, the Lilang series and the Para limestone, regarding the former as upper Trias and the latter as rhætic—using both expressions in the sense originally employed by F. v. Hauc. He believed that the upper Trias rested immediately on carboniferous rocks, and failed to recognize the lower Trias and the Muschelkalk. As has been explained by Hayden (Mem. Geol. Surv. of India, Vol. XXXVI, p. 61), Stoliczka's conclusion was chiefly based on the examination of an imperfect section near Kuling, where he found the *Productus* shales of anthracolithic age overlain by triassic beds with *Daonella Lommeli*.

Considering the imperfect state of our knowledge of triassic Cephalopoda at the time of Stoliczka's survey, it is not surprising to find that his interpretation of the

¹ H. F. Blanford.—“On Dr. Gerard's collection of fossils from the Spiti valley in the Asiatic Society's Museum.” *Journal Asiatic Soc. of Bengal*, 1863, No. 2, pp. 121-138.

² A. Oppel.—“Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti, etc.” *Paleontologische Mittheilungen aus dem Museum des Kgl. bayrischen Staates* I, p. 267.

³ C. v. Guembel.—*Sitzber. bayr. Akad. d. Wissensch. München*, pp. 348-366.

⁴ E. Beyrich.—“Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc.” *Abhandl. Kgl. Akad. d. Wissensch. Berlin*, 1866, No. 2, pp. 105-179.

⁵ F. Stoliczka.—*Mem. Geol. Surv. of India*, Vol. V, Pt. 1, pp. 35-65.

triassic Ammonites of the Himálayas was far from being correct, and that both Muschelkalk and upper-triassic types had been indiscriminately mixed together in the fauna of his so-called "Lilang series." Of the numerous species of Cephalopoda described by Stoliczka the following only have been proved by E. v. Mojsisovics to be of upper-triassic age :—

$$\begin{array}{l} \textit{Arpadites Stracheyi} \text{ Mojs.} \\ \textit{Rimkinites Nitiensis} \text{ Mojs.} \end{array} \quad \left. \vphantom{\begin{array}{l} \textit{Arpadites Stracheyi} \text{ Mojs.} \\ \textit{Rimkinites Nitiensis} \text{ Mojs.} \end{array}} \right\} = \textit{Ammonites floridus} \text{ Salter et Stoliczka.}$$

$$\begin{array}{l} \textit{Paracladiscites indicus} \text{ Mojs.} \\ \textit{Griesbachites Medleyanus} \text{ Stol.} \end{array} \quad \left. \vphantom{\begin{array}{l} \textit{Paracladiscites indicus} \text{ Mojs.} \\ \textit{Griesbachites Medleyanus} \text{ Stol.} \end{array}} \right\} = \textit{A. Gaytani} \text{ Stol.}$$

Considerable progress was subsequently made by C. L. Griesbach,¹ who in 1883 revisited Spiti and succeeded in recognizing the lower Trias and the Muschelkalk. But his short visit added very little to our knowledge of the faunæ of the upper-triassic rock groups.

The detailed survey of Johár and Painkhánda by C. L. Griesbach, and the large collections obtained by the Diener expedition in 1892 from all the fossiliferous triassic beds of the Bambanag and Shalshal cliffs, for some time removed the classical area of Spiti to the background. The examination of upper-triassic Cephalopoda carried out by E. v. Mojsisovics² proved the carnic age of the few Ammonites quoted by Stoliczka from the upper Trias of Spiti. The examination of the Brachiopoda and Lamellibranchiata by Bittner³ led to more important results. He established the occurrence of the true *Daonella Lommeli* Wissm. in the triassic deposits S.-E. of Muth, and thus proved the presence of the ladinic stage in the Himálayas. In the upper Trias of Spiti he was able to distinguish three fossiliferous horizons with widely distributed faunæ, namely, the fauna with *Daonella indica* (Kuling, Khar), the fauna with *Spiriferina Griesbachi* (Kuling, Kibber, Manirang pass), and the *Megalodon*-fauna of the Para limestone of Stoliczka with *Megalodon cultridens* and *Dicerocardium himálayanum*.

In 1898 H. Hayden was deputed to Spiti to make a detailed systematic survey of the whole area. The work was continued by him, accompanied by the late Dr. A. v. Krafft, in 1899, and finished during the summer of 1901. The stratigraphical results concerning the triassic rocks, based on the study of numerous sections and on the examination of large collections, were published in the General Report of the Geological Survey of India for 1899-1900 by A. von Krafft, and in the Memoirs, Vol. XXXVI, Pt. 1 (pp. 60-84), by H. Hayden. The fossils of upper-triassic age were examined by A. v. Krafft as far as they appeared to be of stratigraphical importance.

In the triassic rocks following above the Muschelkalk group, a large number of subdivisions as given below were distinguished by those authors:—

The topmost beds of the Muschelkalk, containing a fauna of ladinic age, pass gradually into shaly beds with *Daonella Lommeli* Wissm. and with numerous

¹ C. L. Griesbach.—"Geology of the Central Himálayas." Mem. Geol. Surv. of India, Vol. XXIII, pp. 206-223.

² "Upper-triassic faunæ of the Himálayas." Palæont. Indica, ser. XV, Himálayan Fossils, Vol. III, Pt. 1.

³ Himálayan Foss., l. c., Vol. III, Pt. 2.

Ammonites characteristic of the ladinic stage. Immediately above this group of shaly beds is the hard, dark *Daonella* limestone, containing few fossils, among them being *Daonella Lommeli* and *Daonella indica* Bittn. The entire thickness of the ladinic stage in Spiti is about 300 feet.

The *Daonella* limestone is overlain by beds containing faunæ of carnic age. These beds fall into six subdivisions. The lowest—*Halobia* limestone—is a continuation of the dark *Daonella* limestone, but it has been separated as a distinct subdivision, owing to the absence of *Daonella* and to the presence of *Halobia* either identical with or nearly allied to *H. comata* Bittn. and *Halobia fascigera* Bittn.

The *Halobia* limestone is overlain by a thick series of soft grey shales, among which two fossiliferous horizons were discovered. The lower, occurring immediately above the *Halobia* limestone, yielded *Joannites cymbiformis* Wulf., the upper, occurring at about 300 feet above the base, is rich in brachiopoda, including *Spiriferina shalshalensis* Bittn. and *Rhynchonella laukana* Bittn.

The grey shales pass gradually into a limestone containing brachiopods and bivalves. A little higher in the series a band of nodular limestone contains Ammonites, chiefly belonging to the genus *Tropites*. This horizon has been correlated with the *Tropites* limestone of Kalapani by A. v. Krafft, and is considered as an equivalent of the zone of *Tropites subbullatus* of the Mediterranean province. A series of dark splintery limestone, containing *Parajuvavites*, has been included in the *Tropites* beds by A. v. Krafft. The uppermost beds of the series containing *Parajuvavites* pass gradually into a mass of dolomitic limestones with few and badly preserved fossils, among which are bivalves characteristic of the upper-carnic stages. The thickness of the carnic beds in Spiti amounts to nearly 2,000 feet, or roughly three times the thickness of the corresponding beds in Painkhánda and Johár.

Above the dolomitic limestone with *Halobia cf. superba* Mojs. and *Daonella cf. styriaca* Mojs. of upper-carnic age, a rapid change takes place in the lithological character of the beds. The noric (juvavic) series consists of two thick rock-groups of calcareous shale, separated by a massive coral limestone, and overlain by brown and white quartzites.

In the lower shaly group two fossiliferous horizons have been discovered by A. v. Krafft. The lower, containing *Hauerites sp. ind.* and *Paratibetites cf. Tornquisti* Mojs., is correlated with the *Hauerites* beds of the Bambanag section (zone of *Clydonautilus Griesbachi* Mojs.), the upper one, rich in Ammonites belonging chiefly to the genus *Juvavites* Mojs., is considered as an equivalent of the *Halorites* beds, "from which they differ, however, by the apparent absence of both *Halorites* and *Parajuvavites*, neither of which genera has been found at this horizon in Spiti."

In the coral-limestone *Spiriferina Griesbachi* Bittn. is a characteristic leading fossil. Consequently Dr. A. v. Krafft believed that this limestone represented the "limestone with *Spiriferina Griesbachi*" of the Bambanag section.

The upper shaly group is rich in bivalves and Brachiopoda. The brachiopod-fauna is almost identical with that of the coral limestone, but among the bivalve *Monotis salinaria* Schloth. is the most characteristic species.

The Monotis beds (upper group of calcareous shales) are overlain by a quartzite series including limestones and shales with *Spiriferina Griesbachi* Bittn. and *Aulacothyris Joharensis* Bittn. This quartzite series, one of the most characteristic and constant horizons of the upper Trias of Spiti, was also found in the Bambanag section by A. v. Krafft, where it follows immediately above the Sagenites beds. A correlation of the Monotis shales of Spiti with the Sagenites beds of Painkhanda appears therefore justified, although *Monotis salinaria* has not been found in the Bambanag and Shalshal cliff sections.

The beds above the quartzite series are of very uniform lithological character. They consist of dolomitic, thin-bedded limestones of black or grey colour, having a thickness of roughly 2,300 feet. They include representatives of the Dachsteinkalk of the Eastern Alps, of the Lias and Oolite. In the lower part of this enormous mass of limestones immense numbers of *Megalodon* and *Dicerocardium* were found. About 370 feet below the top of the limestone mass a specimen of *Stephanoceras coronatum* Brug. was discovered by A. v. Krafft. Since there is no trace of unconformity in the limestone series, but every evidence that the passage into the upper-jurassic Spiti shales is a perfectly gradual one, the series must include rhætic, liassic, and oolitic elements. The discovery of *Spiriferina obtusa* Oppel, 800 feet above the quartzite series, points to Lias; but no rhætic fossils have, so far, been recognized.

The following table exhibits the sequence of beds between the Muschelkalk and the Spiti shales, as given by H. Hayden and A. von Krafft:—

Stages.	Rock-groups.	Thick-ness.	Fossiliferous Horizons.	Corresponding beds in Painkhanda.
Upper Jurassic	Spiti shales	Feet. 500		Spiti shales.
Oolite.	Grey and black, thin-bedded limestones.	2,300	<i>Stephanoceras coronatum</i> Brug. about 1,900 feet above base.	Sulcacutus beds.
Lias.			<i>Spiriferina cf. obtusa</i> Opp. 900 feet above base.	
Rhætic.			<i>Megalodon</i> and <i>Dicerocardium</i> (Para limestone).	Dachsteinkalk.
Noric (Juvavic)	Quartzite series	350	<i>Aulacothyris Joharensis</i> Bittn. <i>Spiriferina Griesbachi</i> Bittn.	Quartzite series.
	Monotis shales (sandy and shaly limestones).	300	<i>Monotis salinaria</i> Schloth. <i>Spiriferina Griesbachi</i> Bittn. <i>Aulacothyris Joharensis</i> Bittn. <i>Distichites</i> nov. sp.	Sagenites beds.
	Coral limestone	100	<i>Spiriferina Griesbachi</i> Bittn.	Limestone with <i>Spiriferina Griesbachi</i> .

Stages.	Rock-groups.	Thick- ness.	Fossiliferous Horizons.	Corresponding beds in Paikhānda.
		Feet.		
Noric (Juvavic) —contd.	Juvavites shales (sandy and shaly limestone).	500	Upper horizon with <i>Juvavites div. sp.</i> , <i>Tibetites cf. Ryalli</i> Mojs., <i>Para-</i> <i>tibetites Tornquisti</i> Mojs., etc. Lower horizon with <i>Hauerites sp.</i> , <i>Paratibetites cf. Tornquisti</i> Mojs.	Halorites beds. Hauerites beds.
	Dolomitic limestone	300	<i>Halobia cf. superba</i> Mojs. <i>Daonella cf. styriaca</i> Mojs. <i>Lima cf. austriaca</i> Mojs.	
	Dark, splintery lime- stone and calcareous shale.	200	<i>Parajuvavites sp. ind.</i>	
Carnic.	Tropites beds (nodular limestone).	15	<i>Clydonantulus Griesbachii</i> Mojs. <i>Tropites cf. subbullatus</i> Haner.	Horizon of <i>Halobia</i> <i>comata</i> Bittn. (<i>Daonella</i> beds.)
	Brachiopod limestone	400	Undermentioned Brachiopoda and Lamellibranchiata.	
	Grey beds (shales with limestone bands).	535	<i>Speriferina shalshalensis</i> Bittn. 300 feet above base. <i>Joannites cymbiformis</i> Wulf. near base.	
	Hard, dark limestone	140	<i>Halobia cf. comata</i> Bittn. <i>Halobia cf. fascigera</i> Bittn.	
Ladinic.		145	<i>Daonella indica</i> Bittn. <i>Daonella Lommeli</i> Wissm.	Horizon of <i>Daonella</i> <i>indica</i> Bittn. and <i>Trematocrinus</i> limestone.
	Daonella shales	160	<i>Daonella Lommeli</i> Wissm. <i>Protrachyceras Archelaus</i> Lbe.	Passage beds.
Anisic.	Upper Muschelkalk	25	Topmost beds with ladinic fossils. <i>Ptychites rugifer</i> Opp. <i>Ceratites</i> <i>Thuylleri</i> Opp.	Upper Muschelkalk.

It is evident from this table that the upper-triassic beds overlying the Muschelkalk are of great thickness in Spiti, and contain even a larger number of fossiliferous horizons than do the sections of the Central Himālayas of Kumaon and Garhwal examined by C. L. Griesbach and by myself. On the other hand, large and representative faunæ are rare. There is no upper-triassic fauna known from Spiti which could bear comparison with the faunæ of the Halorites limestone of the Bambanag section, or with the Tropites limestone of Byans. The majority of upper-triassic horizons in Spiti are poor in fossils, and the fossils themselves are often badly preserved or fragmentary. Some compensation for this is found in the existence in Spiti of a small number of horizons rich in fossils hitherto unrecorded

from the Himálayas. It is the ladinic stage especially which has yielded an interesting fauna closely allied to the homotaxial faunæ of the Alpine region.

The rich collections made in the upper-triassic rocks of Spiti in 1898 and 1899 were examined by A. v. Krafft as far as they appeared to be of stratigraphical importance. A large number, however, were left undetermined. Owing to the sudden death of Dr. A. v. Krafft the triassic fossils collected by Hayden in the summer of 1901 also remained unexamined. All those collections, comprising the ladinic, carnic, and noric faunæ obtained from Spiti since 1898, were submitted to me for examination. My work has been facilitated by the preliminary studies of A. v. Krafft, but the most difficult part, the description of new species of brachiopods and bivalves, and the determination of the *Ammonoidea leiostraca*, has entirely devolved upon me.

In the description of such species as have been examined by A. v. Krafft, the original determination, based on his labels and somewhat scattered notes, will always be quoted. The descriptions themselves have been disposed in this memoir according to different horizons, and the plates have been so arranged that illustrations of fossils from the same rock-group are included in one plate. This treatment of fossils according to their stratigraphical horizon will enable the reader to get a better view of the palæontological character of every well-established horizon possessing a distinct fauna.

I.—FOSSILS FROM THE LADINIC STAGE.

(TOPMOST BEDS OF THE MUSCHELKALK GROUP, DAONELLA SHALES, DAONELLA LIMESTONE.)

A. v. Krafft's examination of the fossils collected from the topmost beds of the Muschelkalk group and from the overlying beds has proved the existence of a rich fauna of *ladinic* age in Spiti.

Besides *Daonella Lommeli* Wissm., *Daonella indica* Bittn. and *Spirigera lunica* Bittn., the following species of Cephalopoda have been enumerated by A. v. Krafft (General Report, Geological Survey of India, for 1899-1900, p. 208):—

- Joannites* cf. *cymbiformis* Wulf.
- Proarcestes bicinctus* Mojs.
- Ceratites* nov. sp. aff. *himalayano* Blfd.
- Arpadites* cf. *Stracheyi* Mojs.
- Rimkinites Nitiensis* Mojs.
- Hungarites* nov. sp. ind.
- „ aff. *Mojsisovicsi* Boeckh.
- Protrachyceras Archelaus* Lhe.
- „ aff. *ladinum* Mojs.
- Gymnites Ecki* Mojs.
- Ptychites Gerardi* Blfd. (= *P. posthumus* Mojs.)

All the specimens mentioned by A. v. Krafft under the above names are before me, and besides these another series of examples, which had not then been determined by this author.

ECHINODERMATA.

CRINOIDEA.

TRAUMATOCRINUS sp. ind. Pl. II, figs. 12, 13.

1889. *Traumatocrinus* S. v. Woehrmann, Die Fauna der sogenannten Cardita und Raibler Schichten. Jahrb. K. K. Geol. Reichsanst., XXXIX Bd., p. 190, Taf. V, fig. 7.

The presence of the genus *Traumatocrinus* (= *Porocrinus* v. Dittmar) in the *Daonella* limestone of Spiti is of special interest because it is strongly in favour of a correlation of this rock-group with the crinoidal limestone of the Shalshal cliff where *Traumatocrinus* is the chief leading fossil.

Fragments of stems have been collected in the *Daonella* limestone near Kágá and W. of Lilang. They closely resemble the forms illustrated by K. v. Dittmar (Benecke's Geognost. palæont. Beitræge, Bd. I, Taf. XX, figs. 1, 2) and by S. von Woehrmann. The segments of the column are circular, very narrow, and joined together most intimately. Their surface exhibits the cross-shaped ornamentation characteristic of the genus *Traumatocrinus*. The points of fusion between the two systems of lines are marked by circular pores, corresponding to the terminations of numerous funnels which intersect the joints at regular intervals.

I have not succeeded in getting a clear view of the surface of a joint with its radiating furrows and numerous canals, the rhombohedral cleavage invariably interfering with any attempt at separating the joints along their original base.

BRACHIOPODA.

SPIRIGERA HUNICA Bittn. Pl. II, figs. 9, 10.

1899. *Spirigera hunica* Bittner, Himálayan Foss., Vol. III, Pt. 2, p. 31, Pl. VI, figs. 8-13.

1900. *Spirigera hunica* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 210.

Spirigera hunica has been described by A. Bittner from the beds with *Daonella indica* of the Shalshal cliff and from Dogkwa Aur encamping ground in Tibet. It has also been found in Spiti at several localities by H. Hayden and A. von Krafft.

Two specimens belonging to the typical form have been illustrated in figs. 9 and 10. My materials are not large enough to add anything of importance to

Bittner's description. Three specimens were sacrificed in vain in attempting to make the internal characters visible. No traces of spiral cones, crura or primary lamellæ have been found. The identification with *Spirigera* is nevertheless pretty certain, both on account of the shape of the beak with its terminal aperture and of the decidedly fibrous structure of the shell, the fibres converging towards the front in the median plane. There is a considerable thickening of the shelly substance in the apical region. This feature is in favour of assigning our species to *Pexidella*, but a decision on this question cannot be given owing to the lack of examples with their internal characters preserved.

Dimensions.

		FIG. 9.	FIG. 10.
Entire length of the shell		16.5 mm.	14 mm.
" breadth " " "		14.5 "	13 "
Length of the dorsal valve		14 "	12 "
Thickness of both valves		10 "	9 "

Locality and geological position: Topmost beds of Muschelkalk.—Banna encamping ground, Thanam valley; S.-E. of Muth.

Daonella shales.—N. of Po, W. of Lilang.

RHYNCHONELLA cf. RIMKINENSIS Bittner. Pl. II, fig. 11.

1899. *Rhynchonella Rimkinensis* Bittner, *Himalayan Foss.*, Vol. III, Pt. 2, p. 33, Pl. VI, fig. 19.

This species has been established by Bittner for the accommodation of a single specimen from the *Traumatocrinus* limestone of the Shalshal cliff. A specimen of *Rhynchonella* from the *Daonella* limestone W. of Lilang is nearest in relationship to *Rhynchonella Rimkinensis*, although their specific identity remains uncertain. My example agrees with *Rh. Rimkinensis* in its equivalve shape, in the presence of high, vertically flattened lateral hinge margins and of a broadly expanded frontal lobe to which five little short folds belong. The beak is very small and pointed. Characters of difference are the greater width and smaller thickness of the present example. In both characters it approaches more closely *Rh. halophila* Bittner.

No intermediate shapes between the type from the Shalshal cliff and the present specimen being known, the latter can be referred to *Rhynchonella Rimkinensis* as cf. only.

RHYNCHONELLA cf. THEOBALDIANA Stol. Pl. II, fig. 8.

1865. *Rhynchonella Theobaldiana* Stoliczka, *Mem. Geol. Surv. of India*, Vol. V, p. 41, Pl. III, fig. 10.

1899. *Rhynchonella Theobaldiana* Bittner, *Himalayan Foss.*, Vol. III, Pt. 2, p. 17, Pl. V, fig. 15.

Stoliczka's type-specimen of this species is an imperfectly preserved and crushed example from Muth of doubtful geological position. From the *Daonella shales* E. of Muth a specimen of *Rhynchonella* is before me, resembling closely *Rh. Theobaldiana*, especially in the presence of a tongue-shaped frontal lobe, which is bordered by acute lateral margins. The front is provided with two small, short folds.

Stoliczka's type-specimen is too badly preserved for establishing its specific identity with the present example.

LAMELLIBRANCHIATA.

DAONELLA LOMMELI Wissm. Pl. III, figs. 1-5.

1841. *Halobia Lommeli* Wissmann, in Wissmann und Graf Muenster, Beitræge zur Geognosie und Petrefactenkunde des südöstlichen Tirol, p. 22, Taf. XVI, fig. 11.
 1858. *Posidonomya Lommeli* Stoppani, Petrifications d'Etain, Paléont. Lomb., p. 93, Pl. 17, fig. 6.
 1874. *Daonella Lommeli* E. v. Mojsisovics, Die triadischen Pelecypodengattungen Halobia und Daonella, Abhandl. K. K. Geol. Reichsanst., VII, p. 19, Taf. II, figs. 13, 14.
 1892. *Halobia Lommeli* Rothpletz, Die Perm-Trias und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 93, Taf. XIV, figs. 11, 12.
 1895. *Halobia Lommeli* Salomon, Geologische und Palæontologische Studien über die Marmolada, Palæontographica, 42 Bd., pp. 83, 114, 154, Taf. V, figs. 2, 3.
 1899. *Daonella cf. Lommeli* Bittner, Himálayan Fos., Vol. III, Pt. 2, p. 33, Pl. VII, figs. 1, 2.
 1909. *Daonella* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, pp. 212, 213.
 1901. *Daonella Lommeli* Bittner, Lamellibranchiaten aus der Trias des Bakonyerwaldes, Resultate der wissenschaftl. Erforschg. des Balatonsees, I. Bd. I. Th. Palæont. Anhang, Budapest, p. 102.

The occurrence of *Daonella Lommeli* in Spiti has been established by Bittner, who referred two valves from the beds overlying the Muschelkalk near Muth (coll. Griesbach) to this species. Large materials have been collected by H. Hayden and A. v. Krafft from various localities. Their specific identity with the Alpine *Daonella Lommeli* may now be said to be indisputable.

Of the thin shelly substance fragments only have been occasionally preserved. But numerous natural casts of the outer and inner sides of both valves are before me, giving an exact picture of the outlines and surface of the shell. As in the Wengen beds of Southern Tirol the casts are, as a rule, found packed together so closely that it is very difficult to extricate an unbroken specimen from the large number of confusedly imbedded examples. The slab of rock illustrated in fig. 1 is a good instance of this mode of preservation. The outlines are rarely complete. They have been drawn from the plaster cast of a left valve in fig. 4. The difference between this specimen and the type from Wengen, illustrated in Pl. II, fig. 13, by E. v. Mojsisovics, is insignificant. The hinge-line is a little less broad and the position of the umbo is, perhaps, shifted somewhat more towards the middle in the Himálayan example, but otherwise the agreement is complete, especially so in the character of fusion of the anterior and posterior margins with the hinge-line.

An exact idea of the hinge region is got from the specimen illustrated in fig. 3, which consists of two gaping valves, still adhering to each other along the hinge-line. This specimen clearly shows the absence of any space free from ribs or furrows in front of the umbo. There is no trace of a distinct rim, which according to Rothpletz might be considered as an anterior ear or wing.

The ornamentation of my Indian examples agrees perfectly with that of the Alpine types. The majority of Himálayan shells is closely ribbed, the bifurcation of the primary furrows beginning in the immediate vicinity of the umbo. But there

are also specimens known to me in which this bifurcation does not arise earlier than in the type from Wengen illustrated by E. v. Mojsisovics. This is, for instance, the case in the beautifully ornamented cast from the *Daonella* limestone west of Lilang, of which an illustration is given in fig. 2. In this specimen both the primary and secondary furrows are cut in deeply, whereas the ribs of third and fourth order within the fasciculi are but weakly developed. In the majority of my Himalayan examples the difference between the primary and secondary furrows is more strongly marked.

The regular decrease in the strength of furrows of different orders is extraordinarily small in a fragment of a right valve from the *Daonella* shales W. of Lilang, which has been illustrated in fig. 5. Although the bundle-shaped arrangement of ribs and furrows is still very distinctly marked, the strength of the different kinds of furrows does not vary considerably. This is just the reverse of what is seen in *Daonella Lindstroemi* v. Mojsisovics (l. c. p. 22, Taf. II, figs. 15-17), of which the present specimen otherwise reminds one in the remarkable length of its hinge-line.

The following measurements have been taken from the cast illustrated in fig. 3 whose outlines have been almost completely preserved:—

Entire length of the shell	. . .	36.5 mm.
„ height „ „	. . .	26 „
Length of the hinge-line	. . .	29 „

In the *Daonella* shales of Kuling some specimens have been noticed which in dimensions are not inferior to the largest Alpine types from the Seiseralpe or from Corvara. A left valve from this locality attains a length of about 120 and a height of 70 mm.

Locality and geological position.—The species is widely distributed in the ladinic stage of Spiti, and is even more common than *Daonella indica* Bittner, with which it is frequently associated. I have examined specimens from the following places and rock-groups:—

- (a) *Daonella shales*:—Kuling, N. of Thabo, W. of Lilang, N. of Po., E. of Muth.
- (b) *Daonella limestone*.—W. of Lilang.

DAONELLA sp. ind. aff. LOMMELI Wissm. Pl. III, fig. 8.

The cast of a left valve from the *Daonella* shales of Lilang differs so considerably from the typical *Daonella Lommeli*, that it cannot be identified with this species. It is distinguished by its strongly elongated outline, and by a remarkable difference in the strength of the primary and secondary furrows. In both characters the Himalayan example recalls *Daonella Lindstroemi* v. Mojsisovics (l. c. p. 22, Taf. II, figs. 15-17). There are four to six furrows of irregular strength, inserted between the primary furrows. But the surface of the ribs composing each bundle is perfectly flat in the Indian type, whereas it is strongly convex in *D. Lindstroemi*.

The species seems to hold an intermediate position between *Daonella Lommeli* and *D. Lindstroemi* or *D. Sturi* Mojs., agreeing with the two latter species in its elongated shape and in the irregularity of secondary furrows, but agreeing with *D. Lommeli* in the arrangement of fasciculi and in the flat shape of its ribs.

DAONELLA INDICA Bittner. Pl. III, figs. 6, 7, *var.*, fig. 10.

1899. *Daonella indica* Bittner, Himalayan Foss., Palæont. Indica, ser. XV, Vol. III, Pt. 2, p. 39, Pl. VII, figs. 4-11.

1903. *Daonella indica* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 208.

The occurrence of this species in Spiti has been established by Bittner. Hayden and A. v. Krafft collected a considerable number of individuals, both in the *Daonella* shales and in the *Daonella* limestone, but found the species less common than *Daonella Lommeli*, with which it is frequently associated.

The two illustrated specimens agree in all their characters with the types which have been figured by Bittner. The description given by this author and based on extensive materials is so exhaustive that I have nothing to add.

The measurements of my largest specimen—a right valve from the *Daonella* limestone W. of Lilang (fig. 1)—are as follows:—

Entire length of the shell	.	.	.	72	mm.
" height " "	:	:	:	61.5	"
Length of the hinge-line	:	.	.	50	"

Locality and geological position: (a) *Daonella shales*.—E. of Muth, N. of Po, Kuling, Thanam valley.

(b) *Daonella limestone*.—W. of Lilang, Pankpolung, Rupshu.

Daonella indica var.—In one of the specimens from the *Daonella* limestone W. of Lilang (fig. 10) the bifurcation of primary ribs is restricted to the central portion of the shell. The ribs adjoining the points of fusion between the hinge-line and lateral margins remain undivided. Thus the ornamentation of the lateral portions of the shell is characterised by a thin radial grooving only, recalling the sculpture in *D. Moussoni* Mer.

I think that this specimen ought to be classed among the varieties of *Daonella indica* Bittn. The absence of any tripartite ribs does not permit an identification with *D. tyrolensis* Mojs., which my specimen otherwise resembles in its considerable height and in the central position of its umbo.

DAONELLA sp. ind. aff. CASSIANÆ Mojs. Pl. III, fig. 9.

A large specimen of *Daonella* is closely allied to *Daonella Cassiana* v. Mojsisovics (Ueber die triadischen Pelecypodengattungen *Halobia* und *Daonella*, Abhandl. K. K. Geol. Reichsanst., VII, 1874, p. 10, Taf. I, figs. 2, 3, 13). It is a right valve with fairly well-preserved outlines, but its ornamentation is partly obscured by the adhering matrix, from which it could not be freed.

The outlines of this specimen are rounded, of nearly equal height and width. The umbo is situated in the middle of the hinge-line and projecting very little above it. The shell is strongly inequilateral, the anterior portion being considerably inferior in size to the posterior one. The anterior and posterior lateral margins meet the straight hinge-line in rounded-off angles.

The sculpture is of unequal strength in the umbonal and ventral regions of the shell, and it gradually dies away in the vicinity of the hinge margins on both sides of the umbo. The species therefore belongs to the group of *Daonella Moussoni*, not to the group of *D. tyrolensis*, in which *D. indica* is included. There are about fifty ribs counted along the periphery of the shell. They bifurcate very rarely and irregularly, and are all of equal strength and crossed by numerous striæ of growth. The weakening of the ribs in the direction towards the hinge margins is quite gradual. There is no space in front of the umbo distinctly marked off from the rest of the valve. The complete absence of an anterior ear marks our species as a representative of the triassic genus *Daonella*.

The measurements of this specimen are as follows :—

Entire length of the shell	.	.	61	mm.
" height " "	.	.	55	"
Length of the hinge-line	.	.	38	"

It is chiefly *Daonella Cassiana* Mojs. among the Alpine representatives of the group of *Daonella Moussoni* which demands a closer comparison with our species. Unfortunately *D. Cassiana* is but imperfectly known. Two fragments of large dimensions from the Ellipticus-beds of the Roethelstein (carnic stage) have been figured by E. v. Mojsisovics. A better preserved example of smaller size from St. Cassian has been illustrated by Bittner (Lamellibranchiaten der alpinen Trias, I. Revision der Lamellibranchiaten von St. Cassian, Abhandl. K. K. Geol. Reichsanst., Bd. XVIII, Taf. IX, fig. 26), but this specimen is of very small dimensions and does not, consequently, agree with the large Indian type in the number of ribs. In their outlines the Alpine and Himalayan forms seem to differ, the latter being higher and more strongly inequilateral. But a fair comparison between our species and *D. Cassiana* cannot be made at present, on account of the insufficient materials so far available.

Locality and geological position.—*Daonella* limestone, Pankpolung, Rupshu.

CEPHALOPODA.

A. NAUTILOIDEA.

PHLOIOCERAS DELICIOSUM nov. sp. Pl. II, fig. 7.

This species differs from the type of the genus *Phloioceras* Hyatt, *Nautilus gemmatus* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, VI-1, p. 11, Taf. III, fig. 1) from the jolic Hallstatt limestone of Aussee by some remarkable peculiarities of its ornamentation. In *Phloioceras gemmatum* the sculpture consists of numerous longitudinal ridges, roughened by tubercles, which die out gradually along the

siphonal area. The number of spiral ridges in a full-grown specimen of 140 mm. in diameter is 3 in the umbilical wall, 10 on the lateral parts, and 13 on the siphonal area. In the present species the number of longitudinal ridges is considerably larger, the ridges are more delicate, and the tubercles are restricted to the ridges adorning the lower portion of the flanks. The siphonal ridges are reduced to thin spiral lines, recalling the spiral lines in *Cladiscites* Mojs.

If the suggestion of E. v. Mojsisovics were correct, that *Phloioceras*, is a representative of the family of *Temnocheilidæ*, and derived from *Pleuromutilus* the present species would be still more distinct from the subgenus *Trachynautilus* than *Phloioceras gemmatum*, all trace of radial sculpture being entirely absent. On the other hand, there is no other genus of *Nautiloidea* to which this species could advantageously be compared. Nor are any of its features strictly opposed to its being included with *Phloioceras*.

The only specimen available for examination is unfortunately only a fragment. The whorls overlap one another to about one-third of their height. The cross-section is higher than broad and of trapezoidal outlines, with a flattened siphonal area and a steep umbilical wall. The greatest width of the shell coincides with the steeply rounded umbilical margin. The siphonal margin is very distinctly defined, nearly acute.

About twenty delicate spiral ridges are counted on the siphonal area and an equal number of ridges on the lateral parts. The lateral ridges are arranged less closely, and those in the vicinity of the umbilical region are set with numerous and delicate tubercles. When the shell is completely preserved, thin transverse striæ of growth are noticed, crossing the longitudinal ornamentation at right angles.

Dimensions.

Diameter of the shell	about 55 mm.
" " umbilicus	9 "
Height of the last volution	29 "
Thickness " " "	25 "

Sutures.—Apparently very simple, but not exactly known.

Locality and geological position.—N. of Thabo, Daonella limestone.

B. AMMONOIDEA.

A. CERATITOIDEA.

CERATITES NARSINGHA nov. sp. Pl. IV, figs. 1, 2.

1900. *Ceratites* nov. sp. aff. *himlayanus* (Blanf.) A. v. Kraft, General Report, Geol. Surv. of India, for 1899-1900, p. 212.

This species is considered by A. von Kraft as very nearly allied to *Ceratites himlayanus* Blanf., "from which it is only distinguished by more complicated sutures and a wider umbilicus, as the involution takes place outside the spiral row of lateral tubercles."

A. v. Krafft's diagnosis of this species is correct, so far as the inner volutions are concerned. In the two specimens available the inner whorls are fairly well preserved and accessible to observation, but the last or body-chamber whorls have been partly broken off. If the inner nucleus of *Ceratites Narsingha* is compared with the type-specimen of *C. Himálayanus*, as it has been illustrated on Pl. I, fig. 4, of my memoir on the Cephalopoda of the Himálayan Muschelkalk (Vol. II, Pt. 2), the similarity is, indeed, very remarkable. There is a complete agreement in the shape of the cross-section. The greatest transversè diameter coincides with the lateral tubercles. The siphonal area is provided with a distinctly marked keel, and separated from the lateral parts by acute edges. The proportion of lateral and marginal tubercles is the same as in *Ceratites himálayanus* or in *C. trinodosus* Mojs., two marginal tubercles corresponding to one lateral tubercle. Umbilical tubercles are entirely absent, but the radiating ribs reach as far as the umbilical margin. The involution takes place outside the spiral line along which the lateral tubercles are arranged. This character, and the greater difference in the strength of marginal and lateral tubercles, are the only characters of distinction between the two species.

This similarity is, however, considerably reduced if we examine the body-chamber volution of the larger type, illustrated in fig. 1. In this whorl a very considerable change in the spiral of involution is noticed. The involution no longer occurs exactly outside the row of lateral tubercles, but half-way between the lateral and marginal tubercles of the penultimate whorl. Thus the umbilicus increases in width more rapidly than does the height of the last volution. Thus the latter is comparatively less high-mouthed near the aperture than the preceding whorl.

At the same time the siphonal keel gradually disappears. It is faintly marked near the aperture of the smaller specimen, but completely obscured in the larger type (fig. 1). The marginal tubercles get very strong and become the predominant element of sculpture.

The lateral parts of the body-chamber whorl have suffered considerably from weathering in my larger example. Obscure traces of lateral tubercles only could be made visible, but it is impossible that the lateral tubercles, if any existed, could rival the marginal tubercles in strength.

No larger sized body-chamber specimen of *Ceratites himálayanus* Blfd. being known, it is impossible indeed to decide whether a close relationship exists between this species and *C. Narsingha*, as might be suggested from a comparison of the chambered nuclei.

Dimensions.

		Fig. 1.
	Last whorl.	Penultimate whorl.
Diameter of the shell	75 mm.	35.5 mm.
" " " umbilicus	28 "	9 "
Height of the { above the umbilical suture	28.5 "	15 "
last volution { " " preceding whorl	24 "	10.5 "
Thickness of the last volution	about 19 "	12 "

Sutures.—Apparently brachyphyllic, but not known in detail.

Locality and geological position.—Daonella shales, Thanam valley, Bashahr N. of Po.

CERATITES (?) WETSONI Oppel. Pl. VI, fig. 1.

1865. *Ammonites Wetsoni* Oppel, Palæontologische Mittheilungen aus dem Museum des Kgl. bayr. Staates I, p. 291, Taf. 86, fig. 2.

1895. *Ceratites Wetsoni* Diener, Himalayan Foss., Palæont. Indica, ser. XV, Vol. II, Pt. 2. Cephalopoda of the Muschelkalk, p. 7, Pl. I, fig. 6.

A fragment as imperfectly preserved as Oppel's type-specimen has been collected by A. v. Krafft in the topmost beds of the upper Muschelkalk S. E. of Muth. Its flat lateral parts are provided with broad, indistinct folds.

The most remarkable character of *Ceratites Wetsoni* is its sutural line. As has been explained by E. v. Mojsisovics and Philippi, this species recalls some *Ceratites* of the German Muschelkalk in the extraordinary width of the second auxiliary lobe, which consists of a large number of rudimentary sutural elements. But it recalls, perhaps still more strongly, some of Waagen's *Meekoceratidæ* from the ceratite formation of the Salt Range. That it belongs to the genus *Ceratites* is altogether extremely doubtful. The sutural line of my fragment agrees exactly with that of Oppel's type-specimen.

I have only mentioned this fragment, because it affords, perhaps, a clue to the true geological position of *Ceratites Wetsoni*.

ARPADITES cf. LISSARENSIS v. Mojsisovics. Pl. I, fig. 9.

1896. *Arpadites lissarensis* E. v. Mojsisovics, Obertriadische Cephalopodenfauna des Himalaya, Denkschr. Kais. Akad. d. Wissensch. math. nat. Klasse, LXIII, p. 51, Taf. XIV, fig. 7.

1899. *Arpadites lissarensis* E. v. Mojsisovics, Himalayan Foss., Palæont. Indica, ser. XV, Vol. III, Pt. 1; Upper-Triassic Cephalopoda fauna of the Himalayas, p. 60, Pl. XIV, fig. 7.

A specimen agreeing very closely with the type from the grey limestone with *Joannites* in the Lissar valley has been collected in the topmost (passage) beds of the Muschelkalk near Kágá by Hayden. The sculpture of the inner volutions is somewhat more strongly developed, and the ribs are only very slightly curved. Both umbilical and marginal tubercles are distinctly marked in the last whorl. The ribs are very irregularly set. The median furrow is shallow, less deep than the marginal furrows accompanying the smooth external keels. The external area is comparatively wider than in the type from the Lissar valley.

All features of difference between the two specimens are of such small importance that I do not feel justified in venturing on a specific separation.

Dimensions.

Diameter of the shell	about 33 mm.
" " " umbilicus	" 17 "
Height of the last volution	" 8 "
Thickness " " "	" 6.5 "

Sutures.—Agreeing with those of *Arpadites Arpadis* v. Mojsisovics, as illustrated in "Cephalopoden der Mediterranen Triasprovinz" (Abhandl. K. K. Geol. Reichsanst., X., Taf. XXV, fig. 29). Lobes faintly serrated, saddles entire. Siphonal lobe short. Second lateral saddle bordering the umbilical suture. No auxiliary lobes developed.

ARPADITES RIMKINENSIS v. Mojsisovics. Pl. IV, figs. 3, 4, 5, 6.

1896. *Arpadites Rimkinensis* E. v. Mojsisovics, Obertriadische Cephalopodenfaunen des Himalaya, Denkschr. Kais. Akad. d. Wissensch., Bd. LXIII, p. 50, Taf. XIV, fig. 6.
 1899. *Arpadites Rimkinensis* E. v. Mojsisovics, Himalayan Foss., Vol. III, Pt. 1, p. 59, Pl. XIV, fig. 6.
 1900. *Arpadites cf. Stracheyi* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 211.

This species is represented very numerously in A. v. Krafft's and Hayden's collections. It has been referred to *Arpadites Stracheyi* v. Mojsisovics (l. c. p. 58) by A. v. Krafft, but this difference in our determinations is of very small importance, *A. Stracheyi* and *A. Rimkinensis* being probably varieties of one single species only. My examination of the rich materials from Spiti has convinced me that the differences between the two forms are not prominent and are in all probability bridged over by intermediate shapes.

The most important stages of growth are illustrated by the accompanying figures. As will be seen from them, specimens of obliquely elliptical shape and with normally rounded outlines are represented among my materials. The proportions of height and width of the cross-section are also subject to a remarkable variability. The specimen from Banna encamping ground (fig. 5) is very thick, the height and width of its aperture being of equal dimensions. The specimen from Kágá (fig. 4) recalls the typical form, being high-mouthed, and provided with an aperture which is nearly twice as high as broad.

The amount of involution also differs considerably. In the specimen illustrated in fig. 5 the whorls increase more slowly than in all the rest of the examples.

The majority of specimens agree in their sculpture with the type from the *Traumatocrinus* limestone of the Shalshal cliff. In a small number of examples only the ribs are more distinctly falciform. But in the strength of the ribs every transitional shape is noticed between the typical form with narrow, strongly raised circumplicate ribs (and *Arpadites Stracheyi* with slight indications of transverse

folds. In the body-chamber of the larger specimens the sculpture becomes gradually obscured. It is in the middle stages of growth that it appears most distinctly developed.

A constant character in all my specimens—more than twenty have been examined altogether—is the development of a deep external furrow bordered by smooth marginal keels. Those external keels are developed at early stages of growth. In the small example from the Daonella shales of the Thanam valley (fig. 6) they are already visible at the beginning of the last volution, corresponding to a diameter of the shell of 9 mm. Marginal edges are, as a rule, not visible, until a diameter of 18 mm. has been reached. In this character my specimens agree perfectly with the description of *Arpadites Stracheyi*, as given by E. v. Mojsisovics.

Dimensions.

	FIG. 3.	FIG. 4.	FIG. 5.
Diameter of the shell . . .	22 mm.	29 mm.	19 mm.
„ „ „ umbilicus . . .	6 „	7.5 „	6 „
Height of the last volution . . .	10 „	13 „	7 „
Thickness „ „ „ . . .	7 „	6.5 „	7 „

Sutures.—No illustration of the sutures of *Arpadites Rimkinensis* has been given by E. v. Mojsisovics, but only a short description, in which the sutural line of this species has been compared to that of *A. Ladon* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, Taf. CLIII, figs. 6-7). On the whole the sutures of my specimens correspond with those of *A. Ladon*, and with the illustration of *Arpadites Stracheyi* (*Ammonites floridus* juv. Salter) in the Palæontology of Niti, Pl. 8, fig. 3d, as given by Salter, excepting some differences of minor importance.

The siphonal lobe is divided by a low median prominence dividing it into two single, pointed branches. Lateral lobes with deep incisions, the second considerably deeper than in *A. Ladon*. First auxiliary lobe coinciding with the umbilical margin and followed by a rounded auxiliary saddle.

Saddles brachyphyllic, serrated faintly and irregularly. In smaller examples the sutures have barely passed the line between a ceratitic and a brachyphyllic stage of development.

Locality and geological position: (a) *Topmost (passage) beds of Muschelkalk*.—Kágá; Banna, e.g., Thanam valley, Bashahr.

(b) *Daonella shales*.—Thanam valley, Bashahr.

Remarks.—The specific characters of *Arpadites Stracheyi* Mojs. are too insufficiently known to prove its identity with *Arpadites Rimkinensis*, although there is strong evidence in favour of such an identification. The obliquely elliptical shape of *A. Stracheyi* is not a character of specific importance, specimens with elliptical and normal outlines being associated among my materials. Nor can any importance be attributed to the smooth surface of the shell, the strength of ribbing being subject to considerable variation in *Arpadites Rimkinensis* and the sculpture

being eventually restricted to the inner volutions only, which are not known in the type-specimen of *A. Stracheyi*. The differences in the sutural line might well be due to incorrect drawing.

HUNGARITES PRADOI d'Archiac. Pl. IV, fig. 11.

1860. *Ceratites Pradol* d'Archiac, Histoire des progrès de la géologie, T. VIII, p. 280.

1882. *Hungarites Pradol* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 225, Taf. XXXII, figs. 7, 8, XXXIII, figs. 1, 2.

A species of *Hungarites* from the Daonella shales of Spiti most strikingly recalls the smaller examples of *Hungarites Pradol* illustrated by E. v. Mojsisovics in Pl. XXXII of his above-quoted memoir in general shape and ornamentation. It is a little smaller than the Spanish example illustrated in fig. 7, but otherwise agrees perfectly, especially so in the high-mouthed aperture, in the presence of a very small umbilicus, and of sharply defined marginal edges bordering the carinate and roof-shaped siphonal area. The sculpture consists of faintly developed, falciform folds only. Traces of lateral tubercles are not visible.

The specimen is provided with a part of its body-chamber, occupying exactly one-half of the last volution.

Dimensions.

Diameter of the shell	45 mm.
" " " umbilicus	3 "
Height of the { above the umbilical suture	25 "
last volution { " " preceding whorl	16 "
Thickness of the last volution	10 "

Sutures.—Agreeing entirely with those of *Hungarites Pradol*.

E. v. Mojsisovics mentions *Hungarites Pradol* among the congeneric species distinguished by three lateral lobes. The correctness of this statement cannot be verified in my specimen. A semicircular arrangement of the sutures is faintly marked, the lobes ascending slightly from the principal to the third lateral lobe and sloping downward in the auxiliary series, which consists of two lobes and one saddle. The siphonal lobe is broad, occupying the entire distance between the two marginal edges. The main saddles are slender and slightly inflated near their tops.

Locality and geological position.—Daonella shales N.-E. of Po. A fragment belonging probably to this species has been collected in the topmost beds of the Muschelkalk N.-W. of Muth by A. v. Krafft.

Remarks.—I cannot find any feature of difference between my Himalayan specimen and *Hungarites Pradol*. *Hungarites Mojsisovicsi* Boeckh, to which it might also be compared, is provided with a wider umbilicus and with a more strongly marked sculpture, consisting of alternating stronger and weaker folds.

HUNGARITES sp. ind. aff. *MOJSISOVICSI* Boeckh. Pl. V, fig. 3.

From the topmost beds of the Muschelkalk near Banna encamping ground, Thanam valley, there is a small specimen of *Hungarites*, reaching only a diameter of 17 mm., which must be placed near *Hungarites Mojsisovicsi* Boeckh. The difference in size between the little shell and the examples illustrated by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, Taf. VII, fig. 6, VIII, fig. 3) is, however, too great to enable one to come to a certain decision about its specific position. The two marginal edges are very distinctly developed. The umbilicus is considerably wider than in the preceding species. Radiating folds, recalling the ornamentation in *Hungarites Mojsisovicsi*, are faintly marked.

Sutures—As far as known, identical with those of *Hungarites Mojsisovicsi*, but with entire saddles.

PROTRACHYCERAS ARCHELAUS Laube. Pl. I, figs. 1, 3; Pl. II, fig. 3.

1869. *Trachyceras Archelaus* Laube, *ex parte*, Die Fauna der Schichten von St. Cassian, Denkschr. Kais. Akad. d. Wissensch., XXX, p. 74, Taf. XL, fig. 1.
 1869. *Trachyceras Archelaus* v. Mojsisovics, *ex parte*, Die Gliederung der oberen Triasbildungen der oestlichen Alpen, Jahrb. K. K. Geol. Reichsanst., XIX, p. 130, Taf. II, fig. 1.
 1882. *Trachyceras Archelaus* v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 118, Taf. XIII, fig. 9, XVI, figs. 1, 2, XVIII, figs. 1, 2, XIX, figs. 1, 2, XXIII, fig. 1, XXXI, fig. 1.
 1899. *Protrachyceras Archelaus* Tommasi, La fauna dei calcari rossi e grigi del Mte. Clapsavon, Palæontographia Italica, Vol. V, p. 25, Pl. III, figs. 5, 6, Pl. IV, fig. 1.
 1900. *Trachyceras* aff. *Archelaus* A. v. Krafft, General Report, Geol. Surv. of India, 1899-1900, p. 212.
 1902. *Protrachyceras Archelaus* Airaghi, Nuovi cefalopodi del calcare di Esino, Palæont. Ital., Vol. VIII, p. 33.
 1903. *Trachyceras Archelaus* (*Protrachyceras*) Frech., Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des suedl. Bakony. Aus dem Palæont. Anhang. zum ersten Teile des ersten Bandes der Resultate der Wissenschaftlichen Erforschung des Balatonsees, p. 24, var. *lævior*, ibid., Taf. V, fig. 1.

In the Himálayan collection fragments agreeing very closely with *Protrachyceras Archelaus* Lbe. are rather richly represented. The better preserved examples which I am going to describe leave no doubt about the presence of the Alpine species in the triassic rocks of Spiti.

Two groups of forms have been distinguished in this species by E. v. Mojsisovics, the typical one with coarse ribs and spines, and a second one with delicate ribs and low spines or tubercles (*var. lævior* Frech). Nearly all my Indian examples belong to the typical form. Their largest representative is the specimen illustrated in fig. 1, which, although attaining a diameter of 103 mm., is still entirely chambered. When complete it must have surpassed Laube's type-specimen considerably in size. The inner nucleus and the beginning of the last volution are missing, but what remains of the last whorl is sufficient to study all the characters of importance

In its involution this specimen agrees with Laube's type from Agordo, the whorls overlapping one another to a small extent only, thus enveloping the marginal and the first lateral rows of tubercles. In the proportions of height and width of the transverse section there is also a nearly complete agreement with Laube's type-specimen and with the Hungarian example from the Bakony, illustrated by E. v. Mojsisovics on Pl. XXXI, fig. 1, of his above-quoted memoir.

The sculpture is very coarse, more strongly marked than in Laube's type. Among the examples illustrated by E. v. Mojsisovics, it is only the specimen from Pozoritta (Taf. XVIII, fig. 1) which is still more strongly sculptured. In the strength and in the details of ornamentation my specimen takes an intermediate position between this and the beautiful type from the Wengen strata of Corvara, illustrated by E. v. Mojsisovics on Taf. XVIII, fig. 2. The ribs are broad, coarse, not very numerous and bifurcating rather rarely. There are six rows of spines present. The external spines are somewhat elongated. The outermost thorns of the lateral row are more strongly developed than the rest, with the exception of the umbilical ones, which are broadly rounded tubercles.

The median furrow is narrow, and equal in width to the distance of the external and marginal spines. In the stronger development of the outer row of the lateral spines our Indian specimen agrees exactly with the type from Corvara illustrated by E. v. Mojsisovics on Pl. XVIII, fig. 2.

The measurements of this specimen are :—

Diameter of the shell	106 mm.
" " " umbilicus	27.5 "
Height of the { above the umbilical suture	49 "
last volution { " " preceding whorl	40 "
Thickness of the last volution	51 "

The sutures are but very imperfectly known to me. The saddles are brachyphyllic, with broadly rounded tops.

This specimen has been collected in the Daonella shales of the Thanam valley, Bashahr, by Hayden.

Two fragments of body-chambers from the Daonella shales of the same locality appear to be very closely related to this type.

Several specimens of smaller size approach *Protrachyceras ladinum* Mojs. in the greater height of their cross-sections. One of those examples has been illustrated in fig. 3. In the typical form the height and width of the transverse section are nearly equal, whereas in this specimen the aperture is high-mouthed, a width of 13.5 mm. corresponding to a height of 17 mm. It differs, moreover, from the typical form of *Protrachyceras Archelaus* by its narrow siphonal part. The slope from the external to the marginal row of spines is as steep as in *P. ladinum*. On the other hand the rate of involution is much more considerable than in *P. ladinum*. In the dimensions of the umbilicus—12 mm. corresponding to a diameter of 38 mm.—the specimen is more nearly allied to *P. Archelaus* than to *P. ladinum*.

It must be borne in mind that E. v. Mojsisovics himself (l. c. p. 125) states the two species to be very similar in young stages of growth, although they are easily distinguishable in full-grown age. I have therefore referred those intermediate shapes to *Protrachyceras Archelaus* as *cf.* only. Besides the specimen illustrated from the Daonella shales N. of Po, this type is represented in the Himalayan collection by two examples from the topmost beds of the upper Muschelkalk of the Thanam valley, Bashahr.

In the Alpine specimens of *Protrachyceras Archelaus*, illustrated by E. v. Mojsisovics, the rate of involution is subject to considerable variation. The maximum rate of involution is reached in the example from Pozoritta (Pl. XVIII, fig. 1), the last volution of which overlaps the preceding one to one-half its height. In the majority of specimens the involution is much smaller. In one of my Himalayan specimens from the Daonella shales of the Thanam valley (Pl. II, fig. 3) the volutions overlap one another along their siphonal part only, the umbilical suture not entirely concealing the outermost row of spines.

In this specimen the sutural line is partly accessible to examination. It agrees with the sutures of the specimen from the Bakony illustrated by E. v. Mojsisovics on Pl. XXXI, fig. 1. The saddles are brachyphyllic, but not interlaced strongly, as has been suggested by Frech.

The measurements of this specimen are as follows :—

Diameter of the shell	67 mm.
„ „ „ umbilicus	21 „
Height of the { above the umbilical suture	25 „
last volution { „ „ preceding whorl	22 „
Thickness of the last volution	24 „

Locality and geological position.—Daonella shales, E. of Muth; Thanam valley, Bashahr.

Remarks.—The type of *Protrachyceras* represented by *P. Archelaus* in the Wengen beds of the ladinic stage ranges into strata of carnic age. A specimen from the Raibl beds of the Schlernplateau in Southern Tyrol has been compared to *Protrachyceras Archelaus* by Koken, to *P. Aspasia* v. Mojs. by myself (Neues Jahrb. f. Mineral, etc., 1901, Bd. II, p. 34, Taf. I, fig. 4). F. Frech (l. c. p. 41) attempted to base a distinction between the two species on the character of their sutural lines, but my examination of the type-specimen of *Protrachyceras Aspasia* could not convince me of the correctness of the fig. 1a, in which the sutures of that species have been illustrated. Young examples of *Protrachyceras Archelaus* and *P. Aspasia* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 631, Taf. CLXVIII, figs. 12, 13, CLXXI, fig. 1) can be distinguished with difficulty only. The example from the Daonella shales of the Thanam valley, illustrated in fig. 3, and referred to *P. Archelaus* as *cf.*, is also very similar to *P. Aspasia*.

PROTRACHYCERAS SPITIENSE nov. sp. Pl. II, figs. 1, 2.

It seems to me advisable to separate this species from the nearly allied *Protrachyceras Archelaus* Lbe. under a special specific name.

My type-specimen (fig. 1), in which both inner volutions and body-chamber have been almost entirely preserved, differs from *Protrachyceras Archelaus* by the very slowly increasing volutions, which overlap one another along the external part only, and by its widely open umbilicus. Among the representatives of *P. Archelaus* there is only the specimen from the Daonella shales of the Thanam valley, illustrated on Pl. II, fig. 3, which approaches it in this respect.

A character common to all examples which I have united in this species is the low and square-shaped cross-section. The height is invariably inferior to the width. But the most constant feature of distinction between *Protrachyceras Archelaus* and *P. Spitiense* is the pattern of sculpture.

In *P. Spitiense* the thorns of the outermost lateral row are developed in an extraordinary manner, thus forming the predominant element of ornamentation. A predominance of the spines of this row has been noticed in some types of *P. Archelaus*. The specimen from Corvara, illustrated by E. v. Mojsisovics on Pl. XVIII, fig. 2, and the Himálayan example illustrated on Pl. I, fig. 1, of the present memoir, show also the thorns of the outermost lateral row more strongly pronounced than the marginal and external spines. But in none of those specimens is the predominance so remarkable and at the same time affecting the external shape of the cross-section. Whereas in *Protrachyceras Archelaus* the elevation of the spines above the general convexity of the shell is not sufficient to influence the elliptical outlines of the cross-section, the thorns on the outer lateral row in *Protrachyceras Spitiense* project so strongly that the distance of their points from the median plane of the shell is equal to that from this plane to the points of the umbilical spines. Thus the outlines of the cross-section are no longer elliptical but square-shaped. The umbilical spines are also strongly developed, but the sculpture in this species is altogether very coarse, more so even than in the specimen of *P. Archelaus* from Pozoritta, illustrated by E. v. Mojsisovics on Pl. XVIII, fig. 1.

In my type-specimen there is only one more lateral row of spines between the rows of the principal lateral and umbilical thorns, the distance being too short for the development of a second one. This character, however, is not constant, but subject to considerable variation. In some of my examples the stout transverse ribs are adorned with either two or three lateral spines.

In fig. 2 the inner nucleus of a middle-sized specimen has been represented. It is much like the inner volutions of *Protrachyceras Archelaus*, from which it differs, however, by the shape of the transverse section. The greatest transverse diameter coincides with the outer row of lateral thorns, some of which are already more strongly developed than the rest of the spines.

Dimensions.

Diameter of the shell	. 65 mm.
„ „ „ umbilicus	. 24 „
Height of the last volution	. 26 „
Thickness „ „ „	29 „

Sutures.—Agreeing in general with those of *P. Archelaus*, but saddles serrated very moderately, with entire tops.

Locality and geological position : (a) *Topmost beds of upper Muschelkalk.*—Kágá; Banna encamping ground, Thanam valley, Bashahr.

(b) *Daonella shales.*—N. of Po.

PROTRACHYCERAS LADINUM v. Mojsisovics. Pl. I, figs. 2, 4, 5.

1869. *Ammonites (Trachyceras) Archelaus* E. v. Mojsisovics, *ex parte*, Jahrb. K. K. Geol. Reichsanst., p. 130, Taf. II, fig. 2.
1882. *Trachyceras ladinum* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 125, Taf. XIV, fig. 3, XV, XVI, fig. 1, XIX, fig. 5, XXII, fig. 1, XXIII, figs. 2, 3, XXXVI, fig. 2.
1899. *Protrachyceras ladinum* Diener, Mitteilungen über einige Cephalopodensuiten aus der Trias des südlichen Bakony, Paläontologischer Anhang zum I. Teil des I. Bandes der Wissenschaftl. Resultate der Erforschg. des Balatonsees, p. 12.
1903. *Trachyceras ladinum (Protrachyceras)* Frech, Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des südlichen Bakony, *ibidem*, p. 26, Taf. VI, fig. 1.

This species, which is distinguished from *Protrachyceras Archelaus* by its smaller umbilicus and by its high whorls with a narrow siphonal part, is represented in the *Daonella shales* of Spiti by three specimens, agreeing perfectly with the small type from Esino, which has been illustrated by E. v. Mojsisovics on Pl. XXII, fig. 1.

My specimen from the *Daonella shales* N. of Po, illustrated in fig. 4, is provided with six spiral rows of spines. There is a distinct marginal row present between the external and lateral rows. This character together with the smaller development of umbilical spines is sufficient to distinguish my Himálayan specimen from *Protrachyceras hispanicum* Mojs. (l. c. p. 123, Taf. XXXII, fig. 1), to which it appears otherwise closely allied. The distance between the umbilical and the first lateral row of spines is only a little greater than between the rest of the spiral rows.

Two of my specimens are of larger size. One of them is, unfortunately, fragmentary, the anterior half of the last volution only having been preserved. The transverse section of this fragment (fig. 5) is very slender. The siphonal part is very narrow and provided with a deep median furrow, accompanied by acute external spines, which are elevated more strongly above the general convexity of the shell than the marginal and lateral ones.

My largest specimen from the *Daonella shales* of the Thanam valley, Bashahr, has been slightly deformed by pressure in the rocks, but is otherwise nearly complete and fairly well preserved. The whorls overlap one another to one-half

their height. In its size, involution and sculpture this specimen (fig. 2) agrees most nearly with the type from the red Wengen limestone of Vamos (Bakony) illustrated by Frech. The external, marginal, and umbilical spines are developed more strongly than the lateral ones. The distance between the spirals of the marginal and outermost lateral spines is equal to that from the innermost lateral to umbilical thorns.

Dimensions.

	FIG. 2.	FIG.
Diameter of the shell	80 mm.	36.5 mm.
" " " umbilicus	16.5 "	9 "
Height of the { above the umbilical suture	40 "	16 "
last volution { " " preceding whorl	28 "	12 "
Thickness of the last volution	25 "	11 "

Sutures.—

Illustrated by E. v. Mojsisovics in Pl. XIV, fig. 2.

Locality and geological position.—Daonella shales, Thanam valley, Bashahr; N. of Po.

PROTRACHYCERAS cf. *LONGOBARDICUM* Mojs. Pl. I, fig. 6: Pl. II, figs. 4, 5.

1882. *Trachyceras longobardicum* v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 126, Taf. XVIII, figs. 4, 5, Taf. XXII, figs. 4, 5.

1899. *Protrachyceras* aff. *longobardicum* A. v. Krafft, General Report, Geol. Surv. of India, 1898-99, pp. 16, 18.

1903. *Trachyceras longobardicum* (*Protrachyceras*) Frech, Neue Cephalopoden aus den Buchenstein, Wengener und Raibler Schichten des südlichen Bakonyerwaldes, Palæont. Anhang zum 1. Teil, des 1. Bandes der Resultate der wissenschaftl. Erforschg. des Balatonsees, p. 27, Taf. VI, fig. 3.

1906. *Protrachyceras* cf. *longobardicum* Diener, Himalayan Foss., ser XV, Pal. Ind., Vol. V, Pt. 2, Pl. XII, fig. 1.

In my memoir on the fauna of the Himálayan Muschelkalk a large specimen of *Protrachyceras* has been described, agreeing in all essential points of its shape and sculpture with *P. longobardicum* v. Mojs. It was collected in the Muschelkalk N.-N. W. of Kágá by H. Hayden, probably in the passage beds between this group and the Daonella shales.

Fragments of large examples of *Protrachyceras*, resembling this example in their dimensions and sculpture, have been found in Hayden's collections from the topmost beds of the Muschelkalk near Muth, and from the Daonella shales N. of Po. In one of those fragments only has the volution been preserved in its entire height from the umbilical margin to the external row of tubercles. In this fragment seven spiral rows of spines have been counted, corresponding to a height of the volution of 43 mm. In all those fragments the ribs are more delicate than in the type from Kágá. Their ornamentation agrees most nearly with that of the specimen from Esino illustrated by E. v. Mojsisovics on Pl. XX, fig. 1, of his above-quoted memoir. The external spines are more strongly pronounced than the lateral and marginal ones. The umbilical tubercles are big, rounded knobs, exactly as in the Alpine type-specimen from Esino.

An identification of these fragments with *Protrachyceras Ralphuanum* v. Mojsisovics (Himálayan Foss., Vol. III, Pt. 1, p. 89, Pl. XVII, fig. 6), from Griesbach's "horizon of *Ammonites Aon*" in the Lissar valley, is not possible. E. v. Mojsisovics noticed the considerable resemblance of his Indian species to *Protrachyceras longobardicum* in its shape and in the corresponding number of spiral tubercles. But those tubercles are coarser and of larger dimensions than in *Protrachyceras longobardicum*. To the strongly developed sculpture of *Protrachyceras Ralphuanum* the delicate ribs and spines of my examples are in striking contrast.

To these three fragments of large dimensions, a small specimen from the Daonella shales W. of Lilang (Pl. I, fig. 6) must be added. It agrees in its size with the small types of *Protrachyceras ladinum*, but is distinguished from them by the greater number of spiral rows of spines. Seven rows of spines are counted corresponding to a height of the volution of 12 mm. only. This specimen recalls especially the Hungarian type from the Bakony, illustrated by Frech.

PROTRACHYCERAS sp. ind. cf. REGOLEDANUM Mojs. Pl. I, fig. 7.

An imperfect fragment of the outer volution of a small Ammonite has a great similarity with *Protrachyceras regoledanum* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 132, Taf. XXIX, figs. 6-8). It certainly belongs to the group of *Trachycerata falcosa*. Its lateral ornamentation consists of very numerous and delicate ribs, having a distinct falciform bend as in *Harpoceras*. Bifurcations of those ribs in the marginal region occur but exceptionally. Along the median furrow the ribs terminate in delicate external tubercles, which are elongated transversely.

Although there exists a close relationship between this species and the Alpine group of *Trachycerata falcosa*, the incomplete state of preservation of the only type-specimen available to me does not permit a specific identification.

Dimensions.—Not measurable.

Sutures.—Not known.

Locality and geological position.—Daonella shales, N. of Po.

PROTRACHYCERAS nov. sp. ind. Pl. II, fig. 6.

This interesting species is, unfortunately, represented by a single, incomplete specimen from the Daonella shales W. of Lilang, whose preservation is not favourable for investigation. On the label accompanying this specimen it has been designated by A. v. Krafft as *Trachyceras aff. margaritosum* v. Mojs.

With *Protrachyceras margaritosum* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. p. 127, Taf. LXXXII, fig. 1) it agrees in its involution, cross-section, and in the number of spiral rows of spines (7). The most prominent

character in the Alpine species is the regular alternation of stout ribs with umbilical spines and delicate ribs without tubercles. In the present specimen ribs without and with umbilical spines are also noticed, but they neither alternate regularly nor do they differ in strength. All the ribs are sharp and comparatively high and narrow. The ribs provided with umbilical spines, as a rule, dichotomise along the umbilical edge, and eventually also in the middle of the flanks. The ribs without umbilical spines are either undivided or bifurcating in the middle of the lateral parts.

In the character of the spines there is a remarkable difference between this species and *Protrachyceras margaritosum*. The spines are very delicate, projecting barely beyond the narrow ribs, whereas they are broad and stout in *P. margaritosum*. To me the connection between the two species seems therefore to be rather distant only.

Dimensions.—Not measurable.

Sutures.—Of these only the siphonal saddle and principal lateral lobe are visible. The lobe is strongly serrated, the saddle broad, with an entire top and margins faintly incised.

ANOLCITES cf. LACZKÓI Diener. Pl. I, fig. 8.

1899. *Anolcites Laczkói* Diener, Mitteilungen ueber einige Cephalopodensuiten aus der Trias des suedlichen Bakony. Palaeontol. Anhang zum I. Teil des I. Bandes der Resultate der wissenschaftl. Erforschg. des Balatonsees, p. 13, Taf. I, fig. 7.

1903. *Trachyceras Laczkói* Frech, Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des suedlichen Bakony, ibid, p. 29, Taf. VI, fig. 4.

The only specimen from the Daonella shales W. of Lilang is so closely related to the Hungarian species from the Wengen limestone of the Bakony, that I should have ventured on a direct identification, had not the difference in size and its fragmentary character necessitated some reserve.

The specimen is provided with slowly increasing, strongly inflated whorls, which overlap one another very slightly only, leaving a wide umbilicus open. The cross-section is thicker than high. The lateral parts pass gradually into the broadly rounded siphonal part, but are separated sharply from the perpendicular umbilical wall by a distinctly marked edge.

The lateral parts are covered with numerous and coarse ribs, which are turned anteriorly in the marginal region. They originate in faintly marked umbilical tubercles and terminate in external tubercles along the median furrow. The external tubercles are but indistinctly marked. Otherwise no traces of spines or tubercles have been noticed.

The median furrow is shallow, but not bridged over by any transverse elements of sculpture connecting the external tubercles. The majority of external tubercles stand exactly opposite each other, but some of them do not correspond on either side of the median furrow. The absence of any transverse bridges crossing the siphonal furrow between two external tubercles is not surprising, considering the

small dimensions of the example. Even in the large type-specimen of *Anolcites Laczkói* from Vamos such bridges make their appearance only exceptionally, and in the vicinity of the aperture.

Both the strongly inflated character of the whorls and the coarse sculpture are a feature of distinction between this specimen and *Anolcites Richthofeni* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. p. 105, Taf. XXIII, figs. 4, 5, Taf. XXXVII, fig. 5).

Dimensions.

Diameter of the shell	43 mm.
" " " umbilicus	14.5 "
Height of the last volution	15 "
Thickness " " "	17 "

Sutures.—Not known.

Remarks.—Frech unites the species from Monte Clapsavon (Italian Alps) illustrated by Tommasi (Fauna dei calcari rossi e grigi del Mte. Clapsavon, Palæontographia Italica, Vol. V, p. 23, Tav. III, fig. 3), and identified with *Anolcites Richthofeni* by that author, with *A. Laczkói* on account of its coarse sculpture. This determination, although probably correct, must remain uncertain, since Tommasi's type-specimen is too poorly preserved to permit a complete identification.

Anolcites Arminiae v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 694, Taf. cc., fig. 3) is provided with a stronger ornamentation, more rapidly increasing volutions, which overlap one another considerably, and with a smaller umbilicus.

B. TROPITOIDEA.

STYRITES (?) LILANGENSIS nov. sp. Pl. VI, fig. 12.

It is difficult to assign to this little shell its systematic position among the genera of triassic Ammonites hitherto described. In its general shape it strongly recalls some species of *Lobites*, especially so by the peculiar involution which leaves the normal spiral in the last whorl.

At first therefore I considered the specimen to be a representative of the genus *Lobites*, but afterwards was convinced of having made a mistake on examination of its sutural line, which I found to be very simple, goniatitic, and entirely different from the sutures of *Lobites*. To this feature of distinction another character has been added, namely, the presence of a body-chamber shorter than the last volution, whereas *Lobites* belongs to the *Leiostraca macrodoma*.

Among triassic genera with goniatitic sutures there are but very few which might put in a claim for the accommodation of the present specimen. Neither

Lecanites Mojs. nor *Nannites* Mojs. are provided with acute external parts. There are only *Styrites* Mojs. and *Badiotites* v. Mojsisovics (Verhandl. K. K. Geol. Reichsanst., 1879, p. 142), with which the present species has this character in common.

Badiotites Eryx Münst., from St. Cassian, the only representative of the genus *Badiotites* hitherto known, agrees with my Himálayan species in its size and in the presence of a sharpened siphonal part confined to the vicinity of the aperture. In the examples from St. Cassian this latter character is much more remarkable than in the illustrations given by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. Taf. XXVIII, figs. 19-31, LXXXI, fig. 7). There is also a fair agreement in the arrangement of the sutural line.

On the other hand the present species and *Badiotites Eryx* are distinguished by some features of such considerable importance that the advisability of their amalgamation in one genus is extremely doubtful. *Badiotites Eryx* is provided with numerous falciform ribs recalling the ornamentation in Jurassic *Harporeratidae*, and has a normal involution. In our Himálayan species the whorls are perfectly smooth and agree with *Lobites* in their involution. The umbilical suture of the last whorl deviates very considerably from the normal spiral, thus causing the umbilicus to expand rather rapidly.

The expanding mouth-margin has not been completely preserved, but there can be no doubt that it did nearly coincide with the aperture of my specimen. The body-chamber must therefore have occupied exactly three-quarters of the last volution.

The genus to which the present species appears to be most nearly allied is *Styrites* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 264).

The group of *Styrites acuti* is also provided with a comparatively short body-chamber, occupying three-quarters of the last volution only. An expanding umbilicus, it is true, is rather rare in this group, but has been observed by E. v. Mojsisovics in *Styrites Hackeli* (l. c. Taf. CXX, figs. 37-39). This character is much more strongly developed in the group of *Styrites tropitiiformes*, but from this group our species is at once distinguished by the absence of a high siphonal keel. In my species the acute shape of the siphonal part is restricted to the anterior portion of the body-chamber. This is a feature which isolates it altogether among the congeneric forms of *Styrites*, which are nearly all provided with sharp siphonal crests, even in early stages of growth. There is but one species, *Styrites Caroli* v. Mojsisovics (l. c. p. 275, Taf. CXXI, figs. 15-17), which is not distinguished by the development of a proper external keel. But in this species the acute siphonal part becomes gradually rounded in old age, whereas it is sharp at early stages of growth. This is just the reverse of what is seen in *Styrites lilangensis*, in which the acute siphonal part is acquired at very late stages of growth only.

It is therefore with some reserve that I propose to include my Himálayan species in the genus *Styrites*, with which it is probably most nearly related.

Dimensions.

Diameter of the shell	11.5 mm.
Diameter of the { at the beginning of the last volution .	1 "
umbilicus { " " end " " " "	3.5 "
Height of the last volution	4.5 "
Thickness " "	4 "

Sutures.—Goniatic. Siphonal lobe divided by a rounded median prominence, each of its two wings terminating in a single sharp point. The rounded lateral lobe less deep than the siphonal lobe. The lateral saddle is followed by a small umbilical lobe and saddle.

Locality and geological position.—*Daonella limestone*, W. of Lilang.

CELTITES TRIGONALIS nov. sp. Pl. VI, fig. 11.

This is a species of *Celtites* with a nearly smooth shell and with very remarkable outlines. The outer volution exhibits three blunt geniculations, causing a deviation from the normal spiral of the tube. These geniculations, however, are not restricted to the outer volution, but are repeated in the preceding whorl. It is only the volution preceding the penultimate one which is normally encoiled. Thus the outlines of the shell are nearly triangular, with bluntly rounded-off angles.

Apart from this strange character of the outlines, our Himálayan species is a typical representative of the genus *Celtites*, in which the ornamentation is but very faintly developed. My only specimen has numerous and slowly increasing whorls, enveloping one another along the flattened siphonal area only, a very low and almost quadrangular cross-section, a body-chamber measuring $1\frac{1}{2}$ volutions, and goniatic sutures which are very distant from each other.

The ornamentation is very delicate and marked in the vicinity of the aperture only. It consists of parabolic ears, which are connected by ribs crossing the siphonal area. But it is not possible to include our species in the subgenus *Cycloceltites* (group of *Celtites annulati*), neither lateral ribs nor paulostome furrows being developed.

Dimensions.

Diameter of the shell	15 mm.
" " " umbilicus	7 "
Height of the last volution	4 "
Thickness " "	5.5 "

Sutures.—I have succeeded in examining the sutural line of the penultimate whorl by splitting off carefully a portion of the last volution.

Sutures standing widely apart, very simple, goniatic. A rounded siphonal lobe is divided by a low median prominence. Its two wings are not pointed. Siphonal saddle broadly rounded. One single lateral lobe and saddle outside the umbilical suture, which divides a small umbilical lobe.

Locality and geological position.—*Daonella limestone*, W. of Lilang.

CELTITES PERAURITUS nov. sp. Pl. VI, fig. 13.

In a small species of *Celtites* the characters of the two groups of *acuteplicati* and *annulati* have been found united. This species differs from all congeneric Alpine forms by an abnormal development of paulostome ribs, which are elevated into high transverse crests crossing the siphonal area without any interruption.

In the penultimate whorl several indistinct paulostome ribs and furrows are noticed, but are not accessible to a thorough examination, their external features being concealed by the last volution. At the beginning of the last volution three paulostome ribs are developed in a very remarkable way. They form sharp transverse ridges which are elevated very considerably above the general convexity of the shell. The first of these ribs coincides exactly with the anterior end of the penultimate whorl. Between this and the next paulostome rib the regular sculpture is entirely absent, the shell remaining completely smooth. The paulostome rib is elevated so strongly in front of the aperture of the last volution, that the lumen of the latter is reduced to a narrow, crescent-shaped slit. The third paulostome rib is less strongly marked. The anterior half of the last whorl is free from paulostome ribs and furrows, and adorned with straight lateral ribs. These ribs are interrupted along the median line of the siphonal area by a narrow, smooth zone, not united as in the subgenus *Cycloceltites* (group of *Celtites annulati*). Thus our species combines the strong development of paulostome ribs peculiar to *Cycloceltites*, with the lateral ornamentation of the group of *Celtites acuteplicati*, which is distinguished by ribs that do not cross the siphonal area.

I need scarcely say that the abnormal development of paulostome ribs, exceeding anything of this kind in Alpine forms of the genus *Celtites*, imparts to our species the character of an isolated form.

Dimensions.

Diameter of the shell		. 13.5 mm.
" " " umbilicus		. 6 "
Height of the last volution		. 4 "
Thickness " "		. 5 "
Height of the penultimate whorl	{ along the crest of a paulostome rib between two paulostome ribs .	. 4 " . 1.5 "

Sutures.—The entire last volution and one-quarter of the penultimate whorl are occupied by the body-chamber. Sutures agreeing with those of the preceding species.

Locality and geological position.—*Daonella limestone*, W. of Lilang.

THANAMITES nov. gen.

This new genus is proposed for the accommodation of a small species, which is rather richly represented in the ladinic stage of Spiti. It is of globose shape.

provided with a very narrow umbilicus and with simple sutures. The leading features of the new genus are obvious from the following description.

THANAMITES BICUSPIDATUS nov. sp. Pl. V, figs. 4, 5.

In its general shape this form reminds one of a small *Arcestes* or, among *Tropitoidea*, of *Didymites* or of a species of *Isculites*, in which the umbilical suture of the last volution has not yet left the normal spiral.

The shell is of globose shape and provided with whorls which widely embrace one another and possess rounded sides which gradually merge into the well-inflated siphonal part. The umbilicus is very small but open and not closed by a callosity. The cross-section is either of equal height and thickness, or somewhat broader than high.

The surface is entirely smooth. There is no furrow or varix either in the body-chamber or in the inner nuclei. The species is longidome and provided with a body-chamber occupying at least one entire volution.

Dimensions.

Diameter of the shell	.	.	18 mm.
" " " umbilicus	.	.	0.5 "
Height of the { above the umbilical suture	.	.	9 "
last volution { " " preceding whorl	.	.	3 "
Thickness of the last volution	.	.	9.5 "

Sutures.—The most interesting character of this species is its sutural line, which is very simple. There is only one lateral lobe present. This lobe is very deep and bicuspidate, terminating in two sharp points, which are separated by a median indentation. Siphonal lobe bifid, with a median prominence, each wing terminating in a single, short point. Saddles with parallel margins and broadly rounded tops. A small umbilical lobe and saddle outside the umbilical suture.

Locality and geological position.—Not rare in the topmost beds of the Muschelkalk near Kágá, and in the Daonella shales of the Thanam valley, Bashahr.

Remarks.—The character of the sutural line marks this species as a representative of the section of *Ammonia trachyostraca*, notwithstanding its external resemblance to *Arcestoidea*. In this respect it holds a position similar to that of *Didymites*, which must also be classed among the *Tropitoidea*, although its external shape seems to point to a relationship with *Arcestoidea*.

The diagnosis of the genus *Thanamites* is as follows: Smooth, *Arcestes*-like shells of globose shape, without varices or labiæ, and with a long body-chamber. Sutures very simple, not containing the normal number of principal lobes. Lateral lobe bicuspidate.

There is no other triassic genus of *Tropitoidea* which could be considered a descendant of *Thanamites*.

THANAMITES BANNENSIS nov. sp. Pl. V, fig. 6.

This species is distinguished from *Thanamites bicuspidatus* by its more slowly increasing whorls and by its more globose shape. The transverse section is more than twice as broad as high. The last volution is but very little elevated above the convexity of the penultimate whorl.

My only specimen available for examination is entirely chambered. Full-grown specimens probably exceeded the preceding species in size.

Dimensions.

Diameter of the shell	.	.	.	13	mm.
" " " umbilicus	.	.	.	1.5	"
Height of the	{	above the umbilical suture		7	"
last volution	{	" " preceding whorl		2	"
Thickness of the last volution	.			15	"

Sutures.—Agreeing in general with those of the preceding species. Siphonal lobe as deep as the bicuspidate lateral lobe and divided by a high median prominence. The umbilical lobe is followed by a small saddle, which is divided by the umbilical suture.

Locality and geological position.—Topmost beds of upper Muschelkalk, Banna encamping ground, Thanam valley, Bashahr.

C. PINACOCERATITOIDEA.

RIMKINITES NITIENSIS v. Mojsisovics. Pl. IV, figs. 8, 9, 10.

1896. *Hungarites Nitiensis* E. v. Mojsisovics, Obertriadische Cephalopodenfaunen des Himalaya, Denkschr. Kais. Akad. d. Wissensch. math. nat. Cl. Bd. LXIII, p. 869, fig. 1, non 2, 3.
 1899. *Hungarites Nitiensis* E. v. Mojsisovics, Himál. Foss. Palæont. Ind. ser. XV, Vol. III, Pt. 1, p. 116, fig. 1, non 2, 3.
 1900. *Hungarites nov. sp.* A. v. Krafft, General Report, Geol. Surv. of India, 1899-1900, p. 310.
 1902. *Rimkinites* E. v. Mojsisovics, Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst. VI-1, Supplement p. 311.

In *Rimkinites Nitiensis* two species were united by E. v. Mojsisovics. The name was first assigned to a small Ammonite from the Traumatocrinus limestone of the Shalshal cliff, distinguished by a median keel and accompanying keel-furrows, faint falciform folds and brachyphyllic sutures. With this species he also identified a second form, which Salter had originally identified with *Carnites floridus* Wulf. The lateral sculpture of this form consists of radiating folds, terminating in marginal tubercles along the external edges of the keel-furrow.

My examination of the materials from Spiti has convinced me that the two forms united by E. v. Mojsisovics are specifically different. In fig. 9 a specimen has been illustrated agreeing perfectly with the small Ammonite from the Shalshal cliff,

and provided with numerous and closely-set falciform ribs. This character of ornamentation is retained in full-grown examples (fig. 8), which differ very remarkably from Salter's *Ammonites floridus*, but are connected with the type of *Rimkinites Nitiensis* by a large number of transitional shapes.

According to the rules of palæontological nomenclature, that specimen must be considered the type of *Rimkinites Nitiensis* which has been described first under that specific name. That name must therefore be retained for the Ammonite from the Traumatocrinus limestone of the Shalshal cliff.

Full-grown specimens of this species (fig. 8) have been described by A. v. Krafft as *Hungarites nov. sp.*, having transverse folds of a most "distinct falciform bend as in *Harpoceras*, but bearing no resemblance to any of the Alpine species." They are slender, high-mouthed, provided with very widely embracing whorls and narrow umbilici. The sides are curved very flatly and regularly. The siphonal area is narrow and has three elevated and sharp edges. The central keel scarcely exceeds in height the marginal ones, which are bordered by deep, rounded keel-furrows. In the casts the keels appear considerably shorter and less sharply defined.

The ornamentation consists of very numerous, falciform ribs, directly imbricating in their crescent-shaped portions.

Dimensions.

Diameter of the shell	42 mm.
" " umbilicus	3 "
Height of the { above the umbilical suture	23 "
last volution . { " " preceding whorl	16 "
Thickness of the last volution	9 "

The species attains considerable dimensions. In some fragments of outer volutions a height of 36 mm. has been noticed. Consequently the diameter could scarcely have been less than 60 mm.

Sutures.—Agreeing exactly with those of the type-specimen from the Shalshal cliff, as illustrated by E. v. Mojsisovics. Saddles brachyphyllic. Siphonal lobe short, with a high and pyramid-shaped median prominence. Two lateral and two auxiliary lobes.

Locality and geological position.—(a) *Topmost beds of upper Muschelkalk*: Kágá; S.-E. of Muth; Banna encamping ground, Thanam valley, Bashahr.

(b) *Daonella shales*: S.-E. of Muth, W. of Lilang; Thanam valley, Bashahr.

(c) *Daonella limestone*: W. of Lilang.

Remarks.—This species, which was originally united with the genus *Hungarites* by E. v. Mojsisovics, has been elevated to the rank of a proper genus, *Rimkinites*, by this author in 1902. I consider this generic separation fully justified. My opinion is that *Rimkinites* does in fact stand neither in close relation with *Hungarites* nor with *Carnites*. From *Hungarites* it does differ not only in the brachyphyllic development of its sutures, but also in its external shape. The

siphonal part is not roof-shaped as in *Hungarites* but truncated. In *Hungarites* the marginal edges never do assume the character of proper keels as in *Rimkinites*. The tricarinate character of the truncated siphonal part is, indeed, a feature of generic distinction between *Hungarites* and *Rimkinites*.

In its ontogeny *Rimkinites* recalls *Carnites*, but in later stages of growth the two genera follow very different lines of development. In *Rimkinites* the tricarinate character of the siphonal area remains unchanged during all stages of growth and there is no adventitious element developed in the sutural line as in *Carnites*. From the ontogeny of *Rimkinites* and *Carnites* it might, however, be suggested that both genera were derived from a common root.

RIMKINITES EDMONDII nov. nom. Pl. VI. figs. 2, 3.

1865. *Ammonites floridus* Salter, Palæontology of Niti, p. 60, Pl. 8, fig. 1, non 2, 3. Pl. 6, fig. 1.

1896. *Hungarites Nitiensis* v. Mojsisovics *ex parte*, Denkschr. Kais. Akad. d. Wiss. LXIII, Bd. p. 669, figs. 2, 3.

1899. *Hungarites Nitiensis* v. Mojsisovics *ex parte*, Himálayan Foss., Pal. Ind., ser. XV, Vol. III, Pt. 1, p. 118, figs. 2, 3, non 1.

Two different species having been united in *Rimkinites Nitiensis* by E. v. Mojsisovics, and this name, according to the rules of palæontological nomenclature, having been restricted to the Ammonite from the Traumatocrinus limestone of the Shalshal cliff, I give the name of *Rimkinites Edmondii* to Salter's so-called *Ammonites floridus*.

The illustration of the smaller specimen in fig. 3 clearly shows the difference in sculpture between equal-sized specimens of *Rimkinites Edmondii* and *R. Nitiensis* in their early stages of growth. In the first no delicate and closely-set falciform ribs are seen, but there are a small number of circumplicate folds radiating from the umbilical margin. Whereas in *R. Nitiensis* the ribs are most distinctly developed in their crescent-shaped upper portions, they are obscured completely in the upper portion of the sides of *R. Edmondii*. Marginal tubercles are developed in later stages of growth only. In my larger specimen (fig. 2) they are faintly indicated in the vicinity of the aperture, but are entirely absent near the beginning of the last volution.

Dimensions.

Diameter of the shell	.	.	.	.	.	22.5 mm.
" " umbilicus	.	.	.	.	.	3 "
Height of the	{	above the umbilical suture	.	.	.	12 "
last volution	{	" " preceding whorl	.	.	.	8 "
Thickness of the last volution	.	.	.	.	.	7 "

Sutures.—As far as accessible to examination, agreeing with those of *Rimkinites Nitiensis*. A third auxiliary lobe is divided by the umbilical suture.

Locality and geological position.—(a) *Topmost beds of upper Muschelknirk*: Banna encamping ground, Thanam valley, Bashahr.

(b) *Daonella shales*: Thanam valley, Bashahr.

STURIA sp. ind. Pl. VI, fig. 4.

Two fragments of disciform shells with a spiral sculpture have been referred provisionally to *Sturia Sansovinii* Mojs. by A. v. Krafft.

The fragment less seriously injured has been illustrated in fig. 4. It is the inner nucleus of a large cast whose surface has been destroyed completely by weathering. But the sutures are exhibited in rough outlines, showing pyramid-shaped saddles and deep, ramified lobes. From the character of the sutural line it is evident that the fragment must, indeed, belong to the genus *Sturia* Mojs., not to *Procladiscites*, which is also provided with a spiral ornamentation.

A specific determination is, of course, impossible. Representatives of the group of *Sturia Sansovinii* range from the Muschelkalk (zone of *Ceratites trinodosus*) into the julic substage (zone of *Trachyceras Aonoides*). They cannot be distinguished from *Sturia forojuliensis* or from *Sturia semiarata*, in any but full-grown and perfectly preserved examples.

Locality and geological position.—(a) *Topmost beds of upper Muschelkalk*: S.-E. of Muth.

(b) *Daonella shales*: N. of Po.

GYMNITES CALOSOMA nov. sp. Pl. VI, fig. 5.

1900. *Gymnites Ecki* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, 1899-1900, p. 212.

The specimen representing this species in the Himálayan collection has been identified with *Gymnites Ecki* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst. X, p. 238, Taf. LX, fig. 3) by A. v. Krafft. He asserts the specific identity to be indisputable, although the sutures could not be compared in detail with those of European examples.

There is, indeed, a very strong resemblance between the present specimen and the type of *Gymnites Ecki*, both in size, general outline, involution, and sculpture; but nevertheless their specific identity cannot be established. E. v. Mojsisovics especially mentions the presence of a steep umbilical wall as one of the leading features in *G. Ecki*, by which it is distinguished from *G. Breunneri* v. Hauer from the carnic Hallstatt limestone of Aussee. Now the Himálayan specimen is provided with lateral parts, which slope from the place of strongest convexity to the umbilical suture, in a flat and very regular curve without any intervention of an umbilical margin. Thus our specimen agrees in this character with *Gymnites Breunneri*, not with *G. Ecki*.

No adequate description nor figure of *Gymnites Breunneri* was known to A. v. Krafft at the time when his report was written. It was only in 1902 that an excellent illustration of the species was published by E. v. Mojsisovics in his supplement to the first part of the monograph of Hallstatt Cephalopoda (Taf. XXII

fig. 1). From this illustration it is evident that our Himálayan specimen stands in a still closer relationship to *Gymnites Breunneri* than to *G. Ecki*. There are some insignificant differences noticed between them. My Indian specimen has a slightly narrower umbilicus, a more slender cross section with the siphonal area acutely rounded, and the spiral row of lateral tubercles is situated a little below the middle of the height of the flanks. But, notwithstanding all these differences of very small importance, I should scarcely have separated the Himálayan species from *Gymnites Breunneri*, had not differences in the character of the sutural line demanded this separation.

Dimensions.

Diameter of the shell	74 mm.
" " " umbilicus	27 "
Height of the { above the umbilical suture	28 "
last volution { " " preceding whorl	18 "
Thickness of the last volution	11 "

Sutures.—As in *Gymnites Breunneri*, the sutural line is less complicated than in many species of *Gymnites* from the Himálayan Muschelkalk. In the details of the sutural line remarkable differences are noticed between the two species. In *G. Breunneri* the three main saddles are of nearly equal height. This is not the case in *G. calosoma*, which has the second lateral saddle developed normally. In *G. Breunneri* the second lateral saddle is richly ramified, with a tripartite arrangement of secondary branches. In *G. calosoma* it is simple, agreeing in its shape with the principal lateral saddle. The siphonal and principal lateral lobes are of equal depth. The two lateral lobes terminate in a median point, whereas in *G. Breunneri* they terminate in two diverging points, separated by a median denticulation.

Locality and geological position.—*Daonella shales*, N. of Po.

Remarks.—The species from the Wengen limestone of the Bakony described as *Gymnites Breunneri* var. *baconica* by Frech (Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des suedlichen Bakony, Palæont. Anhang zum. I. Th. des I. Bandes der Resultate der Wissenschaftlichen Erforschung des Balatonsees, p. 34, Taf. VII, fig. 2) is certainly not identical with F. v. Hauer's species. It is more evolute, the siphonal row of lateral tubercles is situated below the middle of the flanks, and the sutural line differs remarkably, especially so in the shape of the second lateral saddle.

GYMNITES nov. sp. ind.

A fragment of *Gymnites* from the *Daonella shales* N. of Po is too badly preserved to be worthy of a specific determination. Its imperfect state of preservation makes it impossible to give a satisfactory illustration.

The species is involute, recalling in its shape *Gymnites Credneri* or *G. Moelleri* among ladinic and *G. Arthaberi* among carnic types of the genus. The umbilicus is very narrow, its diameter of 10 mm. corresponding to a diameter of the shell of

87 mm. and to a height of the last volution of 47 mm. The specimen has been so strongly deformed by pressure in the rocks that a reconstruction of its transverse section is impossible. On the lateral parts a row of elongated tubercles, drawn-out spirally, appears along a line which divides the sides in the middle. Short radiating ribs are indistinctly developed in the lower portion of the flanks.

Sutures.—Not known.

PINACOCERAS sp. ind. aff. DAMESI Mojs. Pl. VI, fig. 6.

A specimen of *Pinacoceras* of moderate size is before me, which is comparable to *P. Damesi* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 193, Taf. LII, fig. 9). It agrees with this species in the presence of very flat, slowly increasing whorls, which embrace one another to the extent of half their height. The sutures are known to me in rough outlines only. The adventitious elements are arranged along a line sloping very steeply towards the siphonal edge, much more so than in *Pinacoceras Damesi*.

As a specific determination of the representatives of this group in the ladinic and carnic stages of the Alpine Trias is not possible without a thorough knowledge of the sutural line, I must be satisfied with signaling the presence of a species in the Daonella shales of Spiti having a close relationship with *Pinacoceras Damesi* Mojs.

Dimensions.

Diameter of the shell	:	57 mm.
" " umbilicus	.	16 "
Height of the last volution	{ above the umbilical suture	23 "
	{ " " preceding whorl	16 "
Thickness of the last volution	.	4.5 "

Locality and geological position.—*Daonella shales*, N. of Po.

PTYCHITES GERARDI Blfd. Pl. IV, fig. 11; Pl. VI, figs. 8, 9, 10.

1863. *Ammonites Gerardi* Blanford, Journal, Asiatic Soc. of Bengal, Vol. XXII, p. 132, Pl. II, fig. 6.
 1895. *Ptychites Gerardi* Diener, Himál. Foss. Palæontologia Ind., ser. XV, Vol. II, Pt. 2, Cephalopoda of the Muschelkalk, p. 74, Pl. XVIII, figs. 1-3, Pl. XXV, fig. 3.
 1896. *Ptychites posthumus* E. v. Mojsisovics, Obertriadische Cephalopoden faunen des Himálaya, Denkschr. Kais. Akad. d. Wiss. LXIII, p. 669, Taf. XIX, fig. 8, (non 9?).
 1899. *Ptychites posthumus* E. v. Mojsisovics, Himálayan Foss. l. c. Vol. III, Pt. 1, p. 117, Pl. XIX, fig. 8, (non 9?).
 1900. *Ptychites Gerardi* A. v. Kraft, General Report, Geol. Surv. of India, 1899-1900, p. 209.

The presence of the well-known leading fossil of the Indian Muschelkalk, *Ptychites Gerardi* Blfd., in the ladinic stage of Spiti has been signaled by A. v. Kraft. I have found his determination to be entirely correct.

A large specimen from the Daonella shales N. of Po, illustrated on Pl. IV, fig. 11, agrees in all its characters with the typical form of *Ptychites Gerardi*, as illustrated on Pl. XVIII, fig. 2, of my above-quoted memoir. It has the peculiar

shape of the cross-section designated as "trigona" by Blanford, very flatly curved lateral parts, a stair-like umbilicus within which the inner whorls are partly exposed, and a very delicate sculpture consisting of indistinct radiating folds only. My specimen being a cast entirely devoid of its test, the delicate ornamentation of the shell, as illustrated on Pl. XVIII, fig. 1, could not be observed.

The sutural lines of this specimen and of an equally-sized example (Pl. VI, fig. 10) agree with the sutures of the typical form of *Ptychites Gerardi*, not only in the semi-circular arrangement, but even in the minor details. The identity of the species from the Daonella shales of Spiti, and from the Muschelkalk of Painkhánda and Spiti cannot therefore be doubted.

The species attains very considerable dimensions, larger even than were hitherto known to me in examples from the Indian Muschelkalk. The specimen from which the sutural line has been figured on Pl. VI, fig. 10, is the inner nucleus of a full-grown shell measuring nearly 130 mm. in diameter.

The measurements of the specimen illustrated on Pl. IV, fig. 11, are as follows :—

Diameter of the shell	.	.	.	.	.	.	.	104	mm.
" " umbilicus	.	.	.	.	.	.	.	21	"
Height of the	{	above the umbilical suture	.	.	.	.	.	45	"
last volution	{	" " preceding whorl	.	.	.	.	.	17	"
Thickness of the last volution	.	.	.	.	.	.	.	46	"

Besides these large-sized specimens representing the typical form of *Ptychites Gerardi* in the ladinic stage of Spiti, several small examples of *Ptychites* have been collected in the topmost beds of the Muschelkalk and in the Daonella shales by A. v. Krafft. The latter are of a more globose shape and provided with a broadly rounded siphonal part. Their sutural line exhibits the semi-circular arrangement peculiar to *Ptychites Gerardi*, thus differing remarkably from the sutures of the group of *Pt. rugiferi*. By laying bare the inner whorls of a typical *Ptychites Gerardi* I was able to convince myself of their absolute identity with the small specimens of *Ptychites* from the ladinic beds of Spiti.

It has been suggested by A. v. Krafft that the species described as *Ptychites posthumus* by E. v. Mojsisovics has been based on small examples of *Ptychites Gerardi*. A. v. Krafft, who re-examined the type-specimen of *Pt. posthumus* from the black limestone facing the Ralphu glacier in the Lissar valley, states the agreement of its sutural line with that of *Pt. Gerardi*. It is, indeed, most probable that the smaller specimen illustrated in fig. 8 by E. v. Mojsisovics is identical with *Pt. Gerardi*. An identification of the second specimen (fig. 9) is less certain. This specimen is provided with its body-chamber, and shows a remarkable geniculation separating the last air-chamber from the body-chamber.

Ptychites Gerardi does not belong to a group of Ammonites with abnormal body-chambers. If the geniculation of the last whorl in the specimen from the Lissar valley could be proved to be no accidental deformity, I shall be disposed to consider it as a character of specific value. In this case *Pt. posthumus* might be retained as an independent dwarf-species, characterised by an abnormal

body-chamber, as it is often found in phyla of Ammonites, which have passed their acmatic stage.

Locality and geological position.—(a) *Topmost beds of upper Muschelkalk*: Kágá; S.-E. of Muth; Banna encamping ground, Thanam valley, Bashahr.

(b) *Daonella shales*: N. of Po.

MONOPHYLLITES *cf.* WENGENSIS v. Klipstein. Pl. VI, fig. 7.

1846. *Monophyllites Wengensis* A. v. Klipstein, Beitræge zur geologischen Kenntniss der oestlichen Alpen, Bd. I, p. 120, Taf. VI, fig. 11.
1870. *Phylloceras Boeckhi* E. v. Mojsisovics, Jahrb. K. K. Geol. Reichsanst. p. 110, Taf. V, fig. 7.
1873. *Phylloceras Boeckhi* Boeckh, Die geologischen Verhaeltnisse des suedlichen Teiles des Bakony, Mitteilungen aus dem Jahrb. d. kgl. Ungar. Geol. Anst. II, p. 171, Taf. X, figs. 18, 19.
1873. *Lytoceras Wengense* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst. VI-1, p. 72, Taf. XVII, figs. 7-9.
1882. *Monophyllites Wengensis* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 207, Taf. LXXXVIII, figs. 10-12.
1894. *Monophyllites sphaerophyllus* (Haner) = *M. Wengensis* Kittl. Jahrb. K. K. Geol. Reichsanst., p. 104.
1899. *Monophyllites Wengensis* Diener, Mitteilungen ueber einige Cephalopodensuiten aus der Trias des Bakony, Palæontol. Anhang zum I. Teil des I. Bd. der Resultate der Wissenschaftl. Erforschung des Balatonsees, p. 14.
1899. *Monophyllites Wengensis* Tommasi La fauna dei calcari rossi e grigi del Mte. Clapsavon nella Carnia orientale, Palæont. Ital. V, p. 33.
1903. *Monophyllites Wengensis* Frech, Neue Cephalopoden aus den Buchensteiner, Wengener und Raibler Schichten des suedl. Bakony, l. c. p. 37.

A fragment of *Monophyllites* of large size is provided with a sutural line agreeing with that of *M. Wengensis*. It is a cast entirely devoid of its shelly substance. No trace of the radiating ornamentation characteristic of the group of *M. sphaerophyllus* has been noticed. The cross-section is cordiform, with the greatest transverse diameter corresponding to the rounded umbilical margin.

The character of the sutural line is in favour of an identification with *Monophyllites Wengensis*, but some reserve is indispensable on account of the fragmentary state of preservation of the only specimen available for examination.

Locality and geological position.—*Daonella limestone*, W. of Lilang.

MEGAPHYLLITES JARBAS, Münst. Pl. V, fig. 1.

1841. *Ceratites Jarbas* Muenster, Beitræge zur Geognosie und Petrefaktenkunde des nordoestlichen Tirols., p. 136, Taf. XV, fig. 25.
1861. *Phylloceras Jarbas* Laube, Fauna der Schichten von St. Cassian, Denkscr. Kais. Akad. d. Wiss., XXX Bd., p. 85, Taf. XLI, fig. 12.
1873. *Pinacoceras cf. Jarbas* E. v. Mojsisovics, Das Gebirge von Hallstatt, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 47, Taf. XIX, figs. 9, 10, 16.
1882. *Megaphyllites Jarbas* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, ibid. X, p. 193, Taf. LIII, figs. 7, 8. A complete list of synonyms is found in this memoir.

This form agrees perfectly with the specimens of *Megaphyllites Jarbas* from St. Cassian both in the shape of the shell and in the details of the sutural line.

The flattened lateral parts do not admit of comparison with *Megaphyllites oenipontanus* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. p. 193, Taf. LIII, fig. 6) ; nor can the Himálayan specimen be attributed to *M. obolus* v. Mojsisovics (l. c. p. 192, Taf. LIII, figs. 3-5), on account of the different arrangement of its sutures. There remains only *M. sandalinus* v. Mojsisovics (l. c. p. 191, Taf. LIII, figs. 1, 2), which might put in a claim for closer comparison.

Megaphyllites Jarbas and *M. sandalinus* are very nearly allied, and even a distinction of typical examples of both species is no easy matter. Among the characters enumerated by E. v. Mojsisovics it is only the more flattened shape and the smaller size of the Muschelkalk species, *M. sandalinus*, which might be used as features of distinction. Without the type-specimen of *M. sandalinus* at hand for comparison, I should have been at a loss to find sufficient reason for a specific separation of the Indian specimen and *M. sandalinus*. But the more strongly flattened siphonal area in *M. sandalinus*, and the more distinctly defined marginal region are characters of difference in favour of separating my Himálayan specimen from the latter species and of its identification with *M. Jarbas*.

Dimensions.

Diameter of the shell	.	28 mm.
" " umbilicus	.	0 "
Height of the last	{ above the umbilical suture	16 "
volution	{ " " preceding whorl	10 "
Thickness of the last volution		1.05 "

Sutures.—Agreeing completely with those of *Megaphyllites Jarbas* and *M. sandalinus*. I cannot find any difference of specific importance in the character of the sutural lines of these two species.

Locality and geological position.—Topmost beds of Muschelkalk, Bina encamping ground, Thanam valley, Bashahr.

Remarks.—No stratigraphical importance can be attributed to the identification of my Himálayan form with *Megaphyllites Jarbas*, this type ranging in the Aine Trias from the Muschelkalk into the carnic stage, although older and younger representatives of the type have been designated with different names by J. v. Mojsisovics.

D. ARCESTOIDEA.

JOANNITES KOSSMATI nov. sp. Pl. V, fig. 7.

A species of *Joannites* from the Traumatocrinus limestone of the Shalshal cliff has been referred to *Joannites cymbiformis* Wulf. as cf. by E. v. Mojsisovics. It differs, according to the description (Himálayan Foss., Pal. Ind., ser. XY, Pl. III, Pt. 1, p. 101), from the typical *Joannites cymbiformis* by the absence of varices in specimens exceeding a height of the volution of 35 mm. Of the two specimens from the Shalshal cliff which chiefly served for description the smaller one (Pl. XX, fig. 3) has three varices on the cast in the circumference of the last whorl.

The larger specimen, the sutures of which have been figured on Pl. XX, fig. 4, does not show any varices at all, as has been remarked by A. v. Krafft (General Report, Geological Survey of India, for 1898-99, p. 213), who insists on a specific separation of the Himálayan *Joannites* from *J. cymbiformis*.

In A. v. Krafft's and Hayden's collections from Spiti numerous examples of *Joannites* have been noticed, which in their outlines agree very closely with the species from the Traumatocrinus-limestone of the Shalshal cliff. But they are distinguished from it by the presence of two varices only, which are noticed constantly in chambered casts of the most variable dimensions. In this character our Himálayan specimens agree perfectly with *Joannites Joannis Austriæ* v. Klipst., which invariably shows two varices in the circumference of a whorl in all stages of growth. They do indeed resemble the Alpine species from St. Cassian and Aussee so closely, that I should not have separated them, had not differences in the sutural line required it.

In the illustration on Pl. V, fig. 6, the typical shape of *Joannites Kossmati* is represented, with moderately globose volutions of nearly equal height and thickness. From this typical shape a small number of examples differ by more strongly inflated whorls. The deep furrows (varices) of the casts run in an almost straight line across the lateral parts, and cross the siphonal part with a small curvature only. In this respect they also agree with *Joannites Joannis Austriæ*, not with *J. cymbiformis*, in which the varices are curved forward more strongly.

All my specimens consist of air-chambers only. The largest individual present possesses a diameter of 80 mm.

Dimensions.

Diameter of the shell	.	.	.	.	67 mm.
" " umbilicus	.	.	.	.	5 "
Height of the last	{	above the umbilical suture			32.5 "
volution		" " preceding whorl			14 "
Thickness of the last volution	.	.	.	.	38 "

Sutures.—*Joannites Kossmati* has only six saddles outside the umbilical margin, whereas the number of saddles in *J. cymbiformis* and in *J. Joannis Austriæ* are eight or nine. This difference between my Indian specimens and *J. Joannis Austriæ* being a constant feature, the former cannot be identified with the latter.

In the character of the sutural line a distinction from *Joannites Joannis Austriæ* is shown in its slighter curvature, which is due to the very short length of the portion descending from the fifth saddle to the umbilical suture. In the details of ramification the saddles of the two species agree in a remarkable manner.

Locality and geological position.—(a) *Topmost beds of upper Muschelkalk*: Kágá.

(b) *Daonella shales*. W. of Lilang; N. of Po; N. above Thabo; Thanam valley, Bashahr.

(c) *Daonella limestone*: N. above Thabo, N.-W. of Muth.

Remarks.—A. v. Krafft in his stratigraphical notes on the mesozoic rocks of Spiti (General Report for 1899-1900, p. 214) remarks that species similar to *Joannites cymbiformis* occur already in the Muschelkalk. "At Kágá"—he says—"two small specimens were collected by Mr. Hayden in 1898, and mentioned in last year's annual report (p. 16) as *Joannites aff. diffusus* Hauer. But Prof. Diener, to whom they were sent for examination, determined them as probably *J. cymbiformis* Wulf."

The specimens mentioned by A. v. Krafft have been included in the present species, which, although nearly allied to *J. cymbiformis*, can be identified with this species as little as the congeneric form from the Traumatocrinus limestone of the Shalshal cliff.

A. v. Krafft was perfectly right in stating this species passes from the topmost beds of the Muschelkalk group through the entire ladinic stage.

JOANNITES *cf.* KLIPSTEINI Mojs. Pl. V, fig. 8.

1843. *Ammonites multilobatus* A. v. Klipstein, Beitrage zur geologischen Kenntniss der oestlichen Alpen, p. 129, Taf. IX, fig. 1.

1860. *Arcestes cymbiformis* Laube, *ex parte*, Fauna der Schichten von St. Cassian, Denkschr. Kais. Akad. d. Wiss., XXX Bd., p. 87, Taf. XLII, figs. a, c, d.

1875. *Arcestes Klipsteini* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 84, Taf. LXI, figs. 2, 3, LXII, figs. 2, 3.

1882. *Joannites Klipsteini* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, ibidem, X, p. 170.

A specimen of *Joannites* from the Daonella limestone W. of Lilang agrees very closely with *Joannites Klipsteini* Mojs.

It is strongly compressed and provided with flat lateral parts converging very gently and regularly from the umbilical margin towards the flattened siphonal area. In this respect my cast agrees exactly with the illustration given on Pl. XLII, fig. 3b, by E. v. Mojsisovics.

There are five varices in the circumference of the last volution of my specimen, which is entirely chambered. They are nearly straight, with a slightly falciform curvature, which is not equally well developed in every single furrow. Nor are the five varices arranged at equal distances. Three furrows are set rather closely to each other in the anterior half of the last whorl, as is the case in the two Alpine types, illustrated by E. v. Mojsisovics on Pl. LXI, figs. 2 and 3.

Dimensions.

Diameter of the shell	44 mm.
„ „ „ umbilicus	4 „
Height of the { above the umbilical suture	25 „
last volution { „ „ preceding whorl	9 „
Thickness of the last volution	205 „

Sutures.—Only known in rough outlines. As far as known, apparently agreeing with those in *Joannites Klipsteini* or in *J. Joannis Austriae*.

JOANNITES sp. ind. cf. TRIDENTINUS Mojs. Pl. V, fig. 9.

A large, completely chambered specimen of *Joannites* from the Daonella shales of the Thanam valley, Bashahr, belongs in all probability to *Joannites tridentinus* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 168, Taf. XLVII). Notwithstanding the recent description in Frech's memoir on triassic Cephalopoda of the Bakony (Palæontol. Anhang zum ersten Teil des I. Bdes. der Resultate der wissenschaftl. Erforschg. des Balaton-sees, p. 36, Taf. VIII, fig. 1, Taf. IX, fig. 1), the Alpine species is unfortunately known so imperfectly, that it is preferable to refrain from a direct identification.

My specimen agrees with the Alpine type-specimen from the Daonella limestone of Prezzo in the compressed shape of the shell, in the flattened character of the lateral parts, and in the presence of four varices, which in their position correspond exactly to the four quarters of the last volution. A distinction from the type-specimen illustrated by E. v. Mojsisovics is shown in the more broadly rounded siphonal area and in the smaller size of the umbilicus. In the latter character, however, the two examples from the Fured limestone of the Bakony, which have been united with *J. tridentinus* by Frech, answer well to the Indian cast. Neither front views nor cross-sections of those Hungarian specimens have been published by Frech. Nor is the cross-section of the Alpine type known exactly, the figure given by E. v. Mojsisovics having been based on the reconstruction of a specimen partly crushed and deformed by pressure in the rocks.

Dimensions.

Diameter of the shell		. 94 mm.
" " umbilicus		7.5 "
Height of the { above the umbilical suture		47 "
last volution { " preceding whorl		17 "
Thickness of the last volution		34 "

Sutures.—Similar to those of *Joannites Joannis Austriæ*. From eight to nine saddles are counted outside the umbilical suture. As has been noticed by Frech in his Hungarian examples, the saddles are richly ramified and more complicated than in any of the congeneric species from the Wengen beds.

JOANNITES cf. PROAVUS Diener. Pl. V, fig. 10.

1899. *Joannites aff. diffusus* (v. Hauer) A. v. Krafft, General Report, Geol. Surv. of India, 1898-99, p. 18.

1900. *Joannites proavus* Diener, Die triadische Cephalopodenfauna der Schiechlinghoche bei Hallstatt, Beitræge zur Palæont. und Geol. Oester.-Ungarns, etc., Bd. XIII, p. 13, Taf. I, figs. 1, 2.

1906. *Joannites cf. proavus* Diener, Himálayan Fossils, l. c. Vol. V, Pt. 2, Pl. XV, fig. 5, XVII, fig. 5.

This species, which has been described in my memoir on the fauna of the Himálayan Muschelkalk, is represented by numerous examples in the ladinic stage of Spiti. All my specimens are of small or moderate size and provided with very deep constrictions, standing exactly opposite to each other. The few specimens in which portions of the body-chamber have been preserved are too fragmentary

to decide, whether or not the constrictions, which are so characteristic of inner nuclei, do also persist in the body-chamber. The new materials therefore add but little to our knowledge of this species, which is most nearly allied to *Joannites diffissus* v. Hauer.

Good characters of distinction between this species, which is referable to the Alpine *Joannites proavus* with some reserve only, and *J. diffissus* of carnic age are the larger size and the arrangement of the sutures in the Indian species. The sutural line of the latter is arranged along a very flat curve, whereas the curvature is rather considerable in *Joannites diffissus*.

Locality and geological position.—(a) *Topmost beds of upper Muschelkalk:* S.-E. of Muth; Kágá; Banna encamping ground, Thanam valley.

(b) *Daonella shales:* Thanam valley, Bashahr; E. of Muth.

PROARCESTES BICINCTUS v. Mojsisovics. Pl. V, fig. 2.

1865. *Ammonites diffissus* (v. Hauer) Stoliczka, Memoirs, Geol. Surv. of India, Vol. V, Pt. 1, p. 53, Pt. V, fig. 4.

1882. *Arcestes bicinctus* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 167.

1895. *Proarcestes bicinctus* Diener, the Cephalopoda of the Muschelkalk, Himalayan Foss., Vol. II, Pt. 2, p. 87, Pl. XXVIII, fig. 1.

1900. *Proarcestes bicinctus* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 209.

Proarcestes bicinctus has been enumerated by A. v. Krafft among the species of *Ammonites* common to both the upper Muschelkalk and the beds with *Daonella indica*. He found the species to be abundant in the topmost beds of the Muschelkalk at Kágá, at Banna encamping ground, S.-E. of Muth, and in the *Daonella shales* N. of Po. In reality the species is not at all abundantly represented among his materials. The majority of examples identified by him with *Proarcestes bicinctus* belongs to the group of *Joannites proavus* Diener, as could be stated by an examination of their sutural lines.

Among the materials collected in the triassic rocks of Spiti by Hayden and A. v. Krafft not more than two specimens could be identified with *Proarcestes bicinctus*. Although there is a great external resemblance between them and inner nuclei of *Joannites cf. proavus*, their distinction is rather easy, as may be seen at a glance from the figures of the type-specimen of *Proarcestes bicinctus* represented in Stoliczka's memoir and in my monograph of the Cephalopoda of the Himalayan Muschelkalk.

Proarcestes bicinctus is of enormous thickness, the transverse diameter of the cross-section being equal to or exceeding even the diameter of the entire shell. I have never noticed a similar proportion of height and thickness in a species with the sutural line of *Joannites*. The constrictions are less strongly marked than in typical shapes of *J. proavus*, but this feature of difference is less constant, the strength of constrictions being subject to some variation in the latter species according to different stages of growth. That it belongs to either *Joannites* or *Proarcestes* can, of course, be decided at once by an examination of the sutures.

Neither of my two specimens has been perfectly preserved, although their state of preservation is better than in Stoliczka's type-specimen.

Dimensions.

Diameter of the shell			23 mm.
" " umbilicus			35 "
Height of the last	{ above the umbilical suture		10 "
volution	{ " " preceding whorl		5 "
Thickness of the last volution			25 "

Sutures.—The siphonal lobe is narrow and its median prominence is comparatively short. The siphonal saddle is provided with a large, external branch. In this feature *Proarcestes bicinctus* recalls the section of *P. extralabiati* in the Alpine Trias, and not the group of *P. Bramantei* Mojs.

Locality and geological position.—*Daonella shales*, N. of Po.

Remarks.—From the examination of A. v. Krafft's collections the ladinic age of *Proarcestes bicinctus* is evident. The stratigraphical layer of Stoliczka's type-specimen not being known, the species must probably be eliminated from the list of Muschelkalk forms.

PROARCESTES cf. BALFOURI Oppel.

1863. *Ammonites Balfouri* Oppel, Palæont. Mitteil. aus dem Museum d. Kgl. bayr. Staates I, p. 285, Taf. 50, fig. 5.

1895. *Proarcestes Balfouri* Diener, Himal. Foss., Vol. II, Pt. 2, p. 83, Pl. XXVII, figs. 6, 7.

Small specimens of *Proarcestes* consisting of air-chambers only, without any varices or labiæ, are referred to *P. Balfouri*. With this species they agree in their shape and sutures. No examples provided with their body-chambers have as yet been found. The question whether *Proarcestes Balfouri* is identical with *P. Escheri* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, l. c. p. 162, Taf. XLVI, figs. 7-9, and Cephalopoden der Hallstaetter Kalke, l. c. VI-1, p. 112, Taf. LVIII, fig. 18) or not, has therefore to remain still unsettled.

Locality and geological position.—(a) *Topmost beds of Upper Muschelkalk*: S.-E. of Muth.

(b) *Daonella shales.*—N. of Po, W. of Lilang.

PROARCESTES sp. ind. aff. ESINENSIS Mojs. Pl. V, fig. 11.

Inner nuclei of a species of *Proarcestes* with moderately inflated whorls and three furrows on the cast in the circumference of one volution recall *P. esinensis* v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., X, p. 158, Taf. XLV, figs. 1-5). In examples reaching a diameter of 15 mm. the cross-sections are of equal height and thickness. An exact specific determination is not possible on account of the absence of full-grown examples with body-chambers among my materials.

Locality and geological position.—*Daonella shales*, S.-E. of Muth.

PROARCESTES sp. ind. (group of *P. bicarinati*).

Inner nuclei of *Proarcestes*, recalling the group of *P. bicarinati*, are not rare among the Himalayan materials from the ladinic stage. They might be compared to *Proarcestes pannonicus* Mojs., *P. Ausseanus* Muenst., or *P. bicarinatus* Hauer. The casts are provided with two furrows, situated exactly opposite each other, in the circumference of one volution.

Sutures similar to those of *P. Ausseanus*. Siphonal saddle with a distinct external branch.

Locality and geological position.—*Daonella* shales, N. of Po, W. of Lilang, S.-E. of Muth.

II.—FOSSILS FROM THE HALOBIA LIMESTONE.

According to A. v. Krafft's description, an isopic mass of dark, splintery limestone follows above the *Daonella* shales. This mass of limestones, about 280 feet in thickness, contains in its lower part the fauna of *Daonella indica*, whereas in the upper region *Halobia* cf. *comata* has been found. The difference in the faunistic contents of the lower and upper portions of this uniform mass of limestones induced A. v. Krafft to separate the two divisions, designating the lower as *Daonella limestone* and the upper as *Halobia limestone*.

In his stratigraphical notes on the mesozoic rocks of Spiti (General Report, Geological Survey of India, 1899-1900, p. 208) he gave the following sequence of beds between the Muschelkalk and the grey shales with *Joannites cymbiformis*:—

Carnic stage	{ 5. Grey beds.	
	{ 4. Hard, dark, splintery limestones, somewhat bituminous, with calcite veins, weathering greyish brown, intercalated with shaly limestones, in layers of 1-3 feet, containing—	
	<i>Halobia</i> cf. <i>comata</i> Bittn.	} 111 ft.
	„ cf. <i>fascigera</i> Bittn.	
Ladinic stage	{ 3. Black limestones as 4, intercalated with shales. Very large <i>Arcestes</i> sp.	 25 ft.
	{ 2. Hard, black limestone as 4, containing <i>Daonella</i> cf. <i>Lommeli</i> Wissm.	 145 ft.
	{ 1. <i>Daonella</i> shales with—	
	<i>Daonella Lommeli</i> Wissm.	} 160 ft.
	„ <i>indica</i> Bittn.	

A. v. Krafft expressly states (p. 215) to have never met with a *Daonella Lommeli* higher up than in the upper third of series No. 2.

Series No. 2 corresponds to the *Daonella* limestone, No. 4 to the *Halobia* limestone, in which I prefer to include the small band, No. 3 with *Joannites Thanamensis* nov. sp. (*Arcestes* sp. A. v. Krafft).

The fossils of the *Halobia* limestone are very few in number, and—with the exception of *Joannites Thanamensis*—preserved unsatisfactorily. The following two species only have been determined :—

HALOBIA cf. *COMATA* Bittner. Pl. VII, figs. 2, 3, 4.

1899. *Halobia comata* Bittner, *Himálayan Fossils*, Vol. III, Pt. 2, p. 46, Pl. VII, fig. 13.

1900. *Halobia* cf. *comata* et cf. *fascigera* A. v. Krafft, General Report, Geol. Surv. of India, 1899-1900, p. 215.

Among A. v. Krafft's materials there are altogether three casts of *Halobia* which have been referred to *H. comata* and to *H. fascigera* by this author, but which, according to my opinion, should be included in one species only.

They undoubtedly belong to the group of *Halobia rugosa*, and are probably identical with *Halobia comata* Bittn., although they leave much to be desired as regards certain identification. In none of them has the region of the shell in front of the umbo with the anterior wing been preserved, but the ornamentation of the casts agrees so closely with the sculpture characteristic of *Halobia rugosa* that there is sufficient reason for referring them to that group. The ribbing is extremely delicate. The ribs are closely set and undulating. Concentric wrinkles of growth are distinctly developed. They are often connected with a change in the direction and strength of the radiating ribs, but not with a sharp geniculation, as in *H. fascigera*. The umbonal region is delicately ribbed, not smooth as in *Halobia rugosa*.

Locality.—W. of Lilang.

JOANNITES THANAMENSIS nov. sp. Pl. VII, fig. 1.

Among the fragments of "very large *Arcestes*" mentioned by A. v. Krafft in his preliminary notes on the mesozoic rocks of Spiti (General Report, Geological Survey of India, 1899-1900, p. 208) there is a fairly well-preserved, although incomplete, cast of a beautiful *Joannites*, which to me appears worthy of a specific determination.

In its general shape my type-specimen recalls *Joannites Klipsteini* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 84, Taf. LXII, figs. 2-3). It is provided with very flatly curved lateral parts and a broadly rounded siphonal area. It differs, however, from all congeneric species by the complete absence of furrows or varices in the inner volutions. The only furrow which has been noticed was situated in the vicinity of the aperture and belongs to the body-chamber.

The shell, which has been partly preserved, is of remarkable thickness.

Dimensions.

Diameter of the shell		. 214 mm.
" " umbilicus		. 16 "
Height of the { above the umbilical suture		. 105 "
last volution { " , preceding whorl		. 33 "
Thickness of the last volution		. 100 "

Sutures.—I have not succeeded in making all the details of the sutural line accessible to observation. Three lobes and four saddles following the siphonal lobe are known to me fairly well, but as regards the rest of the auxiliary series, I had to be satisfied with studying their rough outlines. There are ten saddles altogether outside the umbilical suture. The ramification of the principal saddles is almost as rich as in *Joannites cymbiformis* and its allies. All the saddles are dimeroidic, whereas the lobes are bipartite at their base, being divided by a high median indentation. The stems of the saddles have a more massive shape than in *J. cymbiformis*, but this is, perhaps, partly due to a too liberal use of the grinding stone and of muriatic acid.

III.—FOSSILS FROM THE GREY BEDS.

Throughout Spiti above the black *Halobia* limestone with *Halobia cf. comata* of middle carnic age, thick, grey, earthy shales follow, in which grey, shaly limestones of various thickness are intercalated. A. v. Krafft describes this series as being of so uniform a character, that it can hardly be sub-divided unless in a very detailed fashion. The entire thickness of the grey beds amounts to at least 500 feet. A thin-bedded, shaly limestone of 20 feet in thickness occurs about the middle of the series.

Two fossiliferous horizons have been discovered in the grey beds, separated by 300 feet of unfossiliferous rocks. The lower one is situated at the very base of the series, lying immediately on the topmost *Halobia* limestones. It is of considerable importance. A. v. Krafft mentions the following species of Cephalopoda, as collected either by himself or by Hayden from this horizon at different localities:—

- Joannites cymbiformis* Wulf.
- Trachyceras cf. Aonoides* Mojs.
- „ *sp. ind. aff. Ariae* Mojs.
- Drepanites nov. sp. ind.*
- Hauerites nov. sp. aff. rarestriato* Mojs.

The second fossiliferous horizon of the series of grey beds was discovered N.-N.-W. of Lilang and N.-W. of Muth in the upper division about 40 feet above the thin-bedded limestone referred to above. The following species have been identified by A. v. Krafft:—

- Spiriferina sh. shalensis* Bittn.
- Rhynchonella laucana* Bittn.
- Discina sp. ind.*
- Distichites sp. ind. aff. Goebli* Mojs.

The bulk of the collections made in this horizon is stated by him to belong to species not recorded yet from the Himálayas.

BRACHIOPODA.

RHYNCHONELLA LAUCANA Bittner. Pl. IX, fig. 1.

1899. *Rhynchonella laucana* Bittner, *Himálayan Foss.*, *Palæont. Ind.*, ser. XV, Vol. III, Pt. 2, p. 41, Pl. VIII, figs. 5, 6.

1900. *Rhynchonella laucana* A. v. Krafft, *General Report, Geol. Surv. of India*, for 1899-1900, p. 217.

Three specimens of a large, smooth *Rhynchonella* can be safely identified with this species from the horizon of *Halobia comata* in the Shalshal cliff. One of them agrees exactly with the type in the height and shape of its frontal tongue. The two others have the frontal tongue of the ventral valve a little higher and narrower, but have been somewhat distorted by pressure. They stand very near *Rh. regilla* from the carnic stage of the Hallstatt limestone, as has been remarked by Bittner. The differences between this Alpine form and the specimens from the Shalshal cliff, as enumerated by that author, have also been observed in my examples

Dimensions.

Entire length of the shell.	.	25.5 mm.
„ breadth „ „	.	23 „
Length of the dorsal valve	.	22 „
Thickness of both valves .	.	22

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

Rhynchonella laucana var. *lilangensis*.—A specimen of *Rhynchonella* of very large size from the same locality (Pl. IX, fig. 2) may be referred provisionally to *Rh. laucana* as a variety. It is distinguished from the typical shape by its highly elevated and narrowly extended frontal tongue, and by the development of distinctly angular lateral folds bordering the mesial sinus. The close affinity to *Rhynchonella laucana* is very probable but not beyond doubt, the beak of my only specimen having been broken off. It is, however, only the character of the beak which permits a safe distinction between the representatives of the groups of *Rhynchonella regilla* Bittn. to which *Rh. laucana* belongs, and of *Rh. subacuta* Mstr.

RHYNCHONELLA (AUSTRIELLA ?) sp. ind. ex aff. *Rh. nux* Suess. Pl. IX, fig. 3.

Among my materials from the upper horizon of the grey beds W. of Lilang there is a single specimen of a globose *Rhynchonella*, which in its general shape recalls very strongly the Alpine *Rh. nux*. It is especially the nearly equi-
 H

character of the shell, in which it agrees with the examples from the Hallstatt limestone as illustrated by Bittner (Abhandl. K. K. Geol. Reichsanst., XIV, Taf. XII, figs. 18-30, Taf. XXXIX, figs. 21, 22). The frontal tongue is high, narrow, lanceolate, impressed in the middle and bordered by deep, angular, lateral folds. From *Rhynchonella laucana* this specimen is distinguished at once by its strongly vaulted dorsal valve, and by the direction of the line, in which the lateral margins of the two valves unite. Unfortunately the apex of the ventral valve has not been preserved. No exact information as to the affinity with *Rhynchonella nux* can be therefore gathered, although the general outlines of the ventral valve lead me to suggest that the apices of the two valves cannot have differed considerably in size.

Provided the supposed affinity of this specimen to *Rhynchonella nux* could be ascertained, it should find its systematical position in the subgenus *Austriella* Bittn.

RYNCHONELLA cf. *SEMIPLECTA* Muenst. Pl. VIII, fig. 5.

1841. *Terebratula semiplecta* Graf Muenster, Beitrage zur Petrefactenkunde IV, p. 55, Taf. VI, fig. 2.

1865. *Rhynchonella semiplecta* Laube, Die Fauna der Schichten von St. Cassian, Denkschr. Kais. Akad. d. Wiss., XXIV, Bd. 2. Abt., p. 24, Taf. XIV, fig. 1.

1890. *Rhynchonella semiplecta* Bittner, Brachiopoden der Alpenen Trias, Abhandl. K. K. Geol. Reichsanst., XIV, p. 100.

For a fuller list of synonyms the memoirs of Laube and Bittner should be consulted.

I cannot but refer a single specimen from the upper horizon of the grey beds W. of Lilang to the group of *Rhynchonella semiplecta* from the triassic strata of St. Cassian. This specimen is of moderate size and intermediate in shape between the two types illustrated in figs. 1 and 1a by Laube. Its frontal tongue is higher than in the typical form, but lower than in the *var. Joannis Austriae* v. Klipst. My Indian specimen resembles this variety in the faint development of lateral and frontal folds. The folds are restricted to the vicinity of the margins. The two valves are equally vaulted. The beak is small and projects very little beyond the hinge-line.

Dimensions.

Entire length of the shell	.	. 18 mm.
„ breadth „ „	.	. 16 „
Length of the dorsal valve	.	. 19 „
Thickness of both valves	.	. 10.5 „

RYNCHONELLA FRESHFIELDI nov. sp. Pl. X, figs. 1, 2.

This is one of the more common species in the Brachiopod-bearing horizon of the grey beds. It is very closely related to *Rhynchonella trinodosi* Bittner (Abhandl. K. K. Geol. Reichsanst., XIV, p. 13, Taf. XXXII, figs. 17-35) and to *Rh. mutabilis* Stoliczka (Mem. Geol. Survey of India, Vol. V, p. 40, Pl. III, figs. 5-9).

The two valves are moderately vaulted, more globose, as a rule, in advanced stages of growth. But even young specimens are always less strongly flattened than equally sized examples of *Rhynchonella trinodosi*. The smaller valve is always more strongly inflated than the opposite one. The sinus and corresponding mesial fold are only developed at a considerable distance from the apices in the frontal region of the shell.

The mesial fold of the dorsal valve is generally provided with three sharp and narrow ribs, to which two equally shaped ribs correspond in the sinus of the ventral valve. Specimens with two ribs in the mesial lobe of the dorsal valve and with a single median rib in the sinus of the ventral valve are quite an exception. In one of these specimens the two sides of the front are strongly asymmetrical. The two ribs bordering the mesial sinus of the larger valve are most prominent. Two smaller lateral ribs are noticed in the marginal region on either side. Even in specimens provided with a comparatively strong sculpture, the ribs converging towards the beak are never fused. The absence of this character distinguishes our species at once from similar forms of rhætic and liassic age (*Rhynchonella austriaca* Suess, *Rh. variabilis* Schloth.)

Rhynchonella Freshfieldi resembles very closely those forms of the group of *Rh. trinodosi* which differ from the typical shape by the development of two ribs in the sinus of the larger valve, and of three ribs in the corresponding frontal lobe of the smaller valve. But this character in *Rh. trinodosi* is as exceptional as is the presence of a smaller number of ribs in *Rh. Freshfieldi*. A specimen of *Rh. trinodosi* which comes nearest to the present Himálayan species has been illustrated by Bittner on Pl. XXXII, fig. 27, of his above-quoted memoir. But even in this specimen the three ribs of the frontal lobe are less prominent than in my Indian type. Another small but constant difference is the steeper slope of the lateral parts from the ribs bordering the mesial fold of the dorsal valve. In the majority of my Indian shells the length and breadth of the ventral valve are equal, whereas in the three-ribbed variety of *Rhynchonella trinodosi* the length is generally inferior to the width of the shell. Nor does any one of the types enumerated by Bittner reach the dimensions of some of my Indian examples.

Notwithstanding all these differences of minor importance, *Rhynchonella Freshfieldi* and *Rh. trinodosi* are so closely related to each other that the Indian species could equally well be regarded as a variety only of *Rh. trinodosi*. Had the specimens collected in the grey beds of Spiti by A. v. Krafft been found in a horizon of Muschelkalk age, I should, myself, probably have included them with the Alpine form.

Rhynchonella mutabilis Stoliczka is a gigantic form of the Alpine *Rhynchonella trinodosi*. The difference between it and *Rh. Freshfieldi* chiefly consists in their respective dimensions.

No geologically younger representatives of the group of *Rh. trinodosi* in the triassic beds of St. Cassian and of the Alps of Bavaria are allied to *Rh. Freshfieldi* as closely as is this leading form of the Alpine Muschelkalk.

Dimensions.

		FIG. 1.	FIG. 2.
Entire length of the shell .	.	14 mm.	12 mm.
„ breadth „ „ .	.	13.5 „	12 „
Length of the dorsal valve .	.	12 „	10.5 „
Thickness of both valves .	.	10 „	7.5 „

Locality and geological position.—Upper horizon of grey beds, N.-W. of Muth.

RHYNCHONELLA HIMAICA nov. sp. Pl. IX, figs. 12, 13.

This species is very nearly allied to *Rhynchonella subacuta* Muenst. var. *coralliophila* Bittner (Brachiopoden der alpinen Trias, Abhandl. K. K. Geol. Reichsanst., XIV, p. 114, Taf. XXXVIII, figs. 7-9) from the St. Cassian beds of the Seelandalpe. It is considerably larger than the typical form of *Rh. subacuta* from St. Cassian, of a strongly compressed shape, provided with a comparatively long and sharp beak, and with expanding lateral parts which are marked off very distinctly from the medial sinus and corresponding lobe.

Both elongated and broad shapes are represented in the Himálayan collections. The two figures illustrate ordinary but not extreme shapes.

Ribs are constantly present in the sinus or mesial fold and on the lateral parts, and are more strongly developed than in any of the Alpine specimens of the group of *Rhynchonella subacuta*. The arrangement of the ribs is remarkable by reason of their close grouping in the sinus and corresponding lobe, whereas the lateral ribs stand less closely. The tripartite character of each valve is very distinctly marked.

Dimensions.

		FIG. 12.	FIG. 13.
Entire length of the shell		12 mm.	12 mm.
„ breadth „ „		12 „	10 „
Length of the dorsal valve		10 „	10 „
Thickness of both valves		5 „	5 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

RHYNCHONELLA cf. **BAJUVARICA** Bittner. Pl. X, fig. 3.

1890. *Rhynchonella bajuvarica* Bittner, Brachiopoden der alpinen Trias, Abhandl. K. K. Geol. Reichsanst., XIV, p. 162, Taf. XLI, figs. 1-5.

A single specimen of a small *Rhynchonella* from the upper horizon of the grey beds W. of Lilang agrees so closely with *Rhynchonella bajuvarica* from the Partnachsichten of the Wendelstein, that it must be referred to this species as cf. It is a moderately narrow and inflated *Rhynchonella* with a high frontal tongue. In the dorsal valve no distinct mesial fold corresponds to this frontal tongue, but a median depression in this valve is its most characteristic sculptural element. In the corresponding sinus of the ventral valve a flat mesial ridge is noticed. Both

this median depression and ridge are broader than all the rest of the ribs or furrows. The lateral ribbing is restricted to the vicinity of the margins.

Rhynchonella bajuvarica is an intermediate shape between *Rh. trinodosi* Bittn. and *Rh. linguligera* Bittn. My Himáláyan specimen stands nearer to the *var. minutula* of *Rh. trinodosi* Bittner (Abhandl. K. K. Geol. Reichsanst., XIV, fig. 34), than any of the Alpine representatives of *Rh. bajuvarica*, the ribbing of the front being more sharply marked than in the types from the Wendelstein.

In its dimensions my example agrees exactly with the Bavarian species.

SPIRIFERINA OROPHILA nov. sp. Pl. IX, figs. 7, 8.

This species—as is the case with *Rhynchonella Freshfieldi* mentioned above—shows a greater similarity with a species of *Spiriferina* from the Muschelkalk than with any congeneric form of upper-triassic age. Externally it resembles very closely *Sp. avarica* Bittner (Abhandl. K. K. Geol. Reichsanst., XIV, p. 35, Taf. XXXV figs. 6, 7) from the Muschelkalk of the Bakony, of which only the ventral valves have as yet been made known. In the internal structure also, at least in that of the umbonal region, the two species agree, as is proved by the faint development of dental plates in both of them. In this character my Indian species also agrees with *Spiriferina Bittneri* Frech (= *Spiriferina fortis* Bittner, Brachiopoden aus der Trias des Bakonyerwaldes, Palæont. Anhang zum I. Theil des I. Bdes. Resultate der wissenschaftl. Erforschung des Balatonsees, p. 21, Taf. III, figs. 11-21). The beak of the ventral valve in all my specimens has been broken off. In the plane of fracture a strong median septum is exhibited.

Spiriferina orophila is remarkably similar to *Sp. avarica* in the small number of folds. In the ventral valve a sinus of moderate depth and width is bordered on either side by a sharply rounded rib. Outside this rib two more folds only follow.

In the dorsal valve the mesial and the two primary lateral folds are of nearly equal strength. There is only one more lateral rib between this primary fold and the hinge-line. In its sculpture the dorsal valve of *Spiriferina orophila* recalls very strongly the dorsal valve of a *Spiriferina* from the Alpine Muschelkalk which has been referred to *Spiriferina fragilis* by Stur, and illustrated by Bittner on Pl. XXXV, fig. 5, of his memoir as *Sp. fragilis var. paucicostata*.

In their outlines my Indian specimens agree better with *Spiriferina avarica* and *Spiriferina Bittneri* than with *Sp. fragilis*. Their hinge-line does not coincide with the greatest breadth of the shell. The area is higher than in *Sp. avarica*, but this character of difference is of very small importance, its great variability in many species of *Spiriferidæ* being a well-known fact.

Notwithstanding its similarity to *Spiriferina avarica* the present form may be easily distinguished from this species by the strength of its ribs, which remains equal throughout the entire length of the ventral valve, whereas in *Sp. avarica* the ribs are most strongly developed in the umbonal region and become gradually obsolete towards the front.

Dimensions.

	FIG. 7.	FIG. 8.
Entire length of the shell .	15 mm.	14 mm.
„ breadth „ „ „	16 „	17.5 „
Length of the dorsal valve	12 „	11 „
Thickness of both valves	12 „	11.5 „
Length of the hinge-line	12 „	12.5 „

The shell is distinctly punctate, but not coarse-grained.

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

Remarks.—*Spiriferina variplecta* Muenst. (Bittner, Abhandl. K. K. Geol. Reichsanst., XIV, p. 72, Taf. I, figs. 20, 21) from St. Cassian is probably also among the allies of our species. It agrees with *Sp. orophila* in the small number of ribs, but possesses, apart from the difference in size, more strongly inflated valves and a very low area.

In its external shape *Spiriferina orophila* recalls also *Sp. austriaca* Suess, from the rhætic stage. Both species agree in the relative proportions of their valves and in the presence of a small number of ribs. But in *Sp. austriaca* the mesial fold of the dorsal valve is strongly elevated and provided with an angular crest, not rounded above. The internal structure of the group of *Spiriferina uncinata* Schafh., of which *Sp. austriaca* is a representative, exhibits close affinities with the group of *Sp. hirsuta*, to which *Sp. avarica* belongs. The existence of a near mutual relationship between *Spiriferina avarica*, *Sp. orophila*, and *Sp. austriaca* is therefore very probable.

SPIRIFERINA GREGARIA SUSS. Pl. IX, figs. 9, 10.

1867. *Spiriferina gregaria* Suess, Verhandl. K. K. Geol. Reichsanst., p. 391.

1889. *Spiriferina gregaria* S. v. Woehrmann, Die Fauna der nordalpinen Carditaschichten, Jahrb. K. K. Geol. Reichsanst., 39 Bd., p. 197, Taf. V, figs. 24-27.

1890. *Spiriferina gregaria* Bittner, Brachiopoden der alpinen Trias., Abhandl. K. K. Geol. Reichsanst., XIV., p. 140, 145, Taf. XXVIII, figs. 14-19.

1900. *Spiriferina gregaria* Bittner, Brachiopoden aus der Trias des Bakonyerwaldes, Palæont. Anhang z. ersten Teil des ersten Bandes der Resultate der Wissensch. Erforschg. des Balatonsees, p. 21.

Numerous specimens of a small *Spiriferina* are before me, which stand so near the well-known *Spiriferina gregaria* of the Alpine Carditaschichten that they may with great probability be referred to that species.

The Indian species belongs to Zugmayer's group of *tripartitæ*. The internal structure of its apical region agrees exactly with that of *Spiriferina gregaria*. A cross-section of the beak shows three longitudinal lamellæ, consisting of the median septum and two dental plates, without any transverse lamellæ.

In their external shape my Himalayan examples agree rather with the Alpine shape from the Carditaschichten of Northern Tirol than with the Carinthian specimens from Bleiberg collected by Lipold. They are either a little longer than wide or of equal length and width, but never elongated transversely. The broad area is very high and slightly concave. The apex of the ventral valve is but little incurved.

The sinus and mesial fold are ribbed. There are as a rule two ribs in the sinus and three in the mesial fold of the dorsal valve. They are always less strong than the lateral ribs, which occur to the number of five or six on either side of the sinus and mesial fold. The lateral ribs do not diverge strongly and have an approximately straight direction, whereas they are distinctly arcuate in the types from Bleiberg. The mesial fold is elevated considerably above the general convexity of the smaller valve.

I have not been able to find any characters of difference between my Indian examples and the type-specimens of *Spiriferina gregaria* as illustrated by Bittner, all of which I have examined personally. The only detail in which they do not agree exactly is the smaller development of erect and lamellose striæ of growth in the Himálayan shells. But this, of course, cannot be considered as being of specific value.

Dimensions.

	FIG. 9.	FIG. 10.
Entire length of the shell	11·5 mm.	10·5 mm.
„ breadth „ „ „	11·5 „	10·5 „
Length of the dorsal valve	8 „	7 „
Thickness of both valves	7 „	7 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

SPIRIFERINA sp. ind. aff. SHALSHALENSIS Bittn. Pl. IX, fig. 11.

1900. *Spiriferina shalshalensis* (Bittner) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 217.

A single specimen of a middle-sized *Spiriferina* from the upper horizon of the grey beds W. of Lilang has been identified with *Sp. shalshalensis* Bittner (Himál. Foss., Palæont. Ind., ser. XV, Vol. III, Pt. 2, p. 42, Pl. IV, fig. 1) from the horizon of *Halobia comata* (Daonella beds, Griesbach) of the Shalshal cliff by A. v. Krafft. Although this specimen stands undoubtedly near the type of *Spiriferina shalshalensis*, it cannot be united therewith on account of some character of difference, which are of more than varietal importance.

Spiriferina shalshalensis belongs to a group of forms in which the smaller valve takes the shape of a lid covering the aperture of the semi-conical larger valve. In the present species this character is less strongly marked, the dorsal valve not being opposed to the ventral one in such a manner as to conceal it entirely if seen from the dorsal side. The high area is not straight but slightly concave. The number of lateral ribs on either side of the sinus is smaller than in *Sp. shalshalensis*. Although the present specimen is considerably larger than the type of *Sp. shalshalensis*, six ribs only are counted on either side of the sinus, whereas Bittner counted not less than nine ribs in his type-specimen. The sinus is distinctly angular, whereas it is sharply rounded at its base in *Sp. shalshalensis*. The greatest width of the shell does not coincide exactly with the hinge-line.

All the characters enumerated, although some of them might be of minor importance, are sufficient for a specific distinction of the present example from *Spiriferina shalshalensis*.

Nothing can be ascertained as to the inner structure of the apical region from an examination of this single specimen. It must therefore be left undecided whether it ought to be grouped with Zugmayer's *bipartitæ* or *dimidiatæ*, although its external resemblance to the group of *Spiriferina hirsuta* is in favour of the latter alternative.

Dimensions.

Entire length of the shell	18 mm.
„ breadth „ „	. 14 „
Length of the dorsal valve	. 10.5 „
Thickness of both valves	. 11 „

SPIRIFERINA DEODARÆ nov. sp. Pl. IX, figs. 5, 6.

A species of this type of *Spiriferina* is not yet known to me from the Alpine Trias. In its outlines and internal characters it recalls more strongly the group of *Spiriferina Suessii* Winkl. than any other congeneric form. There is also a great external resemblance with *Cyrtina* Dav., but the absence of a pseudodeltidium in my Indian examples forbids their identification with that genus or with the nearly allied *Thecocyrtella* Bittn. *Spiriferina Deodaræ* has an open deltidial fissure, exactly like the deltidium of *Sp. Suessii*, but is strongly ribbed. The presence of a strong median septum and the punctate structure of the shell are further arguments in favour of its being grouped with *Spiriferina* Orb.

Two specimens of this interesting species have been available to me for examination, but one of them (fig. 6) has been destroyed for the purpose of making its internal structure visible.

The shell is strongly inequivalve, resembling in its general shape the group of *Spirifer* (*Syringothyris*) *cuspidatus* Mast.

The ventral valve is pyramid-shaped, much deeper than the opposite one and provided with a large, concave sinus, which extends from the apex to the strongly projecting front margin. The area is very large, triangular, with acute edges, and situated at nearly right angles to the general level of the dorsal valve. It is perfectly straight, not concave. The very small and pointed beak is not incurved. The area is smooth, not striated. The hinge-line coincides with the greatest width of the shell.

The open deltidial fissure is very narrow in proportion to its length. The walls of the fissure are occupied by the two dental plates, which converge in the median septum, exactly as in the rhætic groups of *Spiriferina dimidiatæ* illustrated by Zugmayer (Untersuchungen über rhætische Brachiopoden, Beitræge zur Palæont. Oesterr. Ungarns, etc., von. E. v. Mojsisovics u. M. Neumayr, I, p. 25). The median septum agrees in its size and position exactly with the median septum of *Sp. uncinata* or *Sp. Suessii*, but does not project into the deltidial fissure beyond the line of junction between the two converging dental plates.

The dorsal valve is of trapezoidal outlines, with acutely prolonged wings and with a straight hinge-line. It is very moderately convex, with the exception of the strongly elevated mesial fold. This mesial fold is very prominent, smooth, and extends considerably beyond the level of the lateral portions of the valve. It is sharpened into a narrow crest and bordered by deep furrows on either side. In addition to this fold and to the corresponding sinus of the opposite valve, the surface of each valve is ornamented by from twelve to fourteen simple ribs.

Spiriferina Deodaræ is one of the largest representatives of this genus in triassic beds. It is inferior in size to *Sp. Suessii* only.

Dimensions.

Length of the ventral valve .	. 29 mm.
" " " dorsal " . .	. 16 "
Entire breadth of the shell .	. 32 "
Thickness of both valves .	32 "
Height of the area . .	. 20 "

Locality and geological position.—Upper horizon of grey beds, N.-W. of Muth.

Remarks.—A strongly ribbed *Spiriferina* with a very high and vertical area from the upper Trias of the Raxalpe has been described as *Spiriferina oyrrhynchus* by Bittner (Abhandlungen K. K. Geol. Reichsanst. Bd. XVII, p. 23, Pl. I, fig. 10). Its ventral valve although reminding of *Sp. Deodaræ* in its outlines, is, however, distinguished by its tripartite internal structure.

SPIRIFERINA (MENTZELIA) MENTZELII Dunk. Pl. IX, fig. 4.

1851. *Spirifer Mentzelii* Dunker, Palæontographica, I, p. 287, Taf. XXXIV, figs. 17-19.

For further synonyms the reader is referred to Bittner, Brachiopoden der alpinen Trias, Abhandl. K. K. Geol. Reichsanst., XIV, p. 22, and to my memoir on the fauna of the Himalayan Muschelkalk (Vol. V. Pt. 2).

Representatives of the well-known Muschelkalk species *Mentzelia Mentzelii* in rocks of upper-triassic age have been mentioned repeatedly by Bittner, but the types from Bleiberg (l. c. p. 141, Taf. XXVIII, figs. 22, 23) and from the Raibl beds of the Bakony (l. c. p. 158) are all so poorly preserved that a closer comparison with Dunker's species was found impossible. Among my Himalayan materials a single but beautifully preserved specimen of a *Mentzelia* has been noticed, which cannot be separated specifically from *M. Mentzelii*. It agrees with the typical form of this leading species of the Muschelkalk, not with *M. Fraasi* Bittner (l. c. p. 165, Taf. XL, fig. 34, XLI, figs. 15-17). Its sinus is broader and protracted into a frontal tongue, its area higher and more sharply defined than in *M. Fraasi*. The beak is large and as little incurved as in Bittner's type-specimen of *M. Mentzelii* from Recoaro (l. c. Taf. XXXIV, fig. 17).

My specimen is of larger size than the majority of Alpine examples. Of its internal structure the presence of a large median septum has been noticed. It is sufficiently strong to be seen through the transparent shell.

Dimensions.

Entire length of the shell	. 20 mm.
„ breadth „ „ „	21.5 „
Length of the dorsal valve .	15 „
Thickness of both valves .	13 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

ASPIDOTHYRIS nov. gen.

The interesting species serving as type of this genus has a form similar to some groups of *Waldheimia* and *Terebratula* in being smooth, with rounded outlines and a flattened dorsal valve. It must be included in the family of *Centronellinæ*, and is nearly related to the genera *Juvavella* Bittn. and *Nucleatula* Bittn. of upper-triassic age. The following discussion of its generic affinities shows this conclusively.

The internal structure has been studied by making both transverse and longitudinal sections. In two specimens the smaller valve has been ground off gradually along a plane parallel to the line of junction of the two valves. The data resulting from this procedure were controlled by the longitudinal section of a third example. On a combination of these observations the reconstruction in figs. 3, 4, 5 on Pl. XI has been based.

The brachial apparatus consists of a short median septum and of two descending lamellæ which form a very short loop and are united by a large vertical median plate. It is this median plate, not the median septum, which in well-preserved examples is visible through the transparent shell of the dorsal valve. The median plate does not reach into the interior of the valves beyond the junction of the two lamellæ, but rises rapidly in height towards the surface of the smaller valve, where it extends for more than one-half of the length of that valve. The upper lamellæ of the brachidium are supported by strong septal plates. These septal plates are narrow and in a transverse section disappear earlier than the loop or median plate and septum. The entire brachial apparatus is situated more anteriorly than in *Centronella*. The ventral valve is provided with strong dental plates, recalling the subgenus *Dielasma*.

In its internal structure *Aspidothyris* recalls *Juvavella* and *Nucleatula* by the presence of a short loop and of a vertical median plate connecting the two horizontal branches of the brachial lamellæ. But this median plate is of a very different shape in the two Alpine genera and in my Himalayan representative of *Centronellinæ*. It extends towards the outer side of the dorsal, not towards the interior of the ventral valve. Nor does it show any traces of a fringed margin. The presence of septal plates supporting the lamellæ of the dorsal valve and of strong dental plates in the ventral valve are also remarkable characters of difference. The introduction of a new genus for the accommodation of the Himalayan form is therefore justified.

ASPIDOTHYRIS KRAFFTII nov. sp. Pl. XI, figs. 1-5.

In its external shape this species recalls very strongly *Waldheimia subangusta* Muenst., especially so in the flattened character of the dorsal valve. In this character it agrees with many species of *Aulacothyris*, but differs by the absence of any median depression in the smaller valve. The line of juncton between the two valves is perfectly even, without any frontal wave.

All my specimens are short and rounded. The beak is strongly incurved, but does not conceal the false area and its deltidium entirely. The median plate is visible through the thin, transparent shell as a strong, distinctly defined streak.

Dimensions.

Entire length of the shell	14 mm.
„ breadth „ „ „	12 „
Length of the dorsal valve	11 „
Thickness of both valves	7 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

DIELASMA JULICUM Bittn. Pl. IX, fig. 14.

1890. *Terebratula Julica* Bittner, Abhandl. K. K. Geol. Reichsanst., XIV, pp. 125, 158, Taf. IV, figs. 14, 15. Taf. XXXIX, figs. 15, 16.
 1899. *Coenothyris Gemmellaroi*, *C. Calcare*, *C. sicula* Nelli, Boll. Soc. Geol. Ital., Vol. XVIII, p. 221, Pl. II, figs. 1-11.
 1900. *Terebratula julica* Bittner, Brachiopoden aus der Trias des Bakonyerwaldes, Paläontologischer Anhang zum ersten Teil des ersten Bandes der Resultate der Wissenschaftl. Erforschg. des Balatonsees, p. 5, Taf. I, figs. 8-28, Taf. V, figs. 20, 21.

Terebratula (Dielasma) julica, which was first described from the triassic beds of Raibl by Bittner and which is very common in the marls of Veszprem in Hungary of julic age, has also been discovered among A. v. Krafft's materials from Spiti. The only example available for examination slightly exceeds the Alpine specimens in its dimensions, but agrees with them perfectly in all the rest of its characters. In its outlines and sculpture it also recalls *Terebratula gregaria* Suess, but differs from this leading species of the rhætic stage by the presence of strongly developed dental plates in the umbonal region of the ventral valve. As has been remarked by Bittner, *Terebratula julica* ought to be grouped with the subgenus *Dielasma* King, but approaches *Zugmayeria* Waagen in the faint development of its septal plates, which are considerably reduced in the dorsal valve. It is certainly one of the geologically youngest representatives of *Dielasma* which has its chief development during carboniferous and permian times.

In its shape my specimen agrees with the type of *Dielasma jolicum* from Raibl, not with the nearly allied *Terebratula Woehrmanniana* Bittner (l. c. p. 153, Taf. XXXIX, figs. 2-7). It is only a little longer than broad and strongly biplicate. The median depression of the dorsal valve makes its first appearance in the

middle of this valve. It increases more rapidly in depth than in width and causes the front to ascend towards the mesial ridge of the opposite valve in a sharply sinuated curve. The flatly vaulted mesial ridge of the ventral valve is bordered on either side by a deep and narrow groove, terminating in the sharp angles of the corresponding plications of the dorsal valve.

Dimensions.

Entire length of the shell	.	.	.	26.5 mm.
" breadth " "	.	.	.	23 "
Length of the dorsal valve	.	.	.	24 "
Thickness of both valves .	.	.	.	13 "

Locality and geological position.—Upper horizon of grey beds, N.-W. of Muth.

DIELASMA HAYDENI nov. sp. Pl. XI, figs. 6-10.

Dielasma Haydeni in its external characters is as nearly allied to *Terebratula piriformis* Suess (Brachiopoden der Koessener Schichten, Taf. III, figs. 6—9) as *D. julicum* is to *Terebratula gregaria* Suess. But the presence of strongly developed dental plates in the beak of the ventral valve makes its distinction from the rhætic species an easy matter. The cardinal section in fig. 10 shows the two dental plates in the beak of the larger valve and two septal plates in the smaller valve, which are not united, but reach the apex as two separated lamellæ on either side of the beak.

As in *Terebratula piriformis*, a median septum is but very faintly marked by a line so thin and obscure that it has not been rendered visible on the photograph of the section. In some specimens the cast shows three diverging, deeply incised lines, originating from the apex of the smaller valve. The median line suggests the presence of a more strongly developed mesial septum, but this is a mistake. By grinding off the surface of the cast a very little, the line disappears completely. It does not consequently correspond to a true septum but only to a slight thickening of the shell along the median line of the apical region.

This species agrees with *Terebratula piriformis* in its great variability. It is the most common species in the brachiopod-bearing horizon of the grey beds. About fifty specimens altogether are contained in A. v. Krafft's and Hayden's collections. Among them are forms with a straight, not vaulted frontal line and with a more or less emarginated front, elongated shapes with approximately pentagonal outlines, and ovoid or distinctly "piriform" shapes with their greatest width situated in the vicinity of the front, either with equally vaulted valves or with a flattened and depressed dorsal valve.

There are also differences in the character of the false area, bordered by either regularly or sharply rounded edges, and in the relative proportions of length, width, and thickness of the shell.

According to the views explained by Waagen and L. de Koninck, regarding the circumscription of species in *Dielasma*, it would be an easy matter to distinguish several series among my Himálayan materials. I do not think myself justified in considering them as distinct species. There exist intermediate shapes between all the above-mentioned types, and a perfect transition can be traced from one to the other. The presence of such transitional shapes between forms belonging all to the same group of rocks at a single locality is strongly in favour of uniting all of them in a single species.

Dimensions.

	Fig. 6.	Fig. 7.	Fig. 8.	Fig. 9.
Entire length of the shell	. 30 mm.	27 mm.	30 mm.	29 mm.
„ breadth „ „	23 „	22.5 „	25 „	21 „
Length of the dorsal valve	27 „	24 „	25 „	25 „
Thickness of both valves	. 14.5 „	14 „	17 „	18 „

One of my specimens, which has, unfortunately, the apical region of its ventral valve strongly injured, is of very large dimensions, being but little inferior in size to the largest examples of *Terebratula piriformis* Suess. The length of its dorsal valve is 55 mm., corresponding to a breadth of 41 mm. and to a thickness of the entire shell of 28 mm. It is of ovoid outlines, has a perfectly straight front margin, and the two valves equally vaulted.

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

CRURATULA (?) INDICA nov. sp. Pl. XI, fig. 11.

The subgenus *Cruratula* Bittner, known to be one of the most characteristic and interesting forms of the Alpine upper Trias, seems to occur also in the grey beds of Spiti. But it is only by reason of its external shape that a single although well-preserved cast can be referred to this genus. The absence of any other examples available for examination forbids any attempt to reveal its internal structure by a free use of the grinding-stone.

Cruratula indica by its shape recalls *C. Beyrichii* Bittner (Abhandl. K. K. Geol. Reichsanst., p. 201, Taf. VI, figs. 1-4) from the carnic Hallstatt-limestone of Aussee. It is of nearly triangular outlines, with rounded-off frontal angles. The beak is delicate, shorter and less prominent than in *Cruratula Beyrichii*. It is obliquely truncated by an elliptical foramen as in *C. Euclora* Lbe.

Deltidial area small, but distinctly marked and bordered by sharp edges. Ventral valve depressed near the front, but the shallow sinus is not produced into a frontal tongue. The corresponding median impression in the dorsal valve is very faintly developed and restricted to the vicinity of the front. The regularity of the curvature is not interrupted in the visceral portion. Median septum of the smaller valve very distinct and extending for more than one half the entire length of this valve. The valves are moderately and almost equally vaulted, as is the case in *Cruratula Damesi* Bittn. and *C. carinthiaca* Rothpl.

My only specimen is a cast without any remnants of the shelly substance adhering. The punctate structure of the shell, characteristic of the genus *Cruratula*, could not be ascertained therefore. The very long median septum points to a species of *Waldheimia* or of a group of forms nearly allied to that genus.

Dimensions.

Entire length of the shell	. 17.5 mm.
„ breadth „ „	. 22 „
Length of the dorsal valve	. 14.5 „
Thickness of both valves	. 10 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

LAMELLIBRANCHIATA.

Genus: *LILANGINA*, nov. gen.

This is one of the most remarkable new genera of triassic *Lamellibranchiata*. It is probably allied to *Cassianella* Beyr. and to *Hærnesia* Lbe., but differs from them by some remarkable characters. It agrees with *Cassianella* in the strongly inequivalve shape, in the presence of a prosogyrate beak of the larger (left) valve, and of a simple ligamental area. The chief character of difference is its truncated anterior region. In both valves an anterior area is divided off from the visceral portion of the shell by sharp ridges, but anterior wings are entirely absent.

The cardinal region is not known to me in all its details. There is a shallow ligamental groove developed in the area below the apex. It is extended obliquely, as in *Cassianella decussata* Muenst. (Bittner, Abhandl. K. K. Geol. Reichsanst., XVIII, p. 63, Taf. VII, fig. 11). As in *Cassianella* and *Hærnesia*, the apex of the left valve is divided internally by a median septum, which is excentrically situated and corresponds to the external ridge separating the anterior area from the visceral portion. Cardinal teeth have not been noticed.

The leading features of this interesting genus are obvious from the following description of the only species hitherto known.

LILANGINA NOBILIS nov. sp. Pl. VIII, figs. 1, 2.

Large, strongly inequivalve shells, reminding of *Cassianella*. Both valves strongly curved and oblique with terminal beaks.

Left valve inflated, with a prosogyrate apex, which is incurved so strongly that the point of the beak is directed anteriorly, parallel to the hinge-line. From the beak two ribs run across the entire valve towards the ventral margin. They border the narrow central inflation of the valve. In the umbonal region a shallow saddle-like depression is noticed in the middle of the central inflation. The

posterior rib is acutely rounded and dies out gradually in the vicinity of the ventral margin. The anterior rib is slender and keel-shaped. It separates the central inflation of the valve from a low anterior area which is conspicuous by the absence of any anterior wing.

From the posterior rib the shell slopes very steeply towards the short posterior wing, which is not produced beyond the posterior lateral margin. The posterior outlines of this valve recall especially *Hærnesia Joannis Austriæ* Klipst.

The ligamental area is low, narrow, and partly covered by the hinge-margin of the opposite valve.

The right valve is only a little less strongly incurved than the left one. In its outlines it is similar to the left valve of *Perna*, from which it differs, however, by the shape of its beak, which is prosogyrate and remarkably produced, and by the presence of a broad anterior area, separated from the visceral portion of the shell by a sharp rib. The anterior area of this valve is considerably higher than that of the opposite one, and meets the central depression at right angles. No anterior wing is developed. Thus the entire shell appears to be truncated anteriorly by a broad area, imparting to the species an aspect very different from *Hærnesia* or *Cassianella*, to which it otherwise bears a remarkable similarity.

The visceral and posterior regions of the shell are covered with concentric striæ of growth. On the anterior area of both valves the striæ run parallel to the bordering keels. There is no reticulate ornamentation developed, as is characteristic of many species in *Cassianella*.

Dimensions.

Entire length of the shell	65 mm.
„ height „ „	77 „
Thickness of the two valves	24 „
Length of the hinge-line	53 „
Distance of the apex from the point of greatest inflation	44 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

GONODON (SCHAFHÆUTLIA) (?) sp. ind. Pl. VIII, figs. 3, 4.

It is with some reserve that two specimens of bivalves are referred to this triassic genus, which is widely distributed in the upper Trias of the Eastern Alps. They are, it is true, very similar to species of that genus in their external characters, but the structure of their cardinal region is not sufficiently known to me for establishing their generic identification with certainty.

The larger example (fig. 3) is a right valve of very regularly rounded outlines, and with a nearly central position of its apex. Its surface is covered with numerous and delicate lines of growth. It recalls *Gonodon Mellingeri* v. Hauer, especially by the somewhat larger development of its anterior portion. I have entirely failed in my attempts to make the cardinal region accessible to examination.

The second specimen (fig. 4) can with greater probability be referred to *Gonodon*. It is a cast of the two valves which are firmly attached to each other. The shell is not exactly equivalve, but the left valve is slightly inferior in size to the right one. The apices, which are turned forward and moderately incurved, are touching each other. The cardinal region is not accessible for examination, but below the hinge-line of the cast of the left valve two deep grooves are visible on either side of the beak. These grooves might correspond to the terminations of the large horizontal cardinal tooth of the left valve, which fits into the tooth groove of the right valve.

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

LIMA sp. ind. ex a. aff ALTERNANS Bittn. Pl. X, fig. 4.

A single cast of moderate size, consisting of both valves, belongs probably to the genus *Lima*. In favour of an identification with this genus are its oblique and nearly equivalve shape, the steep slope of the anterior side and the faint development of wings, which have been broken off, but were certainly present. The posterior side flattens gradually. The two valves are inflated very little. The anterior area is extremely small and not marked off distinctly from the ribbed part of the valves.

About twenty ribs of moderate strength are counted on the cast. They are separated by intervals three to four times as wide as the ribs. Between two primary ribs a delicate secondary rib is interposed rather regularly. In this character of ornamentation my specimen agrees with *Lima alternans* Bittner (Abhandl. K. K. Geol. Reichsanst., XVIII, p. 175, Pl. XXII, fig. 5) from St. Cassian.

Dimensions.

Entire length of the shell .	. 35 mm.
„ height „ „	. 29 „
Thickness of both valves .	. 7 „

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

Genus: *POMARANGINA* nov. gen.

Among the fossil materials collected in the grey beds of Spiti a large shell is very numerously represented which in its external characters exhibits a remarkable similarity to several triassic genera of *Lamellibranchiata*.

There is especially the genus *Physocardia* Woehrmann (Jahrb. K. K. Geol. Reichsanst., 43 Bd., 1893, p. 671), with which it agrees in the relative dimensions and in the shape of the two valves, which are cordiform and inequilateral, provided with protracted anterior margins, strongly inflated umbones, incurved and prosogyrate beaks and a concentric sculpture. But to those characters in which my

Indian specimens agree with *Physocardia* some features of difference must be added which peremptorily forbid their identification with that genus. Such features of difference are the absence of any escutcheon marked off distinctly from the posterior region of the shell, and the absence of any cardinal tooth in the Himálayan shells. Nor is the left valve the larger one as in *Physocardia*, but on the contrary the right one.¹

One of the most remarkable characters of generic importance in my Indian shells is the absence of any cardinal teeth. This character excludes any affinity with such genera of the family of *Megalodontidae* as might otherwise put in a claim for closer comparison. After having examined carefully a considerable number of casts, I may safely state that no trace of cardinal teeth has been discovered, and that the only indication of a hinge-apparatus are small grooves in the vicinity of the posterior terminations of the cast which correspond to low and narrow lateral teeth, such as have been developed in *Cardinia* Agassiz. But even these lateral teeth are ill-defined and considerably smaller than in the latter genus.

The similarity of the hinge-apparatus to that of *Cardinia* will probably indicate more nearly the true relationship of our shells. Among the family of *Cardiniidae* it is chiefly the genus *Pachycardia* v. Hauer, to which they might be compared. The examples of *Pachycardia rugosa* from the Seiseralpe (abundant as they are in the beds holding an intermediate position between the zones of St. Cassian and Raibl) do not give an exact idea of the shape of the entire shell, because the two valves have scarcely ever been found united. For this purpose the smaller variety (*Pachycardia Haueri* v. Mojs.) is better suited. It agrees with the Himálayan shells in the cordiform shape of its valves, which are strongly inequilateral with inflated umbones and with their ventro-posterior region compressed and elongated. The considerable thickening of the shell in the umbonal region is also a character common to both of them. There is, however, no diagonal keel developed extending from the apex to the posterior angle of the ventral margin. Nor are the two valves of unequal size as in my Indian genus.

The greatest difference between *Pomarangina* and *Pachycardia* consists in the arrangement of the hinge-apparatus. In *Pachycardia* cardinal teeth are always distinctly developed, although the shape and dimensions of the teeth are subject to great variation, and in some specimens a tendency towards simplification of the hinge-apparatus is obvious. This tendency is clearly marked in the right valves of *Pachycardia Plieningeri* Broili (Die Fauna der Pachycardientuffe der Seiseralp Palæontographica Vol. L, 1903, p. 213, Taf. XXVI, fig. 18, XXVII, fig. 1). The left valve of *Pomarangina* has neither cardinal teeth nor grooves for the reception of teeth fixed to the hinge of the opposite valve. The hinge of the right valve has not been laid bare in all its details, but the presence of any cardinal tooth is highly improbable.

¹ It is only by a mistake that S. v. Woehrmann in his diagnosis of *Physocardia* designates the shell as equivalve. It only needs a glance at the illustrations given by him to see the considerable difference in the relative size of the two valves.

I consider the new genus *Pomarangina* as a representative of the family of *Cardiniidae*, and as nearly related to *Pachycardia* Hauer.

POMARANGINA HAYDENI nov. sp. Pl. X, figs. 5, 6.

Shells strongly inflated, cordiform, inequivalve and inequilateral. The difference in the size of the two valves is subject to some variation. The two specimens figured may be considered as extreme types. In the example illustrated in fig. 6 the two valves do not differ in size considerably, whereas in the specimen illustrated in fig. 5 the right valve is remarkably larger than the left one. The ventro-posterior region is compressed and elongated, the anterior portion is shortened and provided with a steep slope. The hinge-line projects beyond the anterior lateral margin, which it joins in a rounded-off angle. The valves are not gaping at their ventral margins.

The specimens are frequently preserved with their test but are then as a rule more strongly deformed and injured than casts. The shelly substance is comparatively thick in proportion to the dimensions of the shell, especially so in the umbonal region. The umbones are prosogyrate, incurved and nearly touch each other. The great thickness of the test imparts to the shells, in which it has been preserved, an aspect very different from that of the cast. Below the apices a small anterior lunula is developed. It is not distinctly defined although more so than the small posterior areola.

The test is covered with numerous concentric ridges, which become more crowded in the umbonal region, but stronger towards the pallial margin. A radial sculpture does not exist. Of this strong and characteristic ornamentation no trace is noticed on the casts.

A description of the hinge-apparatus has been given in the diagnosis of the genus.

Dimensions.

Entire length of the shell	.	.	.	.	50 mm.
" height " " "	.	.	.	.	61 "
Height of the left valve	.	.	.	.	56 "
Thickness of both valves	.	.	.	.	51 "

Locality and geological position.—This species seems to be rather richly represented in the upper horizon of the grey beds. It is the most common bivalve in this horizon between Pomarang and Mani. It is also known from the fossiliferous brachiopod bed, W. of Lilang.

CEPHALOPODA.

AMMONOIDEA.

TRACHYCERAS sp. ind. (group of TRACHYCERATA ACANTHICA).

Pl. XI, fig. 12, Pl. XII, fig. 1.

1900. *Trachyceras* cf. *Aonoides* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 216.

In the lower horizon of the grey beds of Spiti casts of *Trachyceras* are not rare, but are only preserved in fragments, none of them permitting a specific determination. The very narrow circumscription of species introduced in the genus *Trachyceras* and its allies by E. v. Mojsisovics makes an identification of specimens impossible, if one has not to do with well and completely preserved material. I must therefore be satisfied with signaling the presence of different species of *Trachyceras*, two of them belonging undoubtedly to the group of *T. acanthica*. Among the fragments available for examination, those which are most conspicuous and better preserved have been chosen for illustration.

That the fragments before me belong to *Trachyceras*, not to *Protrachyceras*, is proved by the presence of a double row of external tubercles on either side of the siphonal furrow. This furrow is deeply excavated and meets the ribs adorned by the external tubercles obliquely at acute angles. This character prevents my types from being included with the group of *Trachcerata duplica*, in which the siphonal furrow is crossed by the external ribs at right angles.

In a small number of casts fragments of the inner whorls have been preserved. These fragments differ from the outer volution by a more globose shape and by a robust sculpture, as is obvious from the example illustrated on Pl. XI, fig. 12. It is chiefly this character which induced me to group my Indian specimens with the group of *Trachyceras acanthica*, not *margaritosa*.

The two types illustrated in this memoir have been compared to *Trachyceras Aonoides* Mojs., the well-known leading fossil of the jolic substage, by A. v. Krafft. "The Indian species cannot"—he says (l. c. p. 216)—"be said to be perfectly identical with the European types, but so much is certain that it resembles none of the European forms of *Trachyceras* as closely as it does *T. Aonoides* v. Mojsisovics" (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 687, Taf. CXCI, figs. 1-3, Taf. CXCI, figs. 1-4).

With this view I cannot agree. Apart from the difference in the shape of the inner nuclei, as is evident from the specimen illustrated on Pl. XI, fig. 12, there is one important feature of distinction between all my Indian specimens and *Trachyceras Aonoides*, and that is the smaller number of spiral rows of tubercles. In *T. Aonoides* the number of such rows is never less than seventeen, but often rises to 20 and occasionally even to 25. In my Himalayan types it is from 13 to 15 only. Otherwise there is undoubtedly a great similarity to *T. Aonoides* in the

respective characters of ribs and tubercles ; but a similar type of ornamentation is found in many species of *Trachyceras*. The interpretation of species introduced in this genus by E. v. Mojsisovics is so narrow that the differences between them become obvious only after a very careful examination of the illustrations, supported by a comparison of the text, which latter unfortunately lays no special stress on rendering the characters of distinction conspicuous.

Among the casts compared to *Trachyceras Aonoides* by A. v. Krafft, two shapes can be distinguished, differing by the outlines of their cross-sections. In the example illustrated on Pl. XI, fig. 12, the transverse section is triangular. Its greatest diameter coincides with the sharp umbilical edge. From this place the lateral parts converge gradually towards the narrow siphonal area. The external rows of tubercles are situated on elevated ridges, which are marked off distinctly from the general surface of the shell. *Trachyceras Goiserami* E. v. Mojsisovics (l. c. p. 665, Taf. CLXXXVII, fig. 6) might perhaps be compared to this type among European species.

The second shape is represented by the cast illustrated on Pl. XII, fig. 1. It is provided with flat and nearly parallel lateral parts, recalling in this respect *Trachyceras Maximiliani* v. Mojsisovics (l. c., p. 661, Taf. CLXXX, figs. 1, 2). With this species it also agrees in the faint development of tubercles between the umbilical and marginal rows in the outer volution.

Locality and geological position.—*Base of grey beds, west of Thabo, N.-N.-W. of Muth.*

TRACHYCERAS sp. ind. ex aff. ARIÆ Mojs. Pl. XI, figs. 13, 14.

1900. *Trachyceras aff. Ariæ* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 216.

A second group of forms is represented by such specimens as have been compared to *Trachyceras Ariæ* E. v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. Geol. Reichsanst., VI-2, p. 654, Taf. CLXXVI, fig. 3), or to *Trachyceras Griseldis* v. Mojsisovics (l. c. p. 658, Taf. CLXXVIII, figs. 1, 2) by A. v. Krafft. The illustration on Pl. XI, fig. 14, gives a view of the inner nuclei of that species. The cast illustrated on Pl. XI, fig. 13, is a full-grown example of larger size. Its last volution differs from the inner nucleus chiefly by the shape of the cross-section, which is slender and provided with a very narrow siphonal part. The measurements of this specimen are as follows :—

Diameter of the shell . . .	58 mm.
„ „ „ umbilicus . . .	10 „
Height } of the last volution .	{ 29 „
Thickness }	{ 18 „
Distance of the external edges	45 „

A. v. Krafft's determination has already come near the true relationship of this species, in so far as *Trachyceras Ariæ* and *T. Griseldis* are both representatives of the section of *T. acanthica*. The species agrees with *T. Ariæ* in the development of

umbilical and latero-marginal spines, some of them exceeding the rest of the tubercles considerably in size. But this development of true spines is more faintly marked than in *Trachyceras Ariae* and much more faintly than in *T. Griseldis*. Nor do the Indian and European specimens agree in the number of spiral rows of tubercles. *Trachyceras Ariae* has eleven rows, whereas thirteen are counted in the Himálayan examples.

Locality and geological position.—Base of grey beds, W. of Thabo; Banna encamping ground, Thanam valley.

TRACHYCERAS sp. ind.

1900. *Trachyceras* cf. *Aonoides* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 216.

In his stratigraphical notes on the mesozoic rocks of Spiti A. v. Krafft mentions "crushed specimens of *Trachyceras*, closely resembling *T. Aonoides* in sculpture, from N.-N.-W. of Muth (coll. Krafft) and from the right bank of the Lipak river, above Lipak encamping ground (coll. Hayden)."

The specimens before me are crushed so severely, that the shape of their external parts is no longer accessible to examination. As the distinction of *Trachycerata duplica* and of *T. acanthica* or *T. margaritosa* is based on the character of external ribs and tubercles, it is impossible to determine the group of the genus *Trachyceras*, to which the specimens belong. In their mode of preservation they recall strongly the casts of *Trachyceras* which are rather common in the so-called Aonschiefer of lower Austria, or of *Trachyceras Attila* Mojs. in the marls of Veszprem (Hungary).

PARATROPITES sp. ind. Pl. XII, fig. 4.

1900. *Distichites* cf. *Goebli* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 217.

This specimen is mentioned here only, because it has been erroneously compared to *Distichites Goebli* Mojs. of noric age. It is a small cast with few remnants of the shelly substance adhering, and too badly preserved to permit a safe determination. But its generic affinities are more close to *Paratropites* than to *Distichites*. *Distichites* is characterised by the presence of two siphonal keels bordering a median furrow. These keels are always distinctly defined, even in casts without their shelly covering. Of such keels nothing is noticed on the cast before me. The only interruption which I can find in the regular curve of the siphonal part is a trace of a median elevation, comparable to an embryonic keel, as it is sometimes found in casts of *Tropitidæ*. The illustration of *Paratropites Trinker* v. Mojsisovics (Cephalopoden der Hallstätter Kalke. Abhandl. K. K. Geol. Reichsanst., VI-2, Taf. XCV, fig. 13b) is a good instance of this type of fossil, in which the keel, although very strongly developed on the shells, is but very faintly

marked on the casts. The small umbilicus and the sculpture consisting of sigmoidal ribs rising from umbilical tubercles is also in favour of an identification of our specimen with *Paratropites*.

The sutures are but partly known to me. The lobes are provided with deep digitations. The saddles are brachyphyllic with entire tops.

Dimensions.

Diameter of the shell	.	.	.	.	.	.	.	.	.	23 mm.
" " " umbilicus	.	.	.	.	.	.	.	.	.	5 "
Height	} of the last volution	.	.	.	.	.	.	.	.	{ 12 "
Thickness		.	.	.	.	.	.	.	.	{ 9.5 "

Locality and geological position.—Upper horizon of grey beds, W. of Lilang.

CARNITES FLORIDUS Wulfen. Pl. XII, fig. 2.

1793. *Nautilus floridus* Wulfen, Ueber den Kärnthnerischen, pflanenschweifigen Helmintholith, p. 113, Taf. XVIII, fig. 16, XXII, fig. 15, 16, XXIII, fig. 16.
1846. *Ammonites floridus* v. Hauer, Ueber die Cephalopoden des Muschelmarmors von Blättberg, Haidinger's Naturwissensch. Abhandl. I, Bd. p. 22, Taf. I, figs. 5-14.
1873. *Pinacoceras floridum* v. Mojsisovics, Die Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 58, Taf. XXII, figs. 15, 16, XXV, fig. 1-6.
1882. *Carnites floridus* v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichsanst., Bd. X, p. 228, Taf. L, figs. 5-8, LI, figs. 1-3.
1899. *Carnites floridus* Diener, Mittheilungen über einige Cephalopodensuiten aus der Trias des südlichen Bakony. Aus dem paläontologischen Anhang zum Resultate der wissenschaftlichen Erforschung des Balatonsees, Bd. I, 1 Theil, p. 17.
1902. *Carnites floridus* v. Mojsisovics, Die Cephalopoden der Hallstätter Kalke, l. c. VI-1, Supplementb., p. 312.
1905. *Carnites floridus* Frech, Nachträge zu den Cephalopoden und Zweischalern der Bakonyer Trias. Resultate der wissenschaftl. Erforsch. des Balatonsees, I, Bd., 1 Th. Nachtrag., p. 18, figs. 23-25.
1900. *Hauerites nov. sp.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, pp. 215, 216.

I am really at a loss to understand what were the reasons which led A. v. Krafft to mistake this wide-spread leading form of the Alpine zone of *Trachyceras Aonoides* for a representative of the noric genus *Hauerites*. A. v. Krafft states that the sutural line differs from the sutures of *Hauerites*. There is, of course, a certain similarity between our Indian species and *Hauerites raristriatus* Hauer, but they can be distinguished at once by the different character of their siphonal parts. Both in *Carnites* and in *Hauerites* the narrow siphonal area is bordered by sharp keels, but in *Hauerites* the region between the two external keels is deeply excavated and smooth, whereas in *Carnites floridus* a distinct median keel is present. Only in a minority of full-grown specimens of *Carnites floridus* the median keel becomes obsolete and threadlike, or the bordering keels are fused into a sharp external edge.

All my Himalayan specimens have a distinctly three-edged siphonal part and cannot therefore be identified with the genus *Hauerites*. The illustrated example belongs to the typical shapes of *Carnites floridus* Wulf. The only character in which it agrees better with *C. falcoifer* Frech (l. c. p. 20) is the strong development

of sickle-shaped ribs. I am, however, obliged to remark, that to me none of the characters of distinction between *Carnites floridus* and *C. falcifer* appears to be of specific importance and that I can see no sufficient reason for separating the shells from the Hallstatt-limestone from those of the Lagerschiefer of Deutsch-Bleiberg in Carinthia.

Dimensions.

Diameter of the shell	43 mm.
" " " umbilicus	3 "
Height of the last { above the umbilical suture	25 "
{ " " preceding whorl	18 "
Thickness of the last volution	9 "

Sutures.—Agreeing exactly with those of the typical shape of *Carnites floridus* from Deutsch-Bleiberg. Two adventitious elements only present.

Locality and geological position.—Base of grey beds, N.-W. of Thabo; river above Lipak encamping ground; Banna encamping ground, Thanam valley, Bashahr.

CARNITES cf. NODIFER Dien. Pl. XII, fig. 3.

1900. *Drepanites nov. sp.* A. v. Kneff, General Report, Geol. Surv. of India, for 1899-1900, p. 216.

Although I disagree with Frech in considering a specific separation of *Carnites floridus* and *C. falcifer* unnecessary, I must concede that the circumscription of *Carnites floridus* Wulf. adopted by E. v. Mojsisovics is wider than the narrow interpretation of the majority of triassic species introduced by that learned author.

There is certainly good reason for separating from the typical *Carnites floridus* two forms at least which are distinguished from that species by characters considerably more remarkable than the insignificant features of distinction between *C. floridus* and *C. falcifer* by Frech. One of these two forms is provided with three adventitious elements in the sutural line. It is represented in the julic substage of the Alpine Trias by the specimen from Bleiberg illustrated by E. v. Mojsisovics in the first volume of his "Cephalopoden der Hallstaetter Kalke" (Abhandl. K. K. Geol. Reichsanst., VI-1) on Pl. XXV, fig. 4, and in the Himálayan Trias by a specimen from the Tropites-limestone of Byans, illustrated in my memoir on the fauna of that horizon on Pl. XIV, fig. 1. For this form the new specific denomination of *Carnites multilobatus* is proposed here.

The second form differs from the typical *Carnites floridus* by the shape of its cross-section and by the development of strong lateral and marginal tubercles in more advanced stages of growth. The entirely preserved specimen from Deutsch-Bleiberg illustrated by E. v. Mojsisovics in his "Cephalopoden der Mediterranen Triasprovinz" (Abhandl. K. K. Geol. Reichsanst., X) on Pl. LI, fig. 8, and the body-chamber fragment from the same locality illustrated by that author in his above-quoted memoir on the Cephalopoda of the Hallstatt-limestone on Pl. XXI, fig. 6, are representatives of this species, for which the new specific name of *Carnites nodifer* might be introduced.

To this species of *Carnites* a fragment from the grey beds of Spiti is referable with some reserve, due to its incomplete state of preservation. It consists of air-chambers and exhibits strong marginal and lateral tubercles. Its transverse section agrees with that of the large specimen from Bleiberg illustrated by E. v. Mojsisovics. From the external keels the lateral parts slope roof-shaped to the marginal tubercles, where their direction is changed rather abruptly. The siphonal area enclosed by the two keels is rather broad and the median keel is reduced to a broadly vaulted elevation.

Sutures.—Agreeing exactly with those of the type-specimen from Bleiberg. Two adventitious elements only are developed.

Locality and geological position.—Base of grey beds, N. of Thabo.

MONOPHYLLITES sp. ind. aff. SIMONYI Hauer. Pl. XII, fig. 7.

A fragment from the base of the grey beds, W. of Thabo, is a representative of the group of *Monophyllites sphærophyllus* Hauer. Its shell was covered with numerous transverse striæ which I was unfortunately obliged to destroy in my attempts to make the sutural line accessible to examination. The fragment is strongly crushed and does not give any clue as to the true proportions of height and thickness in the original specimen. But it did certainly belong to an example of large size, scarcely inferior in its dimensions to the largest types of *Monophyllites Simonyi* Hauer from the juric Hallstatt-limestone of the Roethelstein near Aussee.

The sutural line is very distinctly visible. It strongly recalls the sutures of *Monophyllites Simonyi* v. Hauer, as illustrated by E. v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, Taf. XVII, figs. 5, 6), from which it differs in some minor details only. There are three auxiliary lobes and saddles present, two of them standing outside the umbilical margin.

The presence of the genus *Monophyllites* in the grey beds of Spiti is of some stratigraphical importance, as it has as yet never been found in triassic strata of younger than carnic age.

JOANNITES CYMBIFORMIS Wulf. Pl. XII, figs. 5, 6.

- 1793. *Nautilus cymbiformis*, Wulfen, Ueber den Kaerntnerischen pflanenschweifigen Helmintholith, p. 121, Taf. XXIX, XXX.
- 1849. *Ammonites bicarinoides* Quenstedt, Cephalopoden, p. 248, Taf. XVIII, fig. 19.
- 1873. *Arcestes cymbiformis* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 85, Taf. LXI, figs. 1-5, Taf. LXII, fig. 1, Taf. LXIII, fig. 1, Taf. LXV.
- 1892. *Joannites cymbiformis* E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, l. c. X, p. 170.
- 1900. *Joannites cymbiformis* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 216.

In his notes on the mesozoic rocks of Spiti A. v. Krafft states that the true *Joannites cymbiformis* Wulf. was collected by him and by H. Hayden in several sections at the base of the grey beds. I found A. v. Krafft's determination to be

perfectly correct. A considerable number of specimens of *Joannites* is before me, all of them agreeing very well with Wulfen's Alpine species. They are provided with three varices in the circumference of one volution. The varices are turned forward distinctly when crossing the siphonal part, as is seen especially well in the back view of the specimen illustrated on Pl. XII, fig. 5.

In two examples the sutural line is accessible to examination in all its details. It agrees entirely with the sutures of *Joannites cymbiformis*, showing eight saddles altogether outside the umbilical margin.

Dimensions.

	Fig. 5.	Fig. 6.
Diameter of the shell	. 57 mm.	81 mm.
„ „ umbilicus	. 3 „	6 „
Height of the last { above the umbilical suture	. 30.5 „	42 „
volution { „ preceding whorl	. 12 „	16 „
Thickness of the last volution	. 27 „	34 „

Locality and geological position.—Base of grey beds, N.-W. of Muth; between Pomarang and Mani; right bank of Lipak river, above Lipak encamping ground; W. of Thabo; W. of Lilang; Banna encamping ground, Thanam valley, Bashahr.

Remarks.—As has been stated by A. v. Krafft, the species from the grey beds, agreeing in all its characters with the true *Joannites cymbiformis*, is certainly different from the species of *Joannites* from the carnic Traumatocrinus limestone of the Shalshal cliff, referred to *J. cymbiformis* as *cf.* by E. v. Mojsisovics (Himál. Foss., Vol. III, Pt. 1, p. 101).

IV.—FOSSILS FROM THE TROPITES BEDS.

In the carnic deposits of Spiti there are, according to the descriptions of H. Hayden and A. v. Krafft, two distinct Cephalopod horizons present, separated from each other by beds of not less than 900 feet in thickness.

The lower horizon with *Joannites cymbiformis* forms the base of the grey beds, the upper one with *Tropites div. sp. ind.* is separated from the brachiopod horizon of the grey beds with *Dielasma Haydeni* by splintery dark limestones, grey shaly limestones and calcareous shales alternating with grey earthy shales of at least 600 feet in thickness. The fauna of the *Tropites* horizon is concentrated in a bed of nodular limestone of 15 feet in thickness. The following Cephalopoda have been determined by A. v. Krafft:—

- Tropites cf. subbullatus* Hauer.
- „ *cf. discobullatus* Mojs.
- „ *cf. fusobullatus* Mojs.
- „ *cf. torquillus* Mojs.
- Juvavites sp. aff. Baechus* Mojs.

Sagenites sp. aff. *Herbichi* Mojs.

„ sp. aff. *erinaceus* Dittm.

Sandlingites nov. sp.

Sirenites nov. sp.

(?) *Heracrites* nov. sp.

Clydonautilus Griesbachi Mojs.

Nautilus sp. ind.

This nodular limestone with *Tropites* was correlated with the zone of *Tropites subbullatus* (tuvalic substage) of the Alpine Trias by A. v. Krafft.

Seventy feet above the nodular limestone with *Tropites*, some specimens of *Parajuavites* nov. sp. were discovered in a dark splintery limestone with alternations of grey shaly limestone and calcareous shales, which continue with the same lithological characters for the next 200 feet. One specimen of the same species was found loose by A. v. Krafft on the nodular limestone with *Tropites*. As he considered it impossible that under the existing circumstances it could have rolled down from a higher horizon, he assumed that it actually belonged to the nodular limestone. He consequently included the upper horizon, in which the species was found *in situ*, in the *Tropites* beds.

The *Tropites*-limestone of Spiti is, indeed, a cephalopod horizon in which as yet no other fossils but cephalopoda—both *Nautiloidea* and *Ammonoidea*—have been found. Nearly all the fossils are, unfortunately, badly preserved. They are altogether not very numerous, and the majority are fragmentary casts with their surface much damaged by weathering. Although they generally admit of a generic determination, it is but rarely possible to arrive at a satisfactory identification of the species. All the examples determined by A. v. Krafft have been mentioned in the text, but a small number of specimens only have been chosen for illustration.

A. NAUTILOIDEA.

CLYDONAUTILUS ACUTILOBATUS nov. sp. Pl. XIII, fig. 1.

1900. *Clydonautilus Griesbachi* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 219.

This species is represented by a very large and tolerably well-preserved specimen, which has been identified with *Proclydonautilus Griesbachi* v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 123, Pl. XXII, fig. 1) from the *Hauerites* beds of the Bamnanag section by A. v. Krafft. I am sorry I cannot agree with this identification. A division of the siphonal lobe by a flat median prominence proves our specimen to belong to the genus *Clydonautilus* in the restricted circumscription as adopted by E. v. Mojsisovics in the "Supplementband" of his "Cephalopoden der Hallstaetter Kalke" (Abhandl. K. K. Geol. Reichsanst., VI-1, Supplem., p. 206), not to *Proclydonautilus*.

In its external characters this specimen stands certainly very near *Proclydonautilus Griesbachi* Mojs. and *Clydonautilus biangularis* Mojsisovics (l. c. p. 124, Pl. XXII, figs. 2, 3). It is provided with a flat siphonal area, which is divided off from the lateral parts by distinct angles. The sides diverge from these marginal angles very regularly towards the place of the greatest inflation of the shell, which corresponds to the region of the lateral saddles. An umbilical margin is not distinctly defined, but the cast descends in a very steep curve from the place of greatest inflation to the open and comparatively wide umbilicus. The umbilicus is too large to have been closed by a callosity.

The cast is entirely smooth without any trace of ornamentation.

Dimensions.

Diameter of the shell	.	.	.	255 mm.
"	"	umbilicus	.	28 "
Height	}	of the last volution	.	{ 146 "
Thickness	}		.	{ 84 "

Sutures.—My specimen is provided with its body-chamber, to which one-third of the last volution belongs. The septa of the two last air-chambers stand more closely to each other than the preceding ones. The sutures differ from those of *Clydonautilus biangularis* by the acutely rounded shape of the deep lateral lobe. The siphonal saddle is situated entirely on the lateral parts, not on the marginal angle, as in *Proclydonautilus Griesbachi*. The median elevation of the siphonal lobe is very flat and low, but sufficiently well marked, to distinguish our specimen from *Proclydonautilus*.

Siphuncle.—Above the middle of the distance between the external parts.

Locality.—E. above Lilang.

Remarks.—Our species is nearly allied both to *Proclydonautilus Griesbachi* and to *Clydonautilus biangularis* Mojs. It differs from them by its wide umbilicus, which was probably open, not closed by a callosity, and by its deep, acutely rounded lateral lobe. From *Proclydonautilus* it is distinguished, moreover, by the presence of a median prominence, which, although flat and low, distinctly separates the siphonal lobe into two halves.

Clydonautilus biangularis has been compared with *Gonionautilus Quenstedti* Hauer by E. v. Mojsisovics. In its external characters and in the shape of its deep, acutely rounded lobes the present species bears even a greater similarity to *Gonionautilus Quenstedti* than does *Cl. biangularis*. The Alpine form is provided with an internal lobe, which is certainly absent in the Indian type from the Halorites limestone of the Bambanag section. It could not be decided whether or not an internal lobe is developed in *Clydonautilus acutilobatus*. Nor is it possible to state whether the shell was covered with radial folds as in *G. Quenstedti* and *G. Salisburgensis* or was smooth, as in *G. securis* Dittm., my type-specimen of *Cl. acutilobatus* being a cast entirely devoid of the shelly substance.

CLYDONAUTILUS sp. ind. Pl. XV, fig. 7.

The cast of a small *Nautilus* from the Tropites beds W. of Lilang is lying before me. It is too badly preserved to permit a specific identification, but is certainly different from *Proclydonautilus Griesbachi* Mojs., because it has the marginal edges very distinctly defined and not rounded, notwithstanding its small dimensions. Its siphonal area is comparatively broad, measuring 11 mm. with a diameter of the shell of 34 mm., quite as much so as in the case of *Proclydonautilus Griesbachi* with a diameter of 45 mm.

The sutural line not being known to me it is impossible to decide whether this species must be grouped with *Clydonautilus s. s.* or with the subgenus *Proclydonautilus*.

GERMANONAUTILUS cf. BREUNNERI v. Hauer. Pl. XIII, fig. 2.

1847. *Nautilus Breunneri* F. v. Hauer, Neue Cephalopoden von Aussee, Haidinger's Naturwissensch. Abhandl. I, p. 262, Taf. VIII, figs. 1-3.

1902. *Germanonautilus Breunneri* E. v. Mojsisovics, Cephalopoden der Hallstatter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, Supplementbd., p. 240, Taf. IX, fig. 2.

A chambered fragment of a strongly inflated *Nautilus* with a smooth shell, a broad siphonal area and very simple sutures agrees very closely with the same species from the jolic Hallstatt-limestone of Aussee.

The whorls embrace one another to more than one-half their height, being much broader than high, and increasing in width more rapidly than in height. The transverse section is trapezoidal with rounded-off angles. The siphonal area is very broad and flattened. The lateral parts converge slightly from the rounded-off umbilical to the siphonal margins. The umbilical wall is very high and vertical.

Fragments of the shelly layer are of remarkable thickness.

Dimensions.

Diameter of the shell	.	.	.	.	.	.	.	61.5 mm.
„ „ umbilicus	.	.	.	.	.	.	.	8.5 „
Height of the {	above the umbilical suture	.	.	.	.	.	.	34 „
last volution {	„ preceding whorl	.	.	.	.	.	.	28 „
Thickness of the last volution	.	.	.	.	.	.	.	48 „

Siphuncle.—Very little below the middle of the distance between the external parts.

Sutures.—Septa very close to each other, with a very broad and flat lateral and siphonal lobe. Internal lobe present.

Locality.—W. of Lilang.

A second specimen from the same locality of doubtful stratigraphical position (Tropites or Juvavites beds?) is referable to this species with some reserve only.

GRYPOCERAS sp. ind.

A strongly weathered cast from the Tropites beds W. of Lilang, in its external characters, recalls *Grypoceras Guembeli* v. Mojsisovics (Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 13, Taf. VII, fig. 2), but is of larger size. The umbilicus is comparatively wide, the whorls overlap one another but slightly. Siphonal area not distinctly defined. Sutures agreeing with those of the Alpine species. The specimen is too badly preserved to permit a safe specific determination.

STYRIONAUTILUS cf. SAUPERI v. Hauer. Pl. XIII, fig. 3.

1846. *Nautilus Sauperi* F. v. Hauer, Cephalopoden des Muschelwärmers von Bleiberg in Kaernten, Haidinger's Naturwiss. Abhandl., I, p. 26, Taf. I, figs. 1-4.
 1847. *Nautilus Sauperi* v. Hauer, Cephalopoden von Ansee, *ibid*, p. 261, Taf. VIII, figs. 4, 5.
 1873. *Nautilus Sauperi* E. v. Mojsisovics, Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 28, Taf. XIV, figs. 5, 6, XV, fig. 1.
 1891. *Nautilus Sauperi* Foord, Catalogue of the fossil Cephalopoda of the British Museum, Pt. II, p. 185.
 1902. *Styrionautilus Sauperi* E. v. Mojsisovics, l. c. Supplementband, p. 209.

A fairly well-preserved cast, comprising the body-chamber, agrees very closely with *Styrionautilus Sauperi* Hauer, one of the more common species of *Nautilidæ* from the zone of *Trachyceras Aonoides* in the Eastern Alps. From the family of *Gryponautilidæ* our specimen is distinguished at once by its small umbilicus, which in the shell was probably closed by a callosity. The narrow siphonal area is separated from the strongly diverging lateral parts by indistinct margins, which are rounded off bluntly. The greatest diameter corresponds to the steeply rounded umbilical margin.

Dimensions.

Diameter of the shell	68 mm.
" " " umbilicus	1.5 "
Height } of the last volution	43 "
Thickness }	41 "

Siphuncle.—Not known.

Sutures.—Agreeing in general with those of the Alpine specimen illustrated by E. v. Mojsisovics, but the lateral lobe is more flatly rounded. Siphonal lobe flat but distinctly developed. Lateral saddle high and slender, standing outside the umbilical margin.

PLEURONAUTILUS sp. ind. aff. WULFENI Mojs.

Two fragmentary specimens of ribbed Nautili from the Tropites beds E. of Lilang remind us of *Pleuronautilus Wulfeni* v. Mojsisovics (Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 10, Taf. VII, fig. 3, Supplementbd., p. 243, Taf. X, fig. 1) from the jolic Hallstatt limestone of the

Salzkammergut. They are not fit for illustration on account of their bad state of preservation.

Both specimens are of large size and provided with their body-chambers. They differ among each other somewhat in the rate of involution. In the shape of their cross-sections they agree exactly with the type-specimen from the Feuerkogel illustrated in the "Supplementband" by E. v. Mojsisovics. This cross-section is quadrangular with rounded-off angles. It shows the siphonal area to be flatly vaulted in the chambered portion of the shell, but flat and depressed along the median line in the body-chamber.

There are about twelve radial folds in the circumference of the last volution. Umbilical and marginal tubercles are very distinctly developed. In one of my specimens there was a third row of lateral tubercles developed, but not regularly, a considerable number of ribs showing no traces of lateral tubercles. E. v. Mojsisovics noticed also faint lateral tubercles in one of his specimens of *Pl. Wulfeni*.

A longitudinal striation of the shell, as is characteristic of *Pleuromutilus Wulfeni*, is certainly absent in the present species. Fragments of the shelly substance adhering to the cast of my smaller example do not show any trace of spiral lines.

Sutures.—Both the siphonal and lateral lobes are very flat and separated by a broadly vaulted saddle.

Remarks.—From *Pleuromutilus tibeticus* v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 120, Pl. XXI, fig. 3) the present species differs by the shape of its cross-section, and by the stronger development of umbilical tubercles. It is perhaps more closely allied to *Pleuromutilus f. ind.* Mojsisovics (l. c. p. 121), from the Daonella beds of Lauka. It agrees with the latter species in the absence of any longitudinal sculpture, but is distinguished by its deeper lateral lobes.

B. AMMONOIDEA.

TROPITES cf. SUBBULLATUS v. Hauer. Pl. XIV, figs. 2, 3.

1849. *Tropites subbullatus* F. v. Hauer, *ex parte*, Ueber neue Cephalopoden aus den Marmorschichten von Hallstatt und Aussee. Haidinger's Naturwiss. Abh., III, p. 19, Taf. IV, figs. 1-4, non 5-7.

For a complete list of synonyms my memoir on the fauna of the Tropites limestone of Byans (this vol., Pt. 1) should be consulted.

1900. *Tropites cf. subbullatus* A. v. Krafft, General Rep., Geol. Surv. of India, for 1899-1900, p. 218.

The genus *Tropites* is rather richly represented in the Tropites beds of Spiti. Among the Ammonites collected in this horizon by Hayden and A. v. Krafft, especially near Lilang and Tikha, two-thirds of the entire number of specimens belong to this genus. But the majority are casts not permitting a specific determination. The list of examples, which can be identified or compared very closely with European species, is a small one only. Of the four species enumerated by A. v. Krafft, three have been based on specimens worthy of illustration. The fourth, *Tropites cf. fusobullatus* Mojs., is too badly preserved for any specific description.

Tropites subbullatus, the chief leading fossil of the tuvalic substage in Europe, is represented by several inner nuclei of the characteristic tun shape but rather badly preserved, and by two larger specimens, which have been chosen for illustration. But among the specimens of *Tropites* referred to this genus as *sp. ind.* the majority probably also belong to this species.

One of the two figured examples is an adult individual, with a large part of its body-chamber preserved. The other is a chambered cast, which has been broken off near the beginning of the body-chamber. It agrees very closely with the example illustrated by E. v. Mojsisovics in Abhandl. K. K. Geol. Reichsanst. VI-2, Taf. CX, fig. 6, but has a somewhat stronger ribbing. Traces of umbilical tubercles, from which the ribs rise either singly or in pairs, are but faintly indicated. The keel is distinctly marked, but not bordered by deep furrows.

In the adult individual, which has, unfortunately, been deformed by pressure in the rocks, the keel is more strongly developed and separated from the siphonal part by comparatively deep and broad keel-furrows. In its outlines and sculpture this example comes very near the typical shapes of *Tropites subbullatus*, as illustrated by E. v. Mojsisovics on Pl. CVI of his above-quoted memoir.

Dimensions.

	Fig. 2.	Fig. 3.
Diameter of the shell .	52 mm.	62 mm.
" " " umbilicus .	18 "	27 "
Height	{ 21 "	17 "
Thickness	{ 25 "	33 "

Sutures.—Not known.

Locality.—E. above Lilang, Tikha.

TROPITES DISCOBULLATUS v. Mojsisovics. Pl. XIV, fig. 1.

1893. *Tropites discobullatus* E. v. Mojsisovics, Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 212, Taf. CII, figs. 7, 8, CIV, figs. 1-6, CV, figs. 2, 3, 4, 7.
1896. *Tropites cf. discobullatus* E. v. Mojsisovics, Denkschr. Kais. Akad. d. Wiss. math. nat. cl., Bd. LXIII, p. 613, Taf. XI, fig. 7.
1899. *J. f. ind. cf. discobullatus* E. v. Mojsisovics, Palæontologia Indica, Himál. Foss., ser. XV, Vol. III, Pt. 1, p. 78, Pl. XI, fig. 7.
1900. *Tropites cf. discobullatus* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.
1906. *Tropites discobullatus* Diener, Fauna of the Tropites limestone of Byans, Himálayan Fossils Pl. V, Pt. 1, p. 147, Pl. IV, fig. 1.

Two specimens in the Himálayan collection can be referred to *Tropites discobullatus* with absolute certainty. They agree more closely with the typical form from the tuvalic Hallstatt limestone than the species from the Tropites limestone of Byans, which shows slight differences in the shape of its keel and keel-furrows. In the specimens from Spiti the keel is not accompanied by distinct furrows. The arrangement and curvature of the ribs is exactly the same in the Indian and Alpine forms.

In the illustrated specimen the umbilicus is narrower than in any of the Alpine types figured by E. v. Mojsisovics. But in my second specimen the proportions of the diameter of shell and umbilicus agree perfectly with those of the example from the Raschberg illustrated by E. v. Mojsisovics on Pl. CIV, fig. 2. In this specimen the surface of the shell has been partly injured by weathering. Its ribbing has been obliterated almost entirely, but the umbilical tubercles are still distinctly, though faintly, developed near the beginning of the last volution.

Dimensions.

	(Specimen figured.)
Diameter of the shell	74 mm.
" " " umbilicus	14.5 "
Height } of the last volution	31.5 "
Thickness }	31 "

The measurements of the second specimen are as follows :—

Diameter of the shell	57 mm.
" " " umbilicus	17 "
Height of the last { above the umbilical suture	25 "
volution { " " preceding whorl	17 "
Thickness of the last volution	22 "

Sutures.—Identical with those of the Alpine type of *Tropites discobullatus*, as illustrated by E. v. Mojsisovics on Pl. CV, fig. 2b. Two lateral saddles, which are dolichophyllic and more deeply incised than in *T. subbullatus*. The first auxiliary saddle recalls the second lateral saddle both in size and outlines and is divided by the umbilical edge. The siphonal lobe is deeper than the principal lateral lobe.

Locality.—W. of Lilang.

TROPITES cf. TORQUILLUS Mojsisovics. Pl. XIV, fig. 4.

1895. *Tropites torquillus* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 210, Taf. CIII, figs. 1-8, CIV, fig. 4.

1900. *Tropites cf. torquillus* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

An inner nucleus with a small fragment of the body-chamber adhering agrees very closely with the Alpine types of *Tropites torquillus* Mojs. The volutions are strongly inflated, with their greatest diameter corresponding to the umbilical edge. The umbilicus is comparatively narrow, funnel-shaped and bordered by vertical walls. Within the umbilicus parts of the inner whorls are exposed, the involution not taking place exactly at the umbilical margin. The lateral parts converge in regular curves towards the broadly rounded siphonal part. The globose shape of this nucleus differs remarkably from the tun shape of equally sized inner nuclei of *Tropites subbullatus* v. Hauer. Its comparison with the nucleus of *Tropites torquillus* from the tuvalic Hallstatt limestone of the Raschberg, illustrated by E. v. Mojsisovics on Pl. CIII, fig. 6, shows a complete agreement, which might perhaps have led me to a direct identification of my Himalayan specimen with the European form, if such an identification could be based safely on the knowledge of inner nuclei only.

In the ornamentation also the two types agree very closely. Even longitudinal striæ, so common in the vicinity of the keel of *Tropites torquillus*, are very distinctly developed in my Himálayan example.

Dimensions.

Diameter of the shell	31 mm.
" " " umbilicus	6 "
Height of the last volution	14 "
Thickness " " "	24 "

Sutures.—The last septum, along which the body-chamber has been broken off, is clearly exposed to examination.

Sutures identical with those of *Tropites torquillus*. One single lateral lobe and saddle only are present. An auxiliary lobe and a small auxiliary saddle stand outside the umbilical edge. The difference from *Tropites subbullatus* in the shape of the lateral lobe, as stated by E. v. Mojsisovics, is rather insignificant. The median point of this lobe is the deepest, but exceeds the neighbouring point in length very little only.

Locality.—Tikha.

TROPITES sp. ind. aff. PARACELSI Mojs.

A cast from the Tropites shales E. above Lilang, which has been strongly distorted and crushed by compression, recalls *Tropites Paracelsi* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 191, Taf. CXCVI, fig. 5) and of the Indian form from the Tropites limestone of Kalapani (Himálayan Foss., Vol. V, Pt. 1, Pl. IV, fig. 5) referred to this species.

The umbilicus seems to have been very wide and shallow. The umbilical edge is adorned with strong tubercles, from which the ribs rise either in pairs or (more rarely) singly. The ribs are separated by broad intercostal spaces, and cross the lateral parts in flat curves which are turned forward towards the aperture. The number of ribs is greater than in the type from the Tropites limestone of Byans.

The specimen is not fit for illustration on account of its bad state of preservation. Nor has it been possible to establish with certainty its affinity to the European species.

PARATROPITES TIKHENSIS nov. sp. Pl. XIV, fig. 5.

There is no species of *Paratropites* hitherto known in which the subgeneric characters are as prominently developed as in the present form. The whorls are high-mouthed, considerably higher than broad, and the umbilicus is extremely small. The narrow umbilicus makes a distinction from all congeneric species of the tuvalic Hallstatt limestone an easy matter.

The volutions increase in height very regularly. The umbilical suture of the body-chamber whorl does not leave the normal spiral. The greatest transverse diameter coincides with the umbilical edge. The lateral parts are almost flat.

and converge very slightly towards the broadly rounded siphonal area, from which they are divided off by indistinct margins. The keel is high, narrow and bordered by indistinct furrows. All my specimens are casts, which by the strong development of keel and keel-furrows lead us to suppose that these two characters were still more prominent in the original shells.

The sculpture consists of dichotomous or bidichotomous ribs, which are either straight or slightly falciform on the lateral parts and are turned forward strongly in the marginal region. There are about fifteen stem ribs in the circumference of the last volution near the umbilical, but more than fifty secondary ribs near the siphonal margin.

Dimensions.

Diameter of the shell	.	.	. 49 mm.
" " " umbilicus	.	.	. 4 "
Height of the last (above the umbilical suture			. 28.5 "
volution { " " preceding whorl			. 14 "
Thickness of the last volution	.	.	. 20.5 "

Sutures.—Almost identical with those of *Paratropites Saturnus* Dittm., as illustrated by E. v. Mojsisovics in Abhandl. K. K. Geol. Reichsanst., VI-2, Taf. CXV, fig. 12. Only two dolichophyllic saddles outside the umbilical margin. Umbilical lobe broad, with rudimentary saddles. Lateral lobe bifid, terminating in two points of equal length, as in *Tropites subbullatus* Hauer.

Locality.—Tikha, W. of Lilang.

TRACHYSAGENITES cf. HERBICHI v. Mojsisovics. Pl. XV, fig. 2.

1893. *Sagenites Herbichi* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 180, Taf. CI, fig. 3, CII, figs. 1-6.

1900. *Sagenites aff. Herbichi* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 213.

The figured cast, which is completely chambered, belongs in all probability to a species very closely allied to *Trachysagenites Herbichi* Mojs. from the tuvalic Hallstatt limestone of Aussee.

It is probably the greater height in comparison to the width of the last volution which induced A. v. Krafft to refrain from an identification with the European species. The present specimen is, indeed, remarkably high-mouthed, but in this respect exceeds but little the full-grown specimen illustrated by E. v. Mojsisovics on Pl. CII, fig. 1. I think this difference to be too insignificant to justify the introduction of a new specific denomination for the specimen from Spiti.

At the beginning of the last volution nine spiral rows of spines are counted. The number of rows is increased to eleven near the aperture of this whorl. The transverse ribs are very numerous, closely set, and narrow. In the character of ornamentation my specimen agrees exactly with equally-sized types of *Trachysagenites Herbichi* from the zone of *Tropites subbullatus* near Aussee.

Dimensions.

Diameter of the shell .	52 mm.
" " umbilicus . . .	8 "
Height of the { above the umbilical suture	28 "
last volution { " " preceding whorl	21.5 "
Thickness of the last volution .	23 "

Sutures.—As far as known agreeing with those of *Trachysagenites Herbichi*. Two lateral saddles are distinctly individualized. Siphonal and principal lateral saddle of equal height, slender and richly serrated. Details of their culminating portions not known exactly. One auxiliary lobe outside the umbilical margin.

Locality.—Tikha.

TRACHYSAGENITES nov. sp. ind.

1900. *Sirenites nov. sp. ind.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

An extraordinarily high-mouthed cast of *Trachysagenites* from Tikha has been mistaken for a representative of the genus *Sirenites* Mojs. by A. v. Krafft, but the complete absence of any siphonal furrow or crenulated keels, and the regular arrangement of spines in the different rows disposed along the rounded siphonal part, clearly show that our specimen must be grouped with the section of *Sagenites spinosi*, not with *Sirenites*.

In its involution and outlines this specimen is very similar to the species of *Sagenites* from the Daonella beds of the Bambanag section, which has been described and illustrated by E. v. Mojsisovics in *Himálayan Fossils*, Vol. III, Pt. 1, p. 41, Pl. XI, fig. 10. Its whorls are twice as high as they are wide and are provided with a very narrow umbilicus. Notwithstanding this external resemblance there is no closer relationship between the two species. The form from the Daonella beds has the transverse and longitudinal ornamentations but very slightly developed, whereas in our specimen transverse ribs and spiral rows of spines are distinctly marked. It belongs undoubtedly to a new species of *Trachysagenites*, but on account of its bad state of preservation it is preferable to refrain from the introduction of a new specific name.

TRACHYSAGENITES GALEATUS nov. sp. Pl. XV, fig. 1.

1900. *Sagenites nov. sp. ex aff. S. erinaceus* (Dittm.) A. v. Krafft, Gen. Rep., Geol. Surv. of India, for 1899-1900, p. 218.

A. v. Krafft has been perfectly right in comparing this new species with *Sagenites erinaceus* v. Dittm. from the tuvalic Hallstatt-limestone of Aussee (*vide* E. v. Mojsisovics, *Die Cephalopoden der Hallstaetter Kalke*, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 179, Taf. C., figs. 2-4). It is represented in the Himálayan collection by the cast of a fairly well-preserved specimen, which in spite of its

large dimensions is almost entirely chambered. The body-chamber has been broken off almost completely, the last septum being situated very close to the aperture. With the commencement of the body-chamber a considerable inflation of the whorl along its umbilical region seems to coincide. From this fact it might be suggested that the helmet shape of the cross-section was still more prominent in the body-chamber than in the chambered part of the shell.

The present species differs from *Trachysagenites erinaceus* chiefly by its narrowly rounded siphonal part. Near the commencement of the last volution the lateral parts are vaulted regularly and unite in a broad curve with the rounded siphonal part. In later stages of growth, however, the cross-section assumes an almost triangular shape, the sides converging in slightly curved planes towards the siphonal part which gradually turns sharply rounded and narrow. The greatest transverse diameter coincides with the umbilical region. The umbilicus is comparatively deep and wide and surrounded by a vertical wall.

In the characters of ornamentation this species takes an intermediate position between *Trachysagenites erinaceus* and *T. Herbichi*. The transverse ribs are arranged more closely than in the first species but are smaller in number than in equally sized examples of *Trachysagenites Herbichi*. Nine to eleven longitudinal rows of spines are counted in the last volution.

Dimensions.

Diameter of the shell .	. 99 mm.
" " umbilicus	. 22 "
Height } of the volution .	{ 49 "
Thickness }	{ 62 "

Sutures.—The sutural line is remarkable for the large development of the principal lateral, and for the reduction of the second lateral, saddle. Siphonal lobe shorter than the principal lateral lobe and divided by a pyramid-shaped median prominence. Principal lateral lobe terminating in a single point. Main saddles richly serrated, phylloidic, with two culminating branches. Second lateral saddle very low, touching the umbilical margin with its interior wall.

Locality.—Tikha.

Remarks.—An inner nucleus of *Trachysagenites* reaching a diameter of 18 mm. only from the Tropites beds W. of Lilang, is perhaps referable to this species. It recalls the small specimen of *Trachysagenites erinaceus* Dittm., illustrated by E. v. Mojsisovics on Pl. C, fig. 4 of his above-quoted memoir, but has the transverse ribs more densely crowded.

EUTOMOCERAS sp. ind. aff. PLINII Mojs.

A fragmentary cast of *Eutomoceras* of very large size, not suitable for illustration, recalls *E. Plinii* v. Mojsisovics (Cephalopoden der Hallstätter Kalke, Abhandl. Geol. Reichsanst., VI-2, p. 289, Taf. CXXX, figs. 4, 6). It is provided with

flat and broad ribs, separated by narrow intercostal furrows, which are bordered by low, vertical walls. The absence of any umbilical tubercles forbids an identification with *E. Theron* Dittm. Traces of spiral lines are indistinctly developed, but tubercles or spines are entirely absent. The species certainly belongs to the section of *Eutomocerata striata*, not of *E. punctata*.

Sutures.—Dolichophyllic, richly serrated, agreeing in general with those of *E. Plinii*. The lateral branches along the outer border of the siphonal saddle are even more strongly individualized than in the Alpine species.

This specimen attains very large dimensions, although exact measurements cannot be given on account of its fragmentary state of preservation. To a diameter of the entire shell of 148 mm., a height of the last volution of 85 mm. corresponds.

Locality.—W. of Lilang.

ANATOMITES sp. ind. cf. BACCHUS Mojs. Pl. XIV, figs. 6, 7.

1893. *Juvavites (Anatomites) Bacchus* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl., K. K. Geol. Reichsanst., VI-2, p. 143, Taf. LXXXVII, figs. 14-21.

1900. *Juvavites* sp. aff. *Bacchus* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

Two fairly well-preserved specimens of *Juvavites* with smooth shells have been compared with *Anatomites Bacchus* Mojs. from the tuvalic Hallstatt-limestone of Aussee by A. v. Krafft. They agree in shape and sculpture so closely with the Alpine types illustrated by E. v. Mojsisovics, that I should have ventured on a direct identification, had not slight differences been noticed in the details of the sutural line.

One of my specimens is an inner nucleus, consisting of air-chambers only, the other has a large portion of its body-chamber preserved, to which the last volution almost entirely belongs.

The whorls are strongly inflated and of globose shape, thicker than high, with their greatest transverse diameter corresponding to the umbilical margin, and with very regularly rounded lateral and siphonal parts. The umbilicus is very small and was probably closed by a callosity.

The ornamentation is very delicate, transverse ribs are faintly marked on the inner nucleus (fig. 7), but the surface of the last whorl in my larger specimen (fig. 6) is almost smooth, with the exception of the persistence of the faint keel-like projection in the middle of the siphonal part. In the inner nucleus this median keel-like projection is accompanied by some longitudinal lines, which in crossing the transverse striæ give a reticulated appearance to its siphonal part.

The presence of a faint median keel-like projection might suggest an affinity of our species with *Jovites*, but this suggestion must be at once excluded on account of the difference in the sutures and of the absence of any compression of the shell at the commencement of the body-chamber. In the very faint development of

sculpture my larger specimen recalls *Anatomites Henrici* v. Mojsisovics (l. c. p. 145, Taf. LXXXVIII, figs. 11, 12), from which it is distinguished, however, by its greater inflation.

Dimensions.

	Fig. 6.	Fig. 7.
Diameter of the shell .	57 mm.	36 mm.
„ „ umbilicus .	2 „	2 „
Height } of the last volution	{ 30 „	22 „
Thickness }	{ 32 „	29 „

Sutures.—The sutural line of the last septum has been preserved in the body-chamber specimen illustrated in fig. 6.

The sutures are characteristic of the genus *Juvavites* and cannot for a moment be mistaken for the sutures of either *Halorites* or *Jovites*. They differ from the sutures of *Anatomites Bacchus* by some subordinate details, especially in the broader base of the lateral saddle.

Locality.—E. above Lilang.

JOVITES SPECTABILIS Diener. Pl. XV, fig. 3.

1906. *Jovites spectabilis* Diener, The fauna of the Tropites limestone of Byans, Himalayan Foss., Vol. V, Pt. 1, p. 123, Pl. XVI, fig. 1, IX, fig. 10.

1900. *Parajuvavites* nov. sp. A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

In his stratigraphical notes on the mesozoic rocks of Spiti A. v. Krafft mentions the discovery of numerous specimens of the Indian genus *Parajuvavites* in grey shaly limestones occurring about seventy feet above the layer with *Tropites*. All the specimens referred to *Parajuvavites* by A. v. Krafft are typical representatives of the genus *Jovites* Mojs., as is proved by the character of their siphonal parts and by their sutures.

One specimen is identical with a species of *Jovites* from the Tropites limestone of Kalapani, for which the name of *J. spectabilis* has been proposed. It is of globose shape. The strong inflation, which corresponds to the commencement of the body-chamber, is followed by a gradual compression. The aperture of this specimen coincides with a region of the shell in which a second inflation and widening of the external part begin to set in. The actual peristome was probably situated considerably in front of this aperture, three-quarters of the last volution only belonging to the body-chamber. The opening of the umbilicus is considerable, although it begins only in the anterior portion of the last whorl.

The contrast in the sculpture of the chambered part of the last volution and of the body-chamber is even more distinctly marked than in the type-specimen of *Jovites spectabilis* from Kalapani. In the body-chamber the ribs are coarser and more distant, but not acute.

Dimensions.

Diameter of the shell	.	.	.	.	.	.	63 mm.
Diameter of the umbilicus	{	at the beginning of the last whorl.					2 "
		„ aperture	„	„			13 "
Height	{	of the last volution.					25 "
Thickness							30 "
Height	{	at the beginning of the last volution.					22 "
Thickness							33 "
Height of the last volution above the preceding whorl	.	.	.	.	.	.	18 "

Sutures.—The only character of difference justifying a specific separation of *Jovites spectabilis* from *Jovites bosnensis* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K.K. Geol. Reichsanst., VI-2, p. 52, Taf. LXXXIII, figs. 2, 3) is the arrangement of the sutural line. In this respect my specimen agrees perfectly with the type from Kalapani, not with the European form. Its saddles are provided with numerous and obliquely disposed lateral branches, exactly as in *Jovites spectabilis* Dien. or in *J. daciformis* Dien.

Locality.—E. above Lilang.

JOVITES cf. SICULUS Gemmellaro. Pl. XV, fig. 4, XVI, fig. 1.

1904. *Jovites siculus* Gemmellaro, I cefalopodi del Trias superiore della regione occidentale della Sicilia, Palermo, p. 150, Pl. IV, figs. 9-12.

Two specimens of *Haloritinæ*, referred to *Parajuvavites* by A. v. Krafft, agree so remarkably with *Jovites siculus* Gemm. from the tuvalic limestone of Feudo Modanesi in Sicily that their close specific relationship might, in a better state of preservation, have led perhaps to a direct identification.

The two specimens are strongly crushed, and no exact idea of their transverse sections can be formed from their outlines, but they certainly belong to a high-mouthed and strongly compressed species, which was not considerably inflated. The egression of the widely expanding umbilicus corresponds to the beginning of the last volution.

The sculpture is subject to very little variation throughout the entire length of the last volution. It consists of numerous transverse ribs which bifurcate at various distances from the umbilical margin. In the vicinity of the siphonal margin these secondary ribs, as a rule, dichotomise a second time. Thus the number of external ribs is nearly four times that of the umbilical ribs. The majority of the stem ribs are distinguished from the secondary ones by their greater strength. From the umbilical margin the ribs run in an almost straight direction towards the middle of the height of the sides, where they are curved forward. They cross the siphonal part without interruption, although with remarkably diminished strength.

Dimensions.—Exact measurements of the illustrated specimens cannot be given. To a diameter of the shell of 103 mm. in the larger example (Pl. XVI, fig. 1) there seem to correspond a width of the umbilicus of 9 mm. and a height of the last volution of 40 mm.

Sutures.—Not known.

Locality.—Tikha, E. above Lilang.

Remarks.—The mistake made by A. v. Krafft in referring the present species to *Parajuvavites* is more easily understood than his grouping *Jovites spectabilis* with the latter genus. There is undoubtedly a great external resemblance between the present specimens and *Parajuvavites buddhaicus* v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 31, Pl. VIII, figs. 1-5) from the Halorites limestone of the Bambanag section. The most remarkable features of distinction between *Parajuvavites* and *Jovites* are not accessible to examination on account of my specimens being crushed and somewhat deformed by pressure in the rocks. Nevertheless some characters of difference are clearly marked in our shells. Such characters are the more irregular folding of the ribs and the smooth median region of the siphonal area in *Parajuvavites buddhaicus*. With typical specimens of the latter species at hand for comparison there is no possibility of identifying the present examples with them.

SANDLINGITES nov. sp. ind. aff. REYERI Mojs. Pl. XV, fig. 5.

1900. *Sandlingites nov. sp. ind.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

The fragment of a body-chamber, comprising less than one-half volution, belongs to a typical representative of the genus *Sandlingites* Mojs. It has a quadrangular cross-section and is deeply impressed along the middle of its broad siphonal area. The numerous ribs cross this median excavation without being interrupted.

The present fragment shows some resemblance to the European *Sandlingites Reyeri* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 713, Taf. CLXVII, fig. 3) and to the Indian *S. Archibaldi* v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 92, Pl. XVII, figs. 3-5), but differs from both by some remarkable characters. Its numerous, densely crowded, transverse ribs do not bifurcate but are simple and very narrow. From the faint umbilical tubercles they run in a straight direction radially to the angular elevations in the middle of the sides, whence they describe a slight concavity directed anteriorly up to the marginal tubercles.

From the marginal, the ribs run straight up to the external, tubercles, which are arranged on either side of the median depression. This is a character of ornamentation which has been described in *Sandlingites Nicolai* from the Halorites limestone of the Bambanag section by E. v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 91, Pl. XVII, figs. 1, 2), but the small number of strong ribs separated by wide intercostal spaces imparts to the latter species a very different aspect.

Sutures.—Not known.

Locality.—Tikha.

SANDLINGITES nov. sp. ind. aff. CASTELLII Mojs. Pl. XV, fig. 6.

This is a much weathered cast, which might, perhaps, be placed near *Sandlingites Castellii* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 711, Taf. CLXII, figs. 16, 17). It is, however, not sufficiently well preserved to permit a tolerably certain decision about its specific position.

The volutions embrace one another considerably. The penultimate whorl completely agrees with those in species allied to *Sandlingites Castellii*, its ornamentation consisting of coarse transverse ribs of equal strength only. The sculpture of the last volution is remarkable for the difference in the strength of stem ribs and of secondary ribs. But in contrast to *S. Castellii*, the majority of secondary ribs are intercalated costæ, not originating from the stem ribs by bifurcation.

The ornamentation is completely interrupted on the siphonal part by a deep median excavation.

Dimensions.

Diameter of the shell	.	.	.	.	.	.	27 mm.
" " " umbilicus	.	.	.	.	.	.	10 "
Height	} of the last volution	.	.	.	.	.	10 "
Thickness		.	.	.	.	.	10.5 "

Sutures.—Not known.

Locality.—Tikha.

CLIONITES HERACLITIFORMIS nov. sp. Pl. XVI, fig. 2.

1900. *Heracrites* (?) sp. ind. A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 218.

This species has been referred to *Heracrites* by A. v. Krafft, but with some hesitation only. He stated its external resemblance to *Heracrites Belloni* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 587, Taf. CXXXIX, fig. 10), but noticed the difference of the ceratitic character of the sutural line.

The difference in the arrangement of sutures is, indeed, of indisputable importance. In the genus *Heracrites* the saddles are richly dolichophyllic and especially their flattened tops are strongly serrated, whereas in our species the sutures are decidedly ceratitic with entire tops. There is still another feature of distinction between our species and *Heracrites Belloni*. In the body-chamber volution of the latter a distinct median keel divides the external furrow. In our species a similar median keel, as is characteristic of *Heracrites* and its allies, is entirely absent, and the two rows of external tubercles border a deeply excavated median depression. These two characters peremptorily forbid the present species to be grouped with *Heracrites*, but demand its reference to the subgenus *Clionites* Mojs., one of the numerous branches of the genus *Arpadites* Mojs. It might be compared to the

group of *Clionites Ares* Mojsisovics (l. c. p. 478, Taf. CXLIV, figs. 1, 2, CXLV, fig. 1). It is chiefly from the back-view, showing the four rows of external tubercles, that a generic relationship of the two species becomes evident.

Apart from the differences of the absence of a faintly developed median keel in my Himálayan species, its similarity with *Heracrites Bellonii* in general shape and sculpture is most striking. This external similarity undoubtedly offers a remarkable case of convergency.

The slowly increasing whorls envelope one another to less than one-third of their height. A little less than one-half volution in my type-specimen belongs to the body-chamber. The volutions are of nearly equal height and thickness. The lateral parts are flatly vaulted, and marked off from the flat and broad siphonal area by a distinct external margin. The steep umbilical wall passes gradually into the flanks by a rounded umbilical margin. The inner volutions, which have been laid bare within the wide umbilicus, are seriously injured by weathering and devoid of sculpture.

The sculpture of the last volution consists of strong lateral ribs, which rise in the umbilical region and bifurcate regularly in the middle of the height of the flanks. The place of bifurcation is marked by coarse tubercles. Between the dichotomising stem ribs secondary ribs are intercalated, which do not bear any tubercles. Both the secondary and stem ribs are adorned with strong marginal tubercles, which are elongated longitudinally and arranged exactly along the marginal edge. The number of marginal tubercles, which in their shape differ considerably from the lateral ones, is at least three times as large as the number of lateral tubercles. In the anterior half of the last whorl fourteen marginal, are counted to four lateral, tubercles. A third row of longitudinally elongated and acute tubercles borders the median furrow on either side. The number of siphonal and marginal tubercles is equal. Traces of ribs have not been noticed in the siphonal area.

Dimensions.

Diameter of the shell	73 mm.
" " " umbilicus	19 "
Height of the last { above the umbilical suture .	30 "
volution { " " preceding whorl .	24 "
Thickness of the last volution	28 "

Sutures.—Not known in detail, but decidedly ceratitic with entire saddles. Marginal walls of the saddles faintly serrated up to the middle of their height. In general agreeing with the sutures of Alpine species of *Clionites* and of the Himálayan representatives of this genus in the Halorites limestone of the Bambanag range.

Locality.—Tikba.

Remarks.—Besides this fairly well-preserved specimen several casts of body-chambers from Tikba and Lilang are before me, belonging to the genus *Clionites* but representing probably species not identical with the present one. As they are

too imperfectly preserved for either description or illustration, I must be satisfied with mentioning their presence.

Clionites heraclitiformis is a species which differs widely from the carnic representatives of the genus *Clionites* in the julie and tuvalie Hallstatt limestone of the Salzkammergut. It is more nearly allied to the group of *Clionites Ares* Mojs. of lower noric age, but differs also from this section of *Clionites* by several remarkable characters. Its lateral sculpture, especially the regular bifurcation of stem ribs, the development of strong lateral, and the absence of umbilical, tubercles does not remind one of the lateral ornamentation in *Cl. Ares*. A feature of distinction still more remarkable is the absence of any spiral striation, as is characteristic of noric species of *Clionites* in the Alpine region:

The present species therefore cannot be considered as a faunistic element with noric affinities, but must be counted among the types peculiar to the Indian triassic province.

PROARCESTES sp. ind. cf. *GAYTANI* Klipst. Pl. XVI, fig. 3.

A tolerably well-preserved cast with fragments of the shelly substance adhering recalls the well-known *Proarcestes Gaytani* v. Klipstein (E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1 p. 100, Taf. LVIII, figs. 1-3), which has also been collected in the Tropites beds of Byans by Smith.

Two-thirds of the last volution belong to the body-chamber. That this specimen must be grouped with *Proarcestes*, not with *Arcestes* s. s., is evident from the fact that two labiæ are noticed on the body-chamber. The specimen shows a remarkable resemblance to *P. Gaytani*, especially in its general shape and in the comparatively large size of the open umbilicus. The lateral parts possess the flattening characteristic of the Alpine types of *P. Gaytani*, although somewhat less distinctly.

Dimensions.

Diameter of the shell		43 mm.
" " " umbilicus		4 "
Height of the last } above the umbilical suture		21 "
volution } " " preceding whorl		9.5 "
Thickness of the last volution		27 "

Sutures.—As far as known, similar to those of *Proarcestes Gaytani*.

Locality.—Tikha.

V.—FOSSILS FROM THE DOLOMITIC LIMESTONE OVERLYING THE TROPITES BEDS.

The uppermost beds with the shaly series containing *Tropites* gradually pass into a mass of dolomitic limestone, 300 feet in thickness. It has yielded few fossils, and those very badly preserved and fragmentary. Among them were some bivalves, which had been determined by the late Dr. A. Bittner, our first authority on Alpine Brachiopoda and Lamellibranchiata, as—

Lima cf. austriaca Bittn.

Halobia cf. superba Mojs.

Daonella cf. styriaca Mojs.

The presence of these forms has induced Hayden to include the dolomitic limestone, just referred to, in the carnic stage.

BRACHIOPODA.

DIELASMA JULICUM Bittner. Pl. XVI, fig. 4.

1896. *Terebratula julica* Bittner, Brachiopoden der alpinen Trias Abhandl. K. K. Geol. Reichsanst., XIV, pp. 125, 158, Taf. IV, figs. 14, 15, Taf. XXXIX, figs. 15, 16.

1900. *Terebratula julica* Bittner, Brachiopoden aus der Trias des Bakonyerwaldes, Sep. Abdr. aus dem Palæont. Anhang zum ersten Teil des ersten Bandes der Resultate der wissenschaftl. Erforschg. des Balatonsees, p. 5, Taf. I, figs. 8-28, V, figs. 20, 21.

This species, characteristic of the carnic stage of the Alpine Trias, is represented in this fauna by specimens as large and well preserved as those described in the foregoing chapter on the fauna of the grey beds of Spiti. It is especially the specimen illustrated which agrees perfectly with Bittner's type-specimens and with my examples from the grey beds of Lilang. It is longer than broad, but has not the elongated outlines of *Dielasma Woehrmannianum* Bittn. The biplicate character of the dorsal valve is very distinctly marked. The front is bordered by three sharply sinuated curves, meeting in two acute angles, which correspond to the terminations of the folds of the dorsal, and to the deep grooves of the opposite valve.

The dental plates of the ventral valve are seen through the transparent shell. They are of considerable length. Their presence makes the identification of this specimen with *Dielasma julicum* certain. Otherwise *Terebratula gregaria* Suess might put in a legitimate claim for comparison.

Dimensions.

Entire length of the shell	.	.	31 mm.
„ breadth „	.	.	27 „
Length of the dorsal valve	.	.	28.5 „
Thickness of both valves			13 „

Locality.—W. of Lilang.

TEREBRATULA aff. PIRIFORMIS Suess. Pl. XVI, fig. 5.

1890. *Terebratula* aff. *piriformis* (Suess) Bittner, Brachiopoden der alpinen Trias, Abhandl. K. K. Geol. Reichsanst., XIV, p. 157, Taf. XXXIX, figs. 12, 13, 14.
1900. *Terebratula* aff. *piriformis* (Suess) Bittner, Brachiopoden aus der Trias des Bakonyerwaldes, Sep. Abdr. aus "Resultate der wissenschaft. Erforschg. des Balatonsees" Palæont. Anhang zum I. Th. des I Bdes, p. 9, Taf. I, figs. 29-39.

Together with *Dielasma julicum* a species of *Terebratula* occurs in the dolomitic limestone overlying the Tropites shales, which at a first glance might be taken as identical with *Dielasma Haydeni* Dien., the most common fossil of the upper horizon of the grey beds of Spiti. But on a closer examination the absence of any dental plates in the ventral valve and the strong development of a median septum in the dorsal valve prove my specimens to belong to the widespread group of *Terebratula piriformis* Suess. Similar forms have been noticed by Bittner in the marls of Veszprem in Hungary.

All my specimens are of small size, strongly elongated and of pentagonal outlines, with a front slightly curved downward and with indistinct dorsal folds. None of them have the typical piriform shape, so frequently noticed in large-sized specimens from the rhætic stage. The two septal plates of the smaller valve are united in the median septum, which is developed very strongly and extending for nearly one-third of the entire length of this valve, thus recalling the genus *Waldheimia*.

Dimensions.

Entire length of the shell	27.5 mm.
" breadth " "	. 17 "
Length of the dorsal valve	. 25 "
Thickness of both valves	. 11.5 "

Locality.—N.-W. of Muth.

SPIRIFERINA sp. ind. aff. SHALSHALENSIS Bittn.

Fragments of a large *Spiriferina* with high, semi-conical ventral valves, recalling *Spiriferina shalshalensis* Bittner (Himál. Foss., Vol. III, Pt. 2, p. 42, Pl. IV, fig. 1), but of a more strongly elongated shape and with the wings sloping very steeply from the umbonal region. Only six ribs on either side of the deeply excavated and smooth median sinus. Area very high and narrow.

My examples are distinguished from the species belonging to the group of *Spiriferina hirsuta* by the absence of any ribs in the mesial sinus. My largest specimen considerably exceeds *Sp. shalshalensis* in its dimensions, measuring 24 mm. in length.

Locality.—N.-W. of Muth.

LAMELLIBRANCHIATA.

The majority of Lamellibranchiata from the dolomitic limestone overlying the Tropites beds in the sections N.-W. of Muth, at Tikha and near Lilang, are fragmentary casts in a state of preservation which renders any specific determina-

tion impossible. Fragments of *Pectines* are represented among them. The cast of a left valve with five primary ribs belongs probably to the subgenus *Antijanira* Bittn. Its anterior wing is not unlike that in *Pecten vespriensis* Bittn. from the carnic stage of the Bakony. Another cast of two valves firmly attached to each other recalls *Fimbria*. A third cast belongs to a *Megalodus* of small size and without posterior edges (*Neomegalodus* Guemb.). Even the three species referred to Alpine forms as *cf.* by the late Dr. A. Bittner are represented in the Himalayan collection by specimens preserved so indifferently, that without the support of Bittner's authority I should probably not have ventured on their identification.

LIMA *cf.* AUSTRIACA Bittner, Pl. XVI, fig. 6.

1895. *Lima austriaca* Bittner, Lamellibranchiaten der alpinen Trias I. Abhandl. K. K. Geol. Reichsanst., XVIII, p. 195, Taf. XXII, fig. 18.

1901. *Lima austriaca* Bittner, Lamellibranchiaten aus der Trias des Bakonyerwaldes, Palæontol. Anhang, I. Th. des I. Bandes der Resultate der wissenschaftl. Erforschg. des Balatonsees, p. 56, Taff. III, fig. 1.

A right valve from Tikha resembles very closely this Alpine species from the upper-carnic Opponitz limestone of lower Austria, and from the marls of Veszprem in Hungary. It agrees in its dimensions with Bittner's type-specimen from Hainfeld, is strongly inequilateral, of oblique shape, and provided with a comparatively broad hinge-margin and distinctly developed wings. Its ornamentation is very remarkable and can be seen clearly by means of a lens only. The delicate and narrow primary ribs are separated by intercostal spaces of very unequal width, which are filled with very thin secondary ribs. The irregularity of ribbing is even still greater than in the Alpine type.

Of all the Lamellibranchiata collected by A. v. Krafft in the dolomitic limestone overlying the *Tropites* beds, this specimen is the only one which seems fit for a tolerably safe determination.

HALOBIA *aff.* SUPERBA v. Mojsisovics. Pl. XVI, fig. 7.

The specimen from the neighbourhood of Lilang, which has been compared with *Halobia superba* v. Mojsisovics (Ueber die triadischen Pelecypodengattungen *Halobia* und *Daonella*, Abhandl. K. K. Geol. Reichsanst., VII, p. 30, Taf. IV, figs. 9, 10), is a fragmentary cast of a left valve. The narrow anterior ear is sharply and distinctly defined and marked off from the adjacent part of the shell. Thus the reference of this specimen to the genus *Halobia* is indisputable.

The apex is strongly vaulted, but does not project considerably beyond the hinge-line. The ribs are very numerous and delicate. They are not undulating throughout their whole extent, but become so in later stages of growth only, exactly as in *Halobia fallax* Mojs. or in *H. superba* Mojs.

Halobia superba is a characteristic leading species of the tuvalic zone of *Tropites subbullatus* in the Hallstatt limestone of Aussee.

DAONELLA aff. STYRIACA Mojsisovics. Pl. XVI, fig. 8.

A few fragments from Tikha and W. of Lilang agree better with this than with any other species of *Daonella*. The large dimensions and the small number of radial furrows recall *Daonella styriaca* v. Mojsisovics (Abhandl. K. K. Geol. Reichsanst., VII, p. 10, Taf. I, figs. 4, 5). The similarity in sculpture with the examples from Pamgunjungang (Sumatra) illustrated by Volz in Zeitschr. Deutsch. Geol. Ges., 1899, Taf. I, fig. 1, is also remarkable.

The umbonal region has not been preserved in any of my casts, but there is no *Halobia* with a similar ornamentation known to me from the Hallstatt limestone. The possibility, of course, cannot be excluded that we have to deal here with fragments of a new species, not yet recorded from the Alpine Trias.

VI.—FOSSILS FROM THE JUVAVITES BEDS.

The dolomitic limestone with *Dielasma julicum* Bittn. and *Lima cf. austriaca* Bittn. of tuvalic age is overlain by a system chiefly composed of calcareous shales with intercalated bands of sandstone and shaly limestone, about 500 feet in thickness.

In the lower part of this system bivalves and brachiopods were found together with fragmentary Ammonites. Among the latter *Paratibetites cf. Tornquisti* Mojs. and a species identical with the form described as *Hauerites nov. f. indet.* by E. v. Mojsisovics (Himál. Foss., Vol. III, Pt. 1, p. 88) are mentioned by A. v. Krafft.

In the middle of the series brown, flaggy sandstones with indistinct plant remains occur. The upper part of the system is rich in Cephalopoda. The commonest genus, according to A. v. Krafft's notes, is *Juvavites*, of which a few forms are said to belong to the groups of *scissi* and of *intermittentes* (subgenus *Anatomites*), but the great majority approach the *continui*, especially *Juvavites Ehrlichi* Hauer.

Among other forms represented in those "*Juvavites beds*" A. v. Krafft mentions the following ones:—

Paratibetites cf. Tornquisti Mojs.

Tibetites cf. Ryalli Mojs.

Anatibetites nov. sp. aff. Kelvini, distinguished from this species by incised saddles.

Clionites aff. Hughesi, Mojs.

Dittmarites nov. sp. aff. Hindei Mojs.

Pinacoceras sp. ind.

Phylloceras sp. ind.

Pleuronantulus sp. ind. aff. tibeticus Mojs.

A. v. Krafft correlated the Juvavites beds of Spiti with the Hauerites beds and Halorites beds of the Bambanag section, although emphasizing some remarkable differences in their faunistic characters. He insists on the strange fact that not a single species of this horizon in Spiti is perfectly identical with a form described

from the Bambanag range, and that neither *Halorites* nor *Parajuvavites*, the two leading genera of the Halorites limestone in Kumaon, have been found in the Juvavites beds of Spiti.

"It appears from the above," he says, "that there is a remarkable faunistic difference between the Halorites beds of the more Eastern Himalayas and their equivalents in Spiti, for which so far no explanation can be given. The facies of these beds in Spiti is rather unfavourable for the preservation of fossils. This no doubt accounts for the comparative scarcity of the fauna."

For a palæontologist, who had the pleasure of studying the enormously rich and excellently preserved fauna of the Halorites limestone of the Bambanag section, the examination of the fossils from the Juvavites beds of Spiti proves a great disappointment. The majority of fossils are fragmentary casts. Well-preserved and characteristic specimens, fit for a specific description, are rather rare.

BRACHIOPODA.

DIELASMA aff. *JULICO* Bittn. Pl. XVII, figs. 2, 3.

The types from the Juvavites beds of Chabrang are so closely allied to *Dielasma julicum* Bittner from the carnic beds of the Alps and Bakony and from the grey beds of Spiti, that the introduction of a new denomination (*postjulicum* or *subjulicum*) is not justified. Among the Alpine shapes there are some almost identical with one or two of my Himalayan examples. But in general there is a slight difference between them, marked by the stronger development of biplicate folds in my Indian specimens. To this character is added a tendency to develop distinct secondary folds rising from the lateral margins half-way between the apex and front.

The dental plates of the ventral valve are large and extend along the entire length of the umbonal region. Thus the relationship of this species to the genus *Dielasma* is indisputable.

Locality.—Chabrang, S. below Gieumal.

LAMELLIBRANCHIATA.

HALOBIA nov. sp. aff. *FASCIGERÆ* Bittn. Pl. XVII, figs. 4, 5.

Several specimens of *Halobia* are before me, but all of them too imperfectly preserved to permit of a safe determination. All these specimens seem to belong to one single species of a rather doubtful systematic position.

If we follow the grouping of *Halobia*, which has been proposed by E. v. Mojsisovics, the present species ought to be united with the group of *Halobia distincta* v. Mojsisovics (Die triadischen Pelecypodengattungen *Daonella* und *Halobia*, Abhandl. K. K. Geol. Reichsanst., VII, p. 28). In one of my type-specimens casts of the two valves have been preserved adhering along the hinge-line.

These two casts show very narrow and elongated ears, differing considerably from the broad ears which are common to all the rest of triassic *Halobia*. Such narrow ears are considered as leading features of *Halobia distincta* and its allies by E. v. Mojsisovics and also as a character of primary importance for the systematic classification of *Halobia*.

If on the other hand we compare the ornamentation of our Indian examples with that of Alpine representatives of the group of *Halobia distincta*, there is no similarity whatever. In this respect our specimens recall most closely the group of *Halobia rugosa* Guemb., especially *H. fascigera* Bittner (Himálayan Foss., Vol. III, Pt. 2, p. 45, Pl. VII, fig. 15). To those forms recalling *Halobia fascigera* belongs, in the first place, the specimen illustrated in fig. 5. It shows a strong, distinctly bundle-like ribbing in the umbonal part of the shell, and a sharp wrinkling caused by the interruption of growth, half-way between the apex and pallial margin. From this angle the ribs undulate throughout their whole extent.

This pattern of ornamentation is so different from the sculpture found in the group of *Halobia distincta* and agrees so closely with that which is met with in *H. rugosa* and its allies, that I should prefer to group the present species with the latter, notwithstanding its narrow ear, which constitutes the only feature of difference from *Halobia fascigera* Bittn.

Locality.—E. above Lilang, W. of Lilang, Chabrang, Kágá, Rájagang.

PECTEN (VARIAMUSSIUM) MARGARITICOSTATUS nov. sp. Pl. XVIII, figs. 1-3.

This species shows a distant external similarity with *Lima serraticosta* Bittner (Himál. Foss., Vol. III, Pt. 2, p. 50, Pl. VIII, figs. 12, 13) from the Halorites limestone of the Bambanag section, but differences of specific and generic importance are revealed by a closer examination.

My specimens are not of oblique but of nearly equilateral shape. The ears, which are not entirely known to me, are of almost equal size, triangular, and without any trace of a byssal notch. The thin shell is raised into five or six ribs of moderate strength, which are crenulated and covered with numerous pearl-shaped tubercles of very delicate shape. These tubercles are formed by the stronger development of the numerous striæ of growth, covering the entire shell, exactly as in *Lima serraticosta*.

The generic difference between *Lima serraticosta* and the present species is clearly evident from a comparison of their casts. In the casts of the species from the Halorites limestone the ribs stand out more clearly than is the case on the surface of the shell itself. In the casts of our form, on the contrary, the surface is intersected by deep furrows corresponding to strong radiating ribs, which are developed on the inner side of the valve.

Species of *Pectines* with thin shells, showing a delicate radiating ornamentation on their external surface and a strong ribbing on the inner side, have been united in the subgenus *Amussium* by Klein. My species is probably a triassic

ancestor of the liassic representatives of this subgenus, although I do not know of any liassic form to which it could be compared more closely. I am, however, obliged to state that a grouping of the jurassic species resembling *Amussium* with that subgenus is not in accordance with the views expressed by Philippi in his beautiful memoir on the morphology and phylogeny of *Pectinidæ* (Zeitschr. Deutsch. Geol. Ges., LII, 1900, p. 82), who considers *Amussium* to be one of the youngest groups of the family and restricted to deposits of neogene and pleistocene age. By palæontologists accepting this view our species might probably be referred to the section *Variomussium* Sacco of the subgenus *Aequipecten*.

Locality.—Casts of this shell are represented numerously among the collections from the base of the Juvavites beds above Lilang, between Mani and Ensa, N. of Kágá.

PECTEN nov. sp. aff. MONILIFERO Muenst. Pl. XVIII, fig. 4.

The remarkable sculpture of a *Pecten*, which shows a distant external similarity with the foregoing species, may justify a description of it so far as it is possible to make out.

This species, of which single valves only are known to me, is equilateral in shape and probably larger than broad. Nothing positive can be affirmed as to the character of the apex and wings, in consequence of the imperfect state of preservation of all specimens available for examination.

The sculpture consists of six strongly raised and broad ribs, which are adorned with small, rounded tubercles. Occasionally weaker rows of tubercles of a similar kind are developed besides the chief row on the crest of these primary ribs. In the intercostal spaces separating the six primary ribs two sharp and roof-like ribs with smooth crests are intercalated. The concentric ornamentation of the shell is very delicate.

Casts of this species are not known to me. The shell was considerably thicker than in the preceding species.

The present species cannot be grouped with the subgenus *Amussium*, its sculpture being too strong and manifold. If it has been described here as *Pecten* sp. aff. *monilifero* Muenst., it is only a distant affinity which can be taken into consideration. But its unsatisfactory state of preservation forbids the introduction of a proper specific name, and I do not know of any other triassic *Pecten* which might put in a claim for closer comparison. According to the illustrations given by Bittner (Lamellibranchiaten der Alpenen Trias, Abhandl. K. K. Geol. Reichsanst., XVIII, Taf. XVIII, figs. 29, 30), *Pecten moniliferus* is a species with ribs of alternating strength and has the primary ribs also adorned with tubercles, but the details of the ornamentation are not known.

Locality.—E. above Lilang, Chabrang, Gaichund.

MYSIDIOPTERA sp. ind.

Two imperfectly preserved casts from Chabrang have been compared to *Mysidioptera* Bittner by A. v. Krafft. They can, indeed, be referred to this genus with

some probability. One of them is of large size, recalling *Mysidioptera incurvostriata* Guemb., as illustrated by Bittner in his "Lamellibranchiaten der Alpenen Trias" (Abhandl. K. K. Geol. Reichsanst., XVIII, Taf. XXII, fig. 11). My examples are too incomplete to venture on a specific identification.

LIMA cf. SERRATICOSTA Bittn. Pl. XVII, fig. 6.

1890. *Lima serraticosta* Bittner, Himalayan Foss., Palæont. Indica, ser. XV, Vol. III, Pt. 2, p. 50, Pl. VIII, figs. 12, 13, Pl. X, fig. 23.

As is shown by some casts from the Juvavites beds E. above Lilang, a species identical with, or at least very closely related to, *Lima serraticosta* seems to occur in the upper triassic rocks of Spiti.

The most complete cast, which has been illustrated, has the obliquely elliptical and distinctly inequilateral shape of a *Lima* with a strongly sloping anterior side. The posterior wing, which alone has been preserved, is extremely small. Both characters speak in favour of an identification with *Lima*, not with *Pecten*, as has been explained by Bittner.

The sculpture of the cast consists of six strong ribs standing out very high above the general convexity of the shell, and separated sharply from the flat intercostal furrows. This ornamentation is exactly identical with that in the cast from the Halorites limestone of the Bambanag section, as illustrated by Bittner.

HOMOMYA sp. ind. aff. LARIANÆ Stopp.

The cast of a large-sized bivalve from Tikha recalls *Pholadomya* (*Homomya*) *lariana* Stoppani (Paléontologie lombardo, 3^e sér., p. 41, Pl. III, figs. 4-7). It is strongly distorted by pressure, slightly inequivalve, and strongly inequilateral. The ventral margin unites with the anterior one, which is truncated obliquely, in an obtuse angle, as in *H. angulata* Agass. The two valves are inflated considerably and their apices almost touch one another. The sculpture consists of very coarse concentric ribs. It cannot be decided whether or not the two valves were gaping posteriorly, their posterior region having been broken off.

Exact measurements cannot be given. To a length of 70 mm. a height of 50 mm. and a thickness of 48 mm. correspond approximately.

The specimen is fit neither for specific description nor illustration.

CARDITA (?) sp. ind.

Numerous casts from the Juvavites beds of Chabrang belong probably to representatives of the genus *Cardita* Brug. They are strongly inflated, nearly equivalve, inequilateral, and with obliquely rounded outlines. The casts are covered with a moderate number of ribs, separated by comparatively wide intercostal spaces. The ribs are most distinctly developed in the marginal region of the cast and are gradually obliterated towards the umbones, which have not been preserved in any of my examples.

This species is certainly different from the most common triassic representatives of the genus, namely, *Cardita crenata* Goldf., *C. Guembeli* Pichl., *C. austriaca* Hauer. It shows a closer similarity with the undetermined species from Predore illustrated by Stoppani on Pl. VI, fig. 21, of the *Paléontologie lombarde* 3^e sér).

Of the hinge apparatus nothing definite can be made out from the imperfect cast. Small, rounded hinge teeth were probably present.

MYTILUS sp. ind. aff. RUGOSO Roem.

The cast of a left valve from the Juvavites beds of Chabrang* recalls the illustration of a species from Azzarola, identified with *Mytilus rugosus* Roemer (*Oolithgeb.*, p. 93, Pl. V, fig. 10) by Stoppani (*Paléontologie lombarde*, 3^e sér, Pl. X., figs. 6, 7).

Posterior margin broad and truncated obliquely. Ventral margin slightly sinuated. Umbonal region broken off, divided by a rounded, not carinate, ridge, which runs from the apex to the ventro-posterior angle.

Surface covered with striæ of growth of irregular strength, some of them being elevated considerably above the general convexity of the shell.

GASTROPODA.

A fragmentary cast of a large-sized snail from the Juvavites beds of Gaichund recalls some forms of triassic Gastropoda from the Hallstatt limestone described by Koken. It is high, turreted, with an acute apical angle. Where the base has been broken off, its diameter is about 40 mm. The corresponding height cannot have been less than 90 mm. The whorls are nearly flat and separated by deeply impressed sutures. Where the test has been preserved, it is covered with numerous and very delicate longitudinal striæ.

The apical region having been broken off, a generic determination of this cast is impossible, several genera very similar in their general shape, as *Acrocosmia*, *Eustylus*, *Chemnitzia*, being only distinguished by the different characters of their apical whorls.

CEPHALOPODA.

A. DIBRANCHIATA.

ATRACTITES sp. ind.

The fragment of a large phragmacone is before me, consisting of six air-chambers. Cross-section strongly elliptical. The ventro-dorsal diameter is the larger one. Lateral parts strongly flattened. In the shape of the transverse section and in the angle of emergence the present cast recalls *Atractites ellipticus* E. v. Moj-

Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, Supplement, p. 196, Taf. XV, fig. 5), but the distance of the septa is considerably larger.

To a ventro-dorsal diameter of 76 mm. a lateral diameter of 64 mm. and a distance of the septa of 16 mm. correspond. The septa describe flatly curved lobes on the lateral, and corresponding saddles on the ventral and dorsal parts.

Locality.—S. of Kibber.

ATRACTITES sp. ind. cf. ALVEOLARIS Quenst.

The fragment of a phragmacone from Chabrang, consisting of two air-chambers only, is very similar to *Atractites alveolaris* Quenstedt (*vide* E. v. Mojsisovics, l. c. Abhandl. K. K. Geol. Reichsanst., VI-1, Supplement, p. 195, Taf. XV, fig. 1), one of the most common Alpine species of the genus in the noric Hallstatt limestone of the Salzkammergut.

The distance of the septa is considerable. Angle of emergence very small. Cross-section nearly circular. Siphuncle touching the inner margin of the shell of the ventral part.

To a diameter of the larger air-chamber of 36 mm. a distance of the septa of 20 mm. corresponds.

B. NAUTILOIDEA.

ORTHOCERAS sp. ind.

Representatives of the genus *Orthoceras* being extremely rare in the noric stage of the Himálayas, I wish to signalize the presence of a fragment of one of very large size in the Juvavites beds W. of Lilang.

The fragment, which has been considerably injured by weathering, consists of the last air-chamber and the adjoining portion of the body-chamber. The diameter of the circular cross-section is not less than 80 mm. Siphuncle situated in the centre of the last air-chamber.

It is out of the question to determine this cast specifically. In the collections of the K. K. Geologische Reichsanstalt equally sized fragments of *Orthocerata lævia* from the Hallstatt limestone of the Sommeraukogel have been identified with *O. dubium* Hauer.

PARANAUTILUS ARCESTIFORMIS nov. sp. Pl. XVIII, fig. 5.

A *Nautilus* with a smooth shell and of globose shape is grouped here with the genus *Paranautilus* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, l. c. VI-1, Supplement, p. 205). As in typical species of *Paranautilus*, the siphuncle is situated a little below the centre, and the sutural line is very simple. A broad and low external saddle is followed by a very flat lateral lobe. Umbilical saddle indistinctly developed. Internal or annular lobe entirely absent.

The triassic species of the genus *Paranautilus* differ from the present form by their high-mouthed volutions. *Paranautilus peregrinus* Waagen (Salt Range Foss., Palæont. Indica, ser. XIII, Vol. I; Productus limestone foss., p. 47, Pl. VI, fig. 3) from the middle Productus limestone of the Salt Range is too badly preserved to allow a closer comparison. Otherwise my species agrees with the diagnosis of *Paranautilus*, as given by E. v. Mojsisovics. It has a very narrow umbilicus and a broadly rounded siphonal area, which passes into the lateral parts without any intervention of marginal edges.

My type-specimen is of globose shape and strongly inflated. At a first glance I was inclined to mistake it for a species of *Arcestes*. It was only after an examination of the sutural line by removing the shelly substance, that I was convinced of its true relationship with a genus of *Nautiloidea*. The whorls are considerably broader than high and they increase very slowly. The height of the last volution above the siphonal part of the preceding whorl is less than one-half its entire height above the umbilical suture. The umbilicus is very small and not closed by a callosity. The figured specimen consists of air-chambers only, but its aperture corresponds to the last septum.

Dimensions.

Diameter of the shell	6.4 mm.
" " " umbilicus	4 "
Height of the last volution } above the umbilical suture	33 "
} " " preceding whorl	15 "
Thickness of the last volution	54 "

Locality.—E. above Lilang.

Remarks.—I do not know of any triassic species of *Nautiloidea*, which in its external characters and in the arrangement of its sutures agrees so closely with some *Nautili* of jurassic and cretaceous habits as does this species. It is, indeed, only the absence of an internal lobe which induces me to separate this species from *Nautilus s. s.*

PLEURONAUTILUS nov. sp. ind. ex aff. KOSSMATI Dien. Pl. XVII, fig. 7.

The only specimen available for examination is a small cast without its shelly substance, consisting of air-chambers only. It is nearly related in the shape of its whorls and in its sculpture to *Pleuromutilus Kossmati* Diener (Mitteilungen über einige Cephalopodensuiten aus der Trias der Südalpen, Neues Jahrb. f. Mineralogie, etc., 1901, Bd. II, p. 28, Taf. I, fig. 1) from the upper-triassic (carnic) rocks of Carniola, and to a second undescribed form from the Pachycardia beds of the Seiser Alpe.

With the latter species the present specimen agrees in the ornamentation of the siphonal area. This area consists of a broad middle portion, which is nearly flat, smooth, and bordered by low spiral keels or ridges. Between those external ridges and the spiral row of marginal tubercles a second ridge is developed. Thus altogether six spiral elements of sculpture are present in the external region outside the marginal angle.

This character of sculpture agrees exactly with the ornamentation described in *Pleuronautilus Lepsiusii* by E. v. Mojsisovics (Cephalopoden de Hallstaetter Kalke, l. c. VI-1, Supplement, p. 244, Taf. X, fig. 2). But in the latter species the lateral tubercles and ribs exceed in strength very considerably the spiral elements of sculpture, whereas in my Himálayan species both are rather faintly developed. There are traces of umbilical, lateral and marginal tubercles present, but they are rather indistinct. The sculpture of the cast is altogether very delicate, and only perceptible when examined carefully.

The inner whorls are, unfortunately, not accessible to observation.

Dimensions.

Diameter of the shell . . .	48 mm.
" " " umbilicus . . .	12 "
Height } of the last volution . .	{ 16 "
Thickness }	{ 19 "

Siphuncle.—Below the middle of the height of the last volution.

Sutures.—Septa separated rather widely from one another. A broad external lobe is separated from a lateral lobe of similar shape by a flat saddle, the apex of which coincides with the outer external ridge. A small umbilical saddle is present on the umbilical margin.

Locality.—Between Pomarang and Mani.

Remarks.—A. v. Krafft has compared this species with *Pleuronautilus tibeticus* v. Mojsisovics (Himálayan Fossils, Vol. II, Pt. 1, p. 120, Pl. XXI, fig. 3) from the Halorites limestone of the Bambanag section. But from that species the present one is distinguished by the faint development of marginal tubercles, and by its clearly marked longitudinal sculpture on the external part. It belongs to a section of *Pleuronautilus*, which in the Alpine Trias is represented by *Pl. Kossmati* and *Pl. Lepsiusii*, but on account of its delicate lateral ornamentation approaches still more closely the subgenus *Trachynautilus* with a predominant spiral sculpture.

PLEURONAUTILUS cf. TIBETICUS, Mojs. Pl. XVIII, fig. 6.

1896. *Pleuronautilus tibeticus*, E. v. Mojsisovics, Beiträge zur Kenntniss der obertriadischen Cephalopodenfaunen des Himálaya, Denkschr. Kais. Akad. d. Wissensch. Wien, math.-nat. Klasse, LXIII, p. 671, Taf. XXI, fig. 3.
1899. *Pleuronautilus tibeticus*, E. v. Mojsisovics, Himálayan Foss. Palæont. Indica, ser. XV, Vol. III, Pt. I, p. 120, Pl. XXI, fig. 3.

The cast of a very large *Pleuronautilus* belongs to a species which is either identical with, or very nearly allied to, *Pl. tibeticus* Mojsisovics, from the Halorites limestone of the Bambanag section. By carefully separating the inner nucleus from the outer volution, I have been able to convince myself of the close agreement of the inner whorls with the type-specimen of *Pl. tibeticus*. The last volution shows some differences in sculpture, which might, perhaps, be considered as arguments forbidding a direct identification with the latter species.

The innermost whorl is but imperfectly known. Near the beginning of the last volution the penultimate whorl has reached the size of the type-specimen of *Pleuromutilus tibeticus* from the Halorites limestone. It has an octagonal cross-section. Lateral parts and siphonal area are flat and separated by obliquely sloping marginal zones, which are bordered by distinct edges. The marginal edge is adorned by low tubercles, from which delicate transverse ribs run across the lateral parts towards the umbilical suture. These folds are but faintly marked and separated by wide intervals.

In the last volution both the cross-section of the tube and the sculpture are subject to a considerable change. The flattening siphonal area broadens out. In the marginal zone the shell becomes inflated and gradually rounded, the marginal ridges getting obscure. The umbilical margin becomes rounded. Thus the octagonal character of the cross-section is lost in the vicinity of the aperture. At the same time the greatest transverse diameter is shifted to the umbilical region, whereas in the inner volutions the distance of the marginal and umbilical edges is nearly equal.

The ornamentation becomes gradually obsolete in the last whorl. The marginal tubercles still continue as faint swellings, which are elongated transversely, but the ribs disappear entirely.

Notwithstanding its large size, my specimen consists of air-chambers only.

Dimensions.

Diameter of the shell	.	.	.	120 mm.
" " " umbilical	.	.	.	43 "
Height	} of the last volution	.	.	49 "
Thickness		.	.	54 "

Siphuncle.—E. v. Mojsisovics was not able to ascertain the position of the siphuncle in his type-specimen of *Pleuromutilus tibeticus*. In the present specimen the position of the siphuncle is exactly central.

Sutures.—Conspicuous by the absence of an internal or annular lobe. External and lateral lobes well individualized and separated by a broadly vaulted saddle which coincides with the marginal region. A small umbilical saddle is present.

Locality.—Tikha.

INDONAUTILUS cf. KRAFFTII, Mojsisovics. Pl. XIX, fig. 1.

1896. *Nautilus* sp. ind. ex. aff. *N. mesodici* E. v. Mojsisovics, Beitrage zur Kenntniss der obertriadischen Cephalopodenfauna des Himalaya, Denkschr. Kais. Akad. d. Wissensch. LXIII., p. 673, Taf. XXI., fig. 2.

1899. *Nautilus* sp. ind. ex aff. *N. mesodici* E. v. Mojsisovics, Himalayan Foss. Pal. Ind. ser. XV. Vol. III, Pt. 1, p. 122, Pl. XXI, fig. 2.

1902. *Indonautilus Krafftii* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst. VI.-I, Supplement, p. 205.

A beautifully preserved cast of a large *Nautilus* agrees so closely with *Indonautilus Krafftii* Mojs. from the Halorites limestone of the Bambanag section, that I should not have hesitated to venture on a direct identification, had not the difference-

in size and the imperfect knowledge of the internal part of the sutural line prevented me from doing so.

My cast is provided with its body-chamber, to which one-half of the last volution belongs. In the body-chamber the flattened external part gradually increases in width and near the aperture is almost equal in breadth to the entire thickness of the penultimate whorl. With this broadening of the siphonal area a depression of the whorl is combined, causing the cross-section of the tube to be slightly wider than high.

Rounded marginal edges are present at the beginning of the last volution and are turned into sharp angles in the body-chamber. The umbilicus is comparatively small, but I have not succeeded in ascertaining whether it has been perforated or not.

Otherwise there is a complete agreement of the two specimens in all their external characters as well as in the arrangement of the sutural line. The septa stand very close to each other. They show a very flat external lobe and a broad lateral lobe adjoining a small umbilical saddle. The absence of an internal lobe could not be ascertained. This character is one of the leading features of *Indonautilus*, as stated in the diagnosis of the genus given by E. v. Mojsisovics.

Dimensions.

Diameter of the shell	.	147 mm.
" " " umbilicus	.	10 "
Height of the { above the umbilical suture		83 "
last volution { " " preceding whorl		62 "
Thickness of the last volution	.	92 "

Locality.—East above Lilang.

Remarks.—There is a great external resemblance between the type-specimen of *Indonautilus Krafftii* and *Grypoceras mesodicum* v. Hauer (*vide* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-1, p. 21, Taf. VIII, fig. 1) from the noric Hallstatt limestone of the Salzkammergut. The chief difference, according to E. v. Mojsisovics, consists in the absence of an internal lobe in *Indonautilus*. My specimen from Lilang, which is provided with its body-chamber and is equal in size to Hauer's type-specimen of *Grypoceras mesodicum*, shows some remarkable characters of difference which exclude any possibility of its identification with the Alpine species. Its umbilicus is considerably smaller, its siphonal area broader, and in the sutural line both the external and lateral lobes are flatter and less strongly individualized.

C. AMMONOIDEA.

DITTMARITES LILLIFORMIS, nov. sp. Pl. XX, fig. 1.

1900. *Dittmarites* nov. sp. ex aff. *Hindei* (Mojs.) A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 221.

This species is represented by a beautifully preserved cast, consisting of air-chambers only. It is very nearly allied to *Dittmarites Lilli* Guembel (*vide* E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, l. c. VI-2, p. 463, Taf. CLIII, fig. 10) among Alpine, and to *Dittmarites Trailli* Diener (Fauna of the Tropites

limestone of Byans, Himál. Foss. Vol. V, Pt. 1, p. 45, Pl. VII, fig. 1) among the Indian representatives of the sub-genus *Dittmarites*.

The volutions are high, compressed, increasing moderately and overlapping one another to the extent of more than one-half their height. The largest transverse diameter is situated above the umbilical margin, which is sharpened into an acute edge separating the flattened lateral parts from the perpendicular umbilical wall. The flatly rounded siphonal area is not marked off distinctly from the flanks. The external keels stand close together. The two external furrows bordering them are very low.

The ornamentation of the lateral parts consists of very numerous, delicate and falciform ribs which terminate abruptly along the siphonal margin. They rise either singly or in pairs from the umbilical edge. Umbilical tubercles are but very indistinctly developed and confined to the beginning of the last volution only. The augmentation of ribs towards the siphonal margin is effected either by bifurcation of the primary ribs at various distances from the umbilical edge or by intercalation of secondary costæ.

My specimen being entirely chambered, the full-grown individual must have attained considerable dimensions. As another three-quarters of the last volution must at least be reckoned for the body-chamber, its diameter cannot have been less than 100 mm.

Dimensions.

Diameter of the shell	.	.	.	.	67 mm.
" " " umbilicus	.	.	.	.	15 "
Height of the { above the umbilical suture	.	.	.	.	28 "
last volution { " " preceding whorl	.	.	.	.	21 "
Thickness of the last volution	.	.	.	.	20 "

Sutures.—Saddles brachyphyllic, with strongly serrated tops. Lobes with deep, finger-like indentations, the central digitation being the deepest.

Siphonal lobe short and narrow, divided by a low median prominence, each wing terminating in a single, sharp point. Second lateral lobe only half as deep as the principal one. Siphonal saddle provided with a very broad base. Second lateral saddle small and followed by a broad, serrated auxiliary lobe.

Locality.—N. of Po (Kamelang station).

Remarks.—The present form is very nearly allied to *Dittmarites Trailli* Dien. and to *D. Lilli* Guemb., but cannot be identified with either species. From *D. Trailli* it is distinguished by its sharp umbilical edge and by remarkable differences in the arrangement of its sutural line. From *D. Lilli* it differs by its smaller umbilicus, by the absence of distinct umbilical tubercles, and by the more faintly developed sculpture of its siphonal area.

DITTMARITES cf. **TRAILLIFORMIS** Dien. Pl. XVIII, fig. 7, Pl. XX, fig. 2.

1906. *Dittmarites trailliformis* Diener, Fauna of the Tropites limestone of Byans, Himálayan Foss., Vol. V, Pt. 1, p. 46, Pl. VII, figs. 2, 3.

Two specimens of *Dittmarites* of moderate size are referable to this species with some reserve, although their fragmentary state of preservation does not allow

a direct identification. They are specially conspicuous by their coarse ribs, which are separated by broad intercostal valleys. The cross-section is less strongly compressed than in the preceding species. The greatest transverse diameter is shifted from the sharply rounded umbilical margin towards the upper region of the flanks. The siphonal area is comparatively broad and flatly rounded.

Indistinct traces of lateral tubercles are noticed, exactly as in the type-specimen of *D. trailliformis* from Teragádh, illustrated in Pl. VII, fig. 3, of my above-quoted memoir.

The measurements of the more complete specimen (Pl. XX, fig. 2) are as follows :—

Diameter of the shell	.	about 50 mm.
" " " umbilicus	.	12
Height	} of the last volution	{ 19 "
Thickness		{ 17 "

A third cast of small size agrees so closely with the inner nucleus of my type-specimens from the Tropites limestone of Teragádh, that I feel justified in referring it to *Dittmarites trailliformis* as *cf.* There is a complete agreement in the character of the involution, in the shape of the tube, and in the width of the umbilicus. The ribs are coarser than in *Dittmarites lilliformis* or in *D. Trailli*. Traces of umbilical or lateral tubercles have not been noticed.

Sutural line not known exactly, but apparently differing from that in *Dittmarites lilliformis*, especially in the relative height of the siphonal and lateral saddles. Otherwise the specimen might be taken for a nucleus of *D. lilliformis*, the inner volutions of which are not known to me.

Locality.—N. of Po (Kamelang station).

CLIONITES sp. ind. aff. HUGHESII Mojs.

1900. *Clionites* sp. ind. aff. *Hughesii* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 221.

The fragment of an outer volution, comprising one-half of the body-chamber whorl, belongs to a species of *Clionites*, which is very nearly allied to *Cl. Hughesii* v. Mojsisovics (Himálayan Foss., Vol. III, Pt. 1, p. 64, Pl. XIV, figs. 1-3). The only remarkable differences are the greater height of the whorl in comparison to its thickness and the sharp separation of the flat siphonal area from the lateral parts. The species was probably provided with more rapidly increasing volutions and with a narrower umbilicus than *Cl. Hughesii*.

The sculpture agrees in its essential characters with the ornamentation of the species from the Halorites limestone. On the siphonal part an external row of tubercles borders a smooth median zone on either side. From these external tubercles transverse ribs run across the lateral parts towards the umbilical margin. Primary ribs and intercalated costæ, which do not reach the lower region of the flanks, alternate rather regularly. Both kinds of ribs show a distinct sigmoidal curvature and are adorned by marginal tubercles, corresponding to the sharply

marked marginal edge. This edge, in which the flat lateral parts meet the siphonal area at nearly right angles, is more distinctly developed than in *Clionites Hughesii*. Only a small minority of ribs bifurcate at the place of marginal tubercles.

Locality.—N. of Po (Kamelang station).

Genus: *CARNITES* v. Mojsisovics.

Subgenus: *METACARNITES* nov. subgen.

1896. *Hauerites* (?) nov. f. ind. E. v. Mojsisovics, Beitræge zur Kenntniss der obertriadischen Cephalopodenfaunen des Himålaya, Denkschr. Kais. Akad. d. Wiss. math. nat. Kl. LXIII, p. 625, Taf. XVI, fig. 6.

1899. *Hauerites* (?) nov. f. ind. E. v. Mojsisovics, Himålayan Foss., Vol. III, Pt. 1, p. 88, Pl. XVI, fig. 6.

1900. *Haurites* sp. ind. A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 220.

From the group of beds No. 6 of the Bambanag section (zone of *Proclodonautilus Griesbachi* Mojs.) a fragment has been described by E. v. Mojsisovics as *Hauerites* (?) sp. ind. In my description of the fauna of the Tropites limestone of Byans I have raised grave objections against the correctness of assigning this fragment to the genus *Hauerites*. I have noticed the remarkable similarity of its sutures with *Carnites* and I have insisted on classing it among the nearest allies of that genus. E. v. Mojsisovics himself described the fragment in question as being provided with a bluntly pointed siphonal edge, and justly remarked that the tapering of the external part to a blunt blade without a furrow has never been observed in *Hauerites*.

In the Juvavites beds of Spiti several specimens of Ammonites have been collected by Hayden and A. v. Krafft, which agree with the fragment from the Bambanag section in the general arrangement of their sutures and in their cross-sections. They recall *Paratibetites Tornquisti* Mojs. in the high-mouthed shape of their smooth disc, which culminates externally in a sharp edge. The richly serrated and dolichophyllic sutures agree in general with those of *Carnites*, but show a richer development of secondary branches in the external than in the lateral saddles and a greater number of adventitious elements.

I believe a special sub-generic denomination to be appropriate for such types of *Carnites*, which are probably direct descendants of the carnic representatives of that genus. As subgeneric designation the name of *Metacarnites* is proposed here, in accordance with my notes on *Carnites cf. floridus* Wulf. in my monograph of the fossils from the Tropites limestone of Byans (l. c. p. 169).

There is a second genus, to which *Metacarnites* seems to be also nearly related, namely *Bambanagites* Mojsisovics (l. c. p. 106). The species of *Bambanagites* from the Halorites limestone are distinguished by falciform folds, but in a species from the Tropites limestone of Byans (l. c. Pl. XIV, fig. 2) those folds are reduced to indentations of the blade-like external edge, recalling the sculpture in *Pinacoceras* (*Pompeckjites*) *Layeri* v. Hauer. In the sutural line there is also a contrast in the development of ramification noticed between the external and principal lateral saddles.

METACARNITES FOOTEI nov. sp. Pl. XXI, fig. 1.

The sculpture of the shell is perfectly smooth. The lateral parts converge gradually towards a sharp external edge from the place of their largest transverse diameter, which is situated a little below the middle of their height.

Diameter of the shell	about 100 mm.
" " umbilicus	2.5 "
Height of the (above the umbilical suture	62 "
last volution { " " preceding whorl	39 "
Thickness of the last volution	25 "

Between the principal lateral lobe, which is the deepest, and the siphonal lobe, which is short, bipartite and divided by a low median prominence, three adventitious lobes and four saddles are counted. Their arrangement differs considerably from that in *Paratibetites angustosellatus* Mojs. (l. c. p. 86, Pl. XVI, fig. 4), and recalls rather that in *Bambanagites Schlagintweiti* Mojsisovics (l. c. p. 107, Pl. XVIII, fig. 2), especially in the monophyllic character of the second and third adventitious saddles. The first adventitious saddle is very short and separated from the adjoining saddle, which is club-shaped and considerably higher, by a narrow lobe, which stands at the same level as the siphonal lobe. The two lobes bordering the third adventitious saddle are considerably deeper and bifid. The fourth adventitious saddle (true external saddle) is the largest, and provided with dolichophyllic notches. Its stem is slightly laced near its base and culminates in a monophyllic branch.

Locality.—W. of Lilang.

This is a species of *Metacarnites*, which in its external shape and in the arrangement of its sutural line approaches so closely the genus *Carnites* Mojs., that it seems to hold an intermediate position between them.

In its general shape, involution and cross-section it agrees as closely with the acutely edged types of *Carnites floridus* Wulf. as with *Paratibetites Tornquisti* Mojs. The external part is sharpened into a blunt blade. The largest transverse diameter coincides with the middle of the flanks. The lateral parts are devoid of any sculpture. There are neither indications of spiral ridges nor of sigmoidal folds.

Dimensions.

Diameter of the shell	.	.	115 mm.
" " " umbilicus	.	.	2 "
Height of the last volution {	above the umbilical suture	.	66 "
	" " preceding whorl	.	31 "
Thickness of the last volution	.	.	29 "

Sutures.—All the saddles are dolichophyllic, but their ramification has not yet reached a higher stage of development than in some types of *Carnites floridus*, especially in the specimen from Carinthia illustrated by F. Frech in his "Nachtraege zu den Cephalopoden und Zweischalern der Bakoñyer Trias" (Separatabdr. aus Palæont. Anhang zu Resultate der wissensch. Erforschung des Balatonsees, 1 Bd. 1, Th., p. 19, fig. 25).

There is, however, one remarkable difference between the sutures of *Carnites floridus* and *Metacarnites Hendersoni*, and this is the contrast in the shape of the external and principal lateral saddles. The external saddle is pyramid-shaped, with a phylloid culmination, whereas the principal lateral saddle is bordered by parallel walls, rounded above and serrated by deep, parallel indentations. The number of adventitious elements is not known to me exactly. Three adventitious lobes are clearly visible outside the true external saddle, but the region adjoining the external blade has frustrated all my attempts at making the external lobe accessible to examination.

There is also a remarkable difference in size between the principal lateral and the following saddles. The second lateral saddle scarcely exceeds in size the auxiliary elements, some of which are dimeroidic. There are at least three auxiliary lobes and saddles outside the umbilical suture.

Locality.—Chabrang.

PINACOCERAS sp. ind. ex. aff. PARMA Mojs.

1900. *Pinacoceras* sp. ind. A. v. Kraft, General Report, Geol. Surv. of India, for 1899-1900, p. 221.

A strongly weathered fragment of quadrangular outlines is, unfortunately, only sufficient to establish its relationship to a species of *Pinacoceras* with very complicated sutures. One main saddle and the two adjoining adventitious saddles are accessible to observation. Their shape points to a form of the group of *Pinacoceras parma* Mojs. The large dimensions of the fragment are also in favour of an identification with a species closely related to *P. parma* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichanst., VI-1, p. 60, Taf. XXIV, fig. 2).

Locality.—Chabrang.

TIBETITES cf. RYALLI v. Mojsisovics. Pl. XX, fig. 4.

1896. *Tibetites Ryalli* v. Mojsisovics, Beitræge zur Kenntniss der Cephalopodenfaunen der oberen Trias de Himálaya, Denkschr. Kais. Akad. d. Wiss., LXIII, p. 637, Taf. XV, figs. 3, 4.

1899. *Tibetites Ryalli* v. Mojsisovics, Himálayan Foss., Vol. III, Pt. 1, p. 77, Pl. XV, figs. 3, 4.

1900. *Tibetites cf. Ryalli* A. v. Krafft, General Report, Geol. Survey of India, 1899-1900, p. 221.

The fragment of a body-chamber, measuring less than one-third of an entire volution, agrees very closely with the fragment of a body-chamber of *Tibetites Ryalli* from the Halorites limestone of the Bambanag section, which has been illustrated by E. v. Mojsisovics in fig. 4 of his above-quoted memoir.

The whorl is higher than wide and reaches its greatest transverse diameter in the region of the lateral tubercles. The external part is steep, roof-shaped and bordered on either side by a row of rounded marginal tubercles. Its median zone consists of two rows of elongated ears, standing closely together. The ribs, which are either strong, primary ribs or more delicate intercalated costæ, show a distinct sigmoidal curvature, with the apex of the curve corresponding to a marginal tubercle.

It is only the incomplete state of this small fragment which prevents me from venturing on a direct identification with *Tibetites Ryalli* Mojs.

Locality.—N. of Po (Kamelang station).

ANATIBETITES KELVINIFORMIS nov. sp. Pl. XX, figs. 5, 6.

1900. *Anatibetites nov. sp. aff. Kelvini* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 221.

The specimen illustrated in fig. 5, consisting of air-chambers with the commencement of the body-chamber adhering to the last septum, is to be regarded as the type of the present species. Although at a first glance this form seems to be identical with *Anatibetites Kelvini* v. Mojsisovics (Himálayan Foss., Vol. III, Pt. 1, p. 80, Pl. XIV, fig. 9), a more minute examination shows that it is distinguished by some remarkable differences in its sutural line.

My type-specimen agrees very closely with *Anatibetites Kelvini* from the Halorites limestone, both in its lateral sculpture and in the gradual obliteration of its external ornamentation in the vicinity of the body-chamber, corresponding to the simultaneous flattening of the siphonal part. Without the knowledge of the differently developed sutures, the present species could not be separated from *Anatibetites Kelvini* Mojs.

Dimensions.

Diameter of the shell	35 mm.
" " " umbilicus	3 "
Height of the { above the umbilical suture.	18 "
last volution { " preceding whorl	11½ "
Thickness of the last volution	15 "

Sutures.—Sutural line standing in a transitional stage from the ceratitic to the brachyphyllic development. Top of the siphonal saddle dimeroidic, divided by a deep indentation. Between the siphonal lobe and the true external saddle two secondary elevations are present, which are, however, not sufficiently individualized to acquire the appearance of independent adventitious saddles.

Median prominence of the narrow siphonal lobe comparatively low.

Principal lateral lobe with deep digitations. Walls of the principal lateral saddle faintly serrated up to the very top. Second lateral saddle entire. The number of auxiliary elements outside the umbilical suture could not be ascertained.

This complicated sutural line stands in remarkable contrast to the simple, ceratitic sutures of *Anatibetites Kelvini*. It approaches more closely the sutures of *Anatibetites Adolphi* Mojs., but differs from them by the regularly dimeroidic character of the external saddle, and by the absence of true adventitious elements between the siphonal lobe and saddle. In *Paratibetites Adolphi* Mojs. or in *P. angustosellatus* Mojs. the external elevations are individualized considerably more strongly than in the present species.

Taking into consideration the brachyphyllic development of the sutural line in the present species, the propriety of placing it in the subgenus *Anatibetites* is questionable. E. v. Mojsisovics himself remarked the close morphological agreement of *Anatibetites* and *Heracrites* Mojs. and considered the difference in their sutures as the only feature of distinction between the two genera. "*Heracrites*," he says (l. c. p. 75), "possesses dolichophyllic sutures, whereas *Anatibetites* has the same ceratitic-developed sutures with divided external saddles as *Tibetites* or *Paratibetites*."

If we examine the sutural line of *Heracrites robustus* v. Haner (vide E. v. Mojsisovics, Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 505, Taf. CXXXVIII, fig. 1), we find both the external and lateral saddles provided with deep indentations. Between the siphonal and principal lateral lobes there is only one large saddle, divided into three fingers of nearly equal size, whilst in our species the true external saddle of dimeroidic shape is separated from the external lobe by a serrated slope, culminating in two small elevations. On the whole the arrangement of sutures differs considerably from that in *Heracrites* and approaches more nearly the sutural line of *Paratibetites*. I consequently do not feel justified in placing the present species in the genus *Heracrites*, but prefer to include it in *Anatibetites*, notwithstanding its brachyphyllic sutures.

My second specimen, illustrated in fig. 6, is the fragment of a body-chamber, comprising one-half of an entire volution. Its sculpture is a little more delicate than in equally-sized specimens of *Anatibetites Kelvini* Mojs., but otherwise I can find no difference whatever. As no traces of septa have been preserved, the determination of this specimen must remain somewhat uncertain, although the probability is undoubtedly in favour of its identification with *Anatibetites Kelviniformis*, not with *A. Kelvini*.

Locality.—N. of Po (Kamelang station), N. of Kágá.

PARATIBETITES TORNQUISTI Mojs. Pl. XVII, fig. 1, Pl. XXI, fig. 2.

1896. *Paratibetites Tornquisti* E. v. Mojsisovics, Beitræge zur Kenntniss der obertriadischen Cephalopodenfaunen des Himålaya, Denkschr. Kais. Akad. d. Wiss. math. nat. Kl., Bd LXIII, p. 644, Taf. XVI, fig. 5.

1899. *Paratibetites Tornquisti* E. v. Mojsisovics, Himålayan Foss., Vol. III, Pt. 1, p. 87. Pl. XVI, fig. 5.

1900. *Paratibetites Tornquisti* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 221.

This is the only species of Ammonites from the Juvavites beds of Spiti, which A. v. Krafft was able to identify with a form described from the Halorites limestone of the Bambanag section.

There is especially the fragmentary cast of a middle-sized specimen from Kamelang station (N. of Po), illustrated in Pl. XXI, fig. 2, which in every respect agrees most closely with the typical form from the Halorites limestone of the Bambanag range. It consists of air-chambers only and is provided with a bluntly pointed external blade. The lateral parts are almost perfectly smooth. Marginal and lateral ridges are but faintly individualized. Feeble traces of sigmoidal folds are also occasionally visible.

Exact measurements of this specimen cannot be given. To a height of the cross-section of 34 mm. a width of 15 mm. corresponds. The sutural line agrees exactly with that of *Paratibetites Tornquisti*. The tops of the saddles are rounded, the serration affecting their marginal walls only. The external saddle is divided into two very unequal halves. Between the outer lappet and the external lobe there is a second elevation, slightly inferior in height. The principal lateral lobe terminates in four points. The number of auxiliary elements is not known to me exactly.

A second specimen from the base of the Juvavites beds at Chabrang is of very large dimensions. As it consists of air-chambers only, it must have attained a diameter of at least 350 mm. in the complete state. It is a cast slightly injured by weathering and devoid of its shelly layer. The surface is entirely smooth, without any traces of spiral ridges or lateral folds. The measurements of this specimen are as follows :—

Diameter of the shell	.	.	.	.	.	.	.	236 mm.
" " " umbilicus.	.	.	.	.	.	.	.	10 "
Height of the { above the umbilical suture	.	.	.	.	.	.	.	144 "
last volution { " preceding whorl	.	.	.	.	.	.	.	80 "
Thickness of the last volution	.	.	.	.	.	.	.	74 "

Apart from its larger dimensions, this specimen differs from the type-specimen of *Paratibetites Tornquisti* Mojs. very slightly in some details of its sutural line. The outer lappet of the external saddle is a little shorter than the secondary elevation bordering the siphonal lobe, which assumes the appearance of a proper adventitious element. The principal lateral lobe terminates with three points at its base. The marginal walls of the external and lateral saddles are serrated up to their very tops. It is a matter of convenience only whether or not these differences should be considered as sufficient for a specific separation of this specimen from *Paratibetites Tornquisti*. I have referred it to the latter species as *cf.* only.

A third fragment from Rajagang corresponds to a portion of the inner nucleus of a large specimen. It shows the marginal tubercles as distinctly developed as in *P. angustosellatus* Mojs., but has a bluntly pointed external blade and sutures of a ceratitic development, agreeing with those of *P. Tornquisti*.

PARATIBETITES sp. ind. aff. *WHEELERI* Dien.

The fragment of a body-chamber from Chabrang recalls *Paratibetites Wheeleri* Dien. (Fauna of the Tropites limestone of Byans, Himálayan Foss., Vol. V, Pt. 1, Pl. VIII, figs. 5-7) from the Tropites limestone of Byans by the combination of marginal and lateral rows of spines with a sharp median edge. It shows a remarkable similarity to the example illustrated in fig. 5, being provided with a helmet-shaped siphonal crest and distinguished by the absence of any transverse sculpture.

The present fragment, which is much injured and not fit for illustration, cannot be identified with *Paratibetites Wheeleri* Dien. The row of lateral tubercles does not coincide with the middle of the height, as in *P. Wheeleri*, but is situated considerably above it.

RHACOPHYLLITES sp. ind.

The inner nucleus of a small Ammonite from Tikha with an elliptical cross-section of the tube, a wide, open umbilicus, and with the sutures of *Phylloceratidæ* recalls *Rhacophyllites debilis* v. Hauer or *Rh. neojurensis* Quenst.

The specimen is not suitable for illustration. It would, on account of its bad preservation, be impossible to give a more detailed opinion as to its agreement with or deviation from the two mentioned European types.

JUVAVITES sp. ind. aff. *EHRLICHI* Hauer. Pl. XXI, fig. 3.

1900. *Juvavites* sp. ind. aff. Ehrlichi (Hauer) A. v. Kraft, General Report, Geol. Surv. of India, for 1899-1900, p. 220.

Among the numerous specimens of *Juvavitinæ* from the Juvavites beds of Spiti there is only a single one, which belongs to *Juvavites* s. s. It is a typical representative of the group of *Juvavites continui* and allied most nearly to *Juvavites Ehrlichi* v. Hauer (Denkschr. Kais. Akad. d. Wissensch., Wien, math. nat. Kl., Bd. IX, p. 155, Taf. IV, figs. 14, 15).

The whorls are subglobose, a little broader than high. Their greatest transverse diameter is situated somewhat above the umbilical margin.

The sculpture consists of numerous and sharp ribs, which cross the external part without undergoing an interruption in the middle region or changing their transverse direction. The ribs are less coarse and more numerous than in *Juvavites Ehrlichi* or even in *J. continuus* E. v. Mojsisovics (Cephalopoden der Hallstaetter

Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 77, Taf. LXXXIX, fig. 12). The majority of ribs originate in pairs from the umbilical margin, but the flatly curved umbilical wall is perfectly smooth, as in the illustration of *J. Ehrlichii*, given by E. v. Mojsisovics (l. c., Taf. LXXXIX, fig. 11). A second bifurcation of a large number of stem ribs is noticed below the middle of the flanks. In the vicinity of the aperture several ribs dichotomize a third time in the marginal region. Ribs and intercostal furrows are of nearly equal width.

Dimensions.

Diameter of the shell	. 34 mm.
" " umbilicus	4 "
Height of the last volution	. 17 "
Thickness " " "	21 "

Sutures.—Only known in rough outlines, recalling the sutures of *Juvavites ind. ex aff. Ehrlichii* v. Mojsisovics (l. c. Taf. LXXXVIII, fig. 9). The siphonal lobe is the deepest. Saddles rounded above. Two small saddles follow from the principal lateral saddle to the umbilical suture.

Locality.—Tikha.

JUVAVITES ANGULATUS nov. sp. Pl. XXI, figs. 4—8.

1900. *Juvavites nov. sp.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 220.

In his stratigraphical notes on the mesozoic rocks of Spiti A. v. Krafft states that the overwhelming majority of *Juvavites* from Spiti differ from all the species known from the Hallstatt limestone by the direction of their ribs, which cross the siphonal part in a curve strongly bent forward, thus causing the ribs from both sides to meet in a rounded-off angle.

There is only one group of Alpine *Juvavites* to which the present form might be compared. This is the small group of *Juvavites Electrae* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 148, Taf. LXL, fig. 13, 14) and *J. fissicostatus* Mojs. (l. c. p. 147, Taf. LXL, fig. 15). Their systematic position has not been definitely ascertained. They recall *Dimorphites* Mojs. in their lateral ornamentation consisting of flat, falciform ribs, and in the sculpture of their external part, along the median zone of which the ribs are strongly protracted forward. But the external part is always rounded, not narrow, nor depressed and bordered by marginal edges, as in typical representatives of the subgenus *Dimorphites*.

The close relationship of *Dimorphites* with *Anatomites* has been ascertained by E. v. Mojsisovics by his examination of inner nuclei of *Dimorphites selectus*. *Dimorphites* has paulostome-ribs in the juvenile stage of growth. It is only in advanced stages of development, that these paulostome-ribs become obliterated, and flat, falciform folds become the predominant element of lateral sculpture. The ontogeny of *Juvavites angulatus* is not known to me. Notwithstanding the large materials of this species available to me for examination, there is not a single

complete specimen among them, and none in which the inner volutions have been preserved. In all the examples collected at different localities by Hayden and A. v. Krafft, the nucleus has suffered from weathering and it has never been possible to secure it owing to its fragility. Out of more than fifty specimens the most perfectly preserved have been chosen for illustration. To the reader this fact may give an idea of the state of preservation in which the majority of examples have been found.

It is possible and even probable that more than one single species could be distinguished among the numerous examples, which have been united provisionally under the name of *Juvavites angulatus*, but I deemed it preferable to abstain from the introduction of more new denominations until the discovery of better preserved materials. In the mean time the most remarkable variations in the outline of the shell may be distinguished as *var. crassa* and *var. compressa*. Within those chief varieties there are still further distinctions to be observed in the strength and number of ribs.

One variety, which is shown in figs. 4 and 5, is provided with very numerous, narrow and sharp ribs, whereas a variety with less coarse and flatter ribs is illustrated in fig. 7. The example illustrated in fig. 6 has very narrow and sharp ribs separated by comparatively wide intercostal spaces. In the specimen illustrated in fig. 8, a distinct bundling of ribs is noticed, each bundle swelling into a flat elevation that is separated from the next elevated fasciculus by a corresponding valley.

Thus the establishment and limitation of the present species offers considerable difficulty, on account of its great individual variability, affecting both the dimensions and ornamentation of mature individuals. Apart from the constant appearance of bifurcations of the ribs, there is no leading feature noticed in their arrangement. Two to six-fold bifurcations take place from the umbilical to the external margins at very different heights, but mostly in the upper half of the lateral parts.

A character common to all individuals is the falciform direction of the ribs with their convexity turned forward in the marginal region and their meeting in a sharply rounded-off angle along the median line of the siphonal part. This latter character is sufficient to distinguish the present species at a glance from all European forms of *Juvavites*. The angular ornamentation of the external part is developed in a similar manner in typical species of the subgenus *Dimorphites* only, but in such species the external area itself is shaped quite differently.

Dimensions.—No complete specimens being available for examination, exact measurements cannot be given. One of the better preserved specimens is the type illustrated in fig. 5, which holds an intermediate position between the *var. compressa* and *var. crassa*. It is of very small size. Its dimensions are as follows:—

Diameter of the shell	27 mm.
„ „ „ umbilicus	2.5 „
Height of the { above the umbilical suture	14.5 „
last volution { „ „ preceding whorl	8 „
Thickness of the last volution	13 „

In the large specimen shown in fig. 4, a height of the last volution of 21 mm. corresponds to a width of 17 mm.

Sutures.—Traces of the sutural line are but imperfectly preserved. The sutures are apparently similar to those of several species of *Anatomites*, with a very deep external lobe and with serial, brachyphyllic saddles.

Locality.—Tikha, W. of Lilang, E. above Lilang, W. of Kágá, Banna encamping ground (Thanam valley, Bashahr), Chabrang, Rajagang, between Pomarang and Mani.

ANATOMITES sp. ind. aff. MELCHIORIS Mojs. Pl. XX, fig. 7, Pl. XXI, fig. 9.

This species belongs to a group of *Anatomites intermittentes*, which is represented by *A. Melchioris* v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 130, Taf. CXXVI, fig. 21), *A. Edithæ* v. Mojsisovics (l. c. p. 133, Taf. LXXXXII, figs. 6, 7), and *A. obliterans* v. Mojsisovics (l. c. p. 131, Taf. CXXVI, figs. 24-27) in the Alpine Trias. It agrees with those forms in its compressed transverse section, in the presence of strong lateral ribs and of paulostome-furrows in the adolescent stage of development, and in the gradual obliteration of the sculpture in advanced stages of growth.

At the beginning of the body-chamber whorl the lateral ornamentation disappears gradually. The ribs are confined to the marginal region, and to the external part where they describe forward turned lappets, exactly as in *Anatomites Melchioris*. At the same time the paulostome-furrows become flattened and obsolete, but the paulostome ribs following them still continue as flat, radiating folds, which do not reach the external margin. The area bordered by two paulostome-folds is nearly smooth.

Dimensions.

Diameter of the shell	32 mm.
" " " umbilicus	2 "
Height of the { above the umbilical suture	17 "
last volution { " " preceding whorl	8 "
Thickness of the last volution	11 "

Sutures.—Agreeing with those of *Anatomites obliterans* Mojs. Saddles pyramid-shaped, with faintly serrated margins, lobes narrow. Siphonal lobe shorter than the principal lateral lobe and divided by a low, flattened median prominence. Principal lateral lobe bifid, having its base divided by a short median point.

Two auxiliary lobes outside the umbilical suture.

Locality.—N. of Kágá, W. of Kágá.

ANATOMITES nov. sp. ind. (group of *A. scissi*). Pl. XXI, fig. 11.

In its external characters and in the general arrangement of sculpture this species recalls *Anatomites Herbichi* E. v. Mojsisovics (Cephalopoden der Hall-

staetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 101, Taf. LXL, fig. 4). It is represented by a single, incomplete specimen only, which is not suitable for the introduction of a new specific denomination.

The whorls are of equal height and thickness, provided with flat lateral parts passing gradually into the rounded siphonal area. The umbilicus is comparatively wide.

The ornamentation consists of sharp and narrow ribs, separated by wide intercostal valleys. Two paulostome-furrows are counted within the anterior half of the (fragmentary) last volution. These paulostome-furrows are not very conspicuous, being only somewhat wider but not deeper than the ordinary intercostal valleys. The paulostome ribs do not differ from the rest of the ribs in strength but only by their catenate arrangement. The chain rib preceding the last paulostome-furrow is trifid, each of the three stems bifurcating a second time in the marginal region.

In all the characters enumerated here the present species agrees with *Anatomites Herbichi*. There is, however, one feature of difference, which makes a distinction between the two forms an easy matter. This is the character of the external ribs, in which my specimen recalls strongly *Juvavites angulatus* Dien. The ribs enter the external part from both sides in a direction strongly turned forward, and meet along the median line at right angles. Some of the ribs touch one another in the corner of those angles. The rest are interrupted for a short distance. This angular shape of the external ribs has not been noticed in any of the European species of *Anatomites*.

Dimensions.

Diameter of the shell	.	30 mm.
„ „ „ umbilicus	.	4 „
Height } of the last volution		14.5 „
Thickness }		15 „

Sutures.—Not known.

Locality.—Rajagang.

ANATOMITES sp. ind. aff. ALPHONSI Mojs. Pl. XXI, fig. 12.

An imperfect cast from the Juvavites beds above Lilang recalls *Anatomites Alphonsi* E. v. Mojsisovics (Cephalopoden der Hallstaetter Kalke, Abhandl. K. K. Geol. Reichsanst., VI-2, p. 143, Taf. XCIV, fig. 11) from the noric stage of the Salzkammergut. Its whorls are of equal height and width, provided with flattened sides and with a highly rounded siphonal part. In the circumference of the last volution three paulostome-furrows are developed. The paulostome ribs preceding those furrows are very broad and flat and not elevated considerably above the general convexity of the shell. The sculpture is interrupted by the paulostome-furrows and in every area begins with very delicate folds restricted to the external region. The ribs cross the siphonal part in very flat curves deviating but very little from a straight, transverse direction. They are not interrupted along the median line of the external part.

Dimensions.

Diameter of the shell	20 mm.
" " umbilicus	2 "
Height } of the last volution	{ 9.5 "
Thickness }	{ 9.5 "

Sutures.—Not known.

ANATOMITES sp. ind. aff. *CAROLI* Mojs. Pl. XXI, fig. 10.

The small, imperfectly preserved cast recalls in its outlines and in the number of paulostome-furrows *Anatomites Caroli* E. v. Mojsisovics (Himalayan Foss., Vol. III, Pt. 1, p. 37, Pl. XI, fig. 2), from the carnic Daonella beds of the Shalshal-cliff S.-E. of Rimkin Paiar. But the sculpture of the areas between the paulostome-furrows is different, and thus necessitates a specific separation of the present form from *A. Caroli*.

The species belongs to the group of *Anatomites scissi*, the ornamentation being of equal strength on both sides of the broad and deep paulostome-furrows. There are four paulostomes counted in the circumference of the last volution. The division of the chain-rib preceding each paulostome is six-fold. The rest of the ribs are also arranged in bundles originating from a two or three-fold division of the stem-ribs. The ribs are sharp and narrow and separated by wider intercostal valleys. In the area between the first and second paulostomes and in front of the foremost paulostome the sculpture decidedly weakens in strength. This is especially the case in the umbilical region, where a small number of stem-ribs only remain more prominent.

The direction of the paulostome-furrows is inclined obliquely towards the anterior. They curve over the external part without any interruption, as well as the ribs nearest to them. Both halves of the shell are formed symmetrically, but the majority of ribs meeting along the middle line of the siphonal part are slightly interrupted. But this interruption can be traced for a short distance only, on account of the fragmentary state of the preservation of my type-specimen.

Dimensions.

Diameter of the shell	. 23.5 mm.
" " umbilicus.	. 3 "
Height } of the last volution .	{ 11.5 "
Thickness }	{ 8 "

Sutures.—Not known.

Locality.—Tikha.

VII.—FOSSILS FROM THE UPPER NORIC SERIES (CORAL LIME- STONE, MONOTIS BEDS, QUARTZITE SERIES).

The Juvavites beds of lower-noric (lacie) age are overlain by a grey limestone mass of about 100 feet in thickness. A. v. Krafft describes it as a true organogenic limestone being chiefly composed of corals resembling *Lithodendron*. A few

specimens of this coral in the Himálayan collection are strongly weathered and not sufficiently preserved for determining the genus. Besides these corals two species of Brachiopoda have been mentioned by A. v. Krafft, namely :—

Spiriferina Griesbachi Bittn.

(?) *Rhynchonella bambanagensis* Bittn.

A. v. Krafft correlated this coral limestone with the "limestone with *Spiriferina Griesbachi*" of the Bambanag section.

The coral limestone is overlain by arenaceous limestones, sandstones and shales, which are lithologically very similar to the Juvavites beds. This subdivision, whose thickness is about 300 feet, is characterised by its richness in bivalves and brachiopods. The chief leading fossil is :—

Monotis salinaria Schloth., which has been found in almost every section of these beds in Spiti, about 100 feet below the top of the series. Together with this characteristic bivalve the following fossils have been enumerated by A. v. Krafft :—

Anodontophora Griesbachi Bittn.

Spiriferina Griesbachi Bittn.

Spirigera Dieneri Bittn.

Rhynchonella bambanagensis Bittn.

Aulacothyris joharensis Bittn.

Distichites nov. sp.

A. v. Krafft believed the *Monotis* beds of Spiti to represent the *Sagenites* beds of the Bambanag section, which are overlain by a quartzite series lithologically identical with the quartzite occurring immediately above the *Monotis* shales in Spiti.

The white and brown quartzites overlying the *Monotis* beds form a very conspicuous horizon of 300 feet in thickness. Thick bands of shale and limestone are intercalated with the quartzites. A. v. Krafft describes a sequence observed near Lilang, as follows :—

6. Great thickness of black and grey dolomitic limestone.
2. Dark grey, hard limestone with *Spiriferina Griesbachi* Bittn. and *Lima serraticosta* Bittn. about 200 feet.
3. Thin band of white quartzite.
4. Black, sandy shales, with *Aulacothyris joharensis* Bittn., alternating with thin, brown quartzite layers, 100 feet.
5. Thick brown quartzite.
1. Brown quartzite, about 20 feet.

Faunistically the quartzite series is distinguished by the occurrence of a very interesting brachiopod (*Spirigera nov. sp.*) found for the first time by Mr. Hayden near Mani, but common throughout Spiti. Otherwise the fauna, according to A. v. Krafft's manuscript notes, contains only stragglers of forms known from lower beds.

The majority of fossils are common to the three divisions (coral limestone, *Monotis* beds, quartzite series) of this stage. These faunæ will, therefore, be treated together in the present chapter.

BRACHIOPODA.

SPIRIFERINA GRIESBACHI Bittner. Pl. XXII, figs. 7-13.

1865. *Spirifer tibeticus* Stoliczka, Memoirs, Geol. Survey of India, Vol. V, Pt. 1, p. 28, Pl. III, figs. 1, 2.
 1865. *Spirifer altivagus* Stoliczka, *ibid.*, p. 29, Pl. III, fig. 3.
 1895. *Spiriferina Griesbachi* Bittner, in Diemer, Ergebnisse einer Expedition in den Central Himálaya von Paikhandá, Johar und Hundes, Denkschr. Kais. Akad. d. Wissensch., LXII, p. 558.
 1899. *Spiriferina Griesbachi* Bittner, Himálayan Foss., Palæont. Ind., ser. XV, Vol. III, Pt. 2, p. 51, Pl. IX, figs. 1-13.
 1900. *Spiriferina Griesbachi* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, pp. 222-224.

A full description of the numerous varieties of this species, one of the most abundant types of the upper noric beds of Spiti, will be found in Bittner's memoir. I can add but little to what has been stated by that eminent author. Bittner's descriptions having been based on the specimens collected by myself in the Bambanag section, some of the varieties peculiar to the Trias of Spiti will be treated here in greater detail.

The shape represented in fig. 7 is the typical one in the coral limestone overlying the Juvavites shales. It is of small size and provided with a high area of the ventral valve. The median rib is very thin and low, but several ventral valves have been found together with the median rib more strongly developed. The bipartite median lobe of the dorsal valve is narrower than in the large-sized examples from the Monotis beds. The number of lateral ribs is comparatively small. There is no other type of *Spiriferina Griesbachi* which agrees so closely with *Sp. Moscai* Bittner (Fossilien der Trias von Balía Maaden, Jahrb. K. K. Geol. Reichsanst., 1892, XLII, p. 80, Taf. IV, fig. 8) from the upper Trias of Anatolia. I am unable to find any distinctive feature between them except the more shallow depression of the mesial sinus in *Sp. Moscai*.

Equally sized shapes of *Spiriferina Griesbachi*, identical with those from the coral limestone, have also been found in the Monotis beds of Lilang and Kágá by A. v. Krafft. Near Lilang they occur together with the large-sized shapes, which represent the typical form of *Spiriferina Griesbachi* in the Monotis beds of Spiti.

The few specimens of *Sp. Griesbachi* from the quartzite series are also very similar to the type from the coral limestone. They are of small size, provided with a high area and with a comparatively small number of lateral ribs. In one of the ventral valves the median rib dividing the sinus is scarcely inferior in strength to the lateral ribs.

The main layer of *Spiriferina Griesbachi* in the noric stage of Spiti is the Monotis beds. As has been remarked by A. v. Krafft (l. c. p. 223), the specimens from this series were found in beds about 30 to 50 feet higher than the layer with *Monotis salinaria*. They are distinguished from the small examples of the coral limestone below and of the quartzite series above by their remarkable size. It must, however, be mentioned that small individuals, not exceeding in size the

specimens from the coral limestone and quartzites, are also abundant in the Monotis beds near Lilang, Kágá, and Tikha.

The typical shapes of *Spiriferina Griesbachi* in the Monotis beds are represented by the specimens illustrated in figs. 8 and 12. Narrower forms without any wings are rare, but broad individuals with attenuated wings, of a transversely fusiform shape, are rather frequently met with. One of the extreme types is shown in fig. 13, but a gradual passage exists between them and the typical shapes of more elongated outlines.

The sinus is always broad and divided by a mesial rib of very unequal strength. The mesial lobe of the dorsal valve corresponds in its width to the sinus of the opposite valve. The deep furrow dividing this lobe never reaches the apex of the beak. On each side of the sinus and mesial lobe there are from eight to eleven ribs of moderate strength. The ribs become gradually obliterated towards the marginal region of the wings. Thus near the margin of the area there remains, as a rule, a space without ribs or almost without them. But there are some exceptions to this rule as is shown in fig. 9, the specimen illustrated being ribbed up to the very terminations of its wings. The width of the area and the curvature of the beak are subject to considerable variations and are not features of specific importance.

A small number of large specimens are provided with a coarser sculpture. Their ribs are broader and more strongly marked than in the typical shapes. Such specimens are identical with *Spirifer tibeticus* Stoliczka and *Sp. altivagus* Stol., which have been mistaken for carboniferous species by that author. They might be considered as varieties of *Sp. Griesbachi*, but no specific value can be attributed to the small differences in sculpture, by which they might be distinguished from the typical *Sp. Griesbachi*. I have illustrated two individuals belonging to the *var. tibetica* in figs. 10 and 11. The small value of the difference in the strength of ribbing will be appreciated by comparing those illustrations with fig. 13, which marks a true transitional shape between figs. 10 and 12.

In this variety the strength of the median rib is still more variable than in the typical shape. The sinus of the individual shown in fig. 10 is provided with a very strong and broad mesial rib, whereas in the specimen illustrated in fig. 11 this rib is barely elevated above the general concavity of the sinus, which is nearly smooth.

Dimensions.

The great variability of this species in its outlines and proportions will be seen from the following measurements :—

(a) *Typical shape.*

	Fig. 8.	Fig. 12.
Entire length of the shell . . .	27 mm.	24 mm.
Length of the dorsal valve . . .	22 "	20 "
Greatest breadth of the shell . . .	37 "	28 "
Thickness of both valves . . .	18.5 "	18 "
Breadth of the area of the ventral valve . . .	6 "	5 "

(b) *Fusiform shape.*

		Fig. 9.	Fig. 13.
Entire length of the shell	. .	. 16 mm.	24 mm.
Length of the dorsal valve	. .	. 14 "	21 "
Entire breadth of the shell	. .	. 28 "	43 "
Thickness of both valves	. .	. 12 "	18.5 "
Breadth of the area of the ventral valve		. 4.5 "	4 "

(c) *Var. tibetica Stol.*

		Fig. 10.	Fig. 11.
Entire length of the shell	. .	. 28 mm.	27.5 mm.
Length of the dorsal valve	. .	. 22 "	22 "
Entire breadth of the shell	. .	. 31 "	38 "
Thickness of both valves	. .	. 19 "	21 "
Breadth of the area of the ventral valve		. 6 "	5 "

Locality and geological position.—

(a) *Coral limestone*:—E. above Lilang, Chabrang.

(b) *Monotis beds*:—E. above Lilang, Chabrang, between Po and Dankbar, Mani, between Pomarang and Mani, 4 miles W. of Po, N. of Kágá, Tikha, N. of Manirang, between Po and Mani, N.-W. of Muth.

(c) *Quartzite series*:—Tikha, Mani.

Remarks.—Bittner has drawn attention to the close resemblance of *Spiriferina Griesbachi* to *Spirifer tibeticus* Stoliczka and *Spirifer altivagus* Stoliczka, described as carboniferous forms from the Kuling shales of Kibber. He considered it probable that these three species are identical. To me their identity seems to be fully established on the strength of the occurrence of specimens agreeing exactly with *Spiriferina tibetica*—Stoliczka's species is a *Spiriferina*, not *Spirifer*—in the same triassic beds together with typical shapes of *Sp. Griesbachi*.

A. v. Krafft (l. c. p. 223) also strongly advocates their identity, refuting Stoliczka's statement of a carboniferous age of *Sp. tibetica* and *Sp. altivaga*. "Stoliczka's specimens," he says, "cannot have been collected from the carboniferous, as nowhere in the true carboniferous of Spiti was found a brachiopod similar to *Sp. tibetica*. Moreover, nowhere within many miles of Kibber, where Stoliczka found loose specimens of *Sp. tibetica*, do carboniferous rocks occur. On the other hand north of Kibber, near the Parang-lá, Mr. Hayden observed the beds with *Sp. Griesbachi*, so that doubtlessly Stoliczka's loose specimens had come from those beds."

The specific identity of *Spiriferina Griesbachi* and *Sp. tibetica* having been fully established, the question might be raised, which of these two names should be retained for this species. Advocates of an unlimited rule of priority in palæontological nomenclature will find no difficulty in deciding this question in favour of Stoliczka's name. I am, however, obliged to disagree with this view for several important reasons, and I prefer to retain Bittner's name, although this proceeding is perhaps not in accordance with the strict principles of priority.

I am far from underrating the great value of this principle in all questions of scientific nomenclature, but, in accordance with Beyrich, I believe there

are cases which must be treated as exceptions from the general rule. In my memoir on the permian fossils of the Central Himálayas (Pal. Ind., ser. XV, Himál. Foss., Vol. I, Pt. 5, p. 27) I had to deal with a case very similar to the present one.

In 1862 a species of *Retzia* (*Hustedia*) from the Productus limestone of the Salt Range had been described as *R. grandicosta* by Davidson. Later on this species was collected at many localities in beds of upper carboniferous and permian age. In palæontological literature it was known by the name introduced by Davidson until Frech in 1901 (*Lethæa palæozoica*, II Bd., 3 Lfg., Explanation of Pl. 57 b) united it with *R. remota* Eichwald. Eichwald had proposed this denomination for a Russian species in 1860, but his description and figures are in noway sufficient for an identification of the Russian and Indian forms. His type-specimen was a cast devoid of its shelly substance and it had been quoted from Kushwa, a place where younger beds than limestones of devonian age are not known to occur, as has been stated by Nikitin, who consequently refuted the identity of *Retzia remota* and *R. grandicosta*. This uncertainty has been cleared up by Tschernyschew (*Die obercarbonische Brachiopodenfauna des Ural und Timan*, Mémoires Com. Géol. de la Russie, St. Pétersbourg, 1902, Vol. XVI, No. 2, p. 107). He declared the two species to be identical, but proved Eichwald's type-specimen to have been collected from Sterlitamak, not from the locality mentioned by Eichwald himself.

Now I consider it advisable to raise the question, whether we ought to adhere to the strict principles of priority in such an exceptional case, and retain a name based on a cast unfit for description and illustration, together with a misleading statement of the locality and horizon from which it had been collected. Are we not, on the contrary, obliged to respect the historical rights of a name assigned to species, of which the exact horizon had been determined along with a much better description and with a correct knowledge of the affinities of the shell?

Our case is a similar one. Stoliczka's name has been proposed for a species of doubtful stratigraphical position. The name *Spiriferina Griesbachi* has been assigned to a species of which the exact horizon was determined, and has even been applied to designate the horizon itself. To replace the name *Spiriferina Griesbachi* by the misleading denomination of *Sp. tibetica*—the species is known from the Indian slope of the mesozoic belt of the Himálayas, not from Tibet—would therefore cause great inconvenience. To this reason a second and even more important one might be added. *Spiriferina tibetica* does not represent the *typical* shape of the species, but an exceptional one. It is hardly possible to unite the typical and most common shape as *var. Griesbachi* with *Sp. tibetica*, when the form to which the name of *Sp. Griesbachi* was first assigned, actually represents the standard type of the species.

For the reasons just mentioned the name of *Spiriferina Griesbachi* can, I think, be retained, and consequently I have united here *Sp. tibetica* and *Sp. altivaga* as varieties of that species.

SPIRIGERA DIENERI Bittner. Pl. XXIII, fig. 6.

1895. *Spirigera Dieneri* Bittner in Diener, Ergebnisse einer geologischen Expedition in den Central Himálaja von Johat, Paikhánda und Hundes, Denkschr. Kais. Akad. d. Wiss., LXII, p. 558.

1899. *Spirigera Dieneri* Bittner, Himálayan Foss., l. c. Vol. III, Pt. 2, p. 54, Pl. X, figs. 1-14.

1900. *Spirigera Dieneri* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 223.

Of this species, one of the most abundant and characteristic fossils of the limestone with *Spiriferina Griesbachi* in the Bambanag section, two specimens only have been collected by Hayden in the Monotis beds of Spiti. One of them has been perfectly preserved and shows all the specific characters enumerated by Bittner. It is a wide form of moderately large size, agreeing most closely with Bittner's type-specimen illustrated on Pl. X, fig. 8. The ventral valve still retains its original bipartite character, being divided by a mesial sinus, which originates in the umbonal region and widens out into a triangular frontal tongue. The dorsal valve in its frontal region begins to assume a tripartite shape, whereas the median furrow has been still preserved in the apical region.

The beak is protracted forward considerably.

Locality and geological position.—Monotis beds, Mani.

SPIRIGERA (?) *MANIENSIS* v. Krafft (ms.). Pl. XXIII, figs. 2-4.

1904. *Spirigera* nov. sp. A. v. Krafft, in Hayden, The geology of Spiti, Mem. Geol. Surv. of India Vol. XXXVI, Pt. 1, p. 84.

This is the chief leading fossil of the quartzite series of Spiti. On the labels accompanying some of the specimens I find the name of *Rhynchonella Maniensis* in A. v. Krafft's handwriting. He seems to have considered the species at first as a *Rhynchonella*, but to have changed his mind later on, as in Hayden's notes on the trias of Spiti the form has been mentioned as *Spirigera* nov. sp.

It is, indeed, not easy to arrive at a satisfactory determination of its systematic position. Its general habit recalls a *Rhynchonella*. In the majority of specimens the beak has been broken off entirely, but in a small number of examples which I have myself cleaned from the adhering matrix, parts of the beak have been made accessible for examination. There is very little probability of its having been pointed. It was small, but most probably truncated at its termination and pierced by a foramen. I am sorry to say I have not succeeded in ascertaining the presence of spiral cones by grinding off the frontal and lateral parts of the cast in six specimens. Only in one of those specimens indistinct traces of spiral cones have been noticed. The only internal characters known to me with certainty are the two dental plates of the ventral valve.

Thus the determination of the generic position of *Spirigera Maniensis* must be based on external features only, its internal structure remaining unknown. Against its reference to *Rhynchonella* the shape of the beak, which appears to have possessed a distinct terminal opening, is a strong argument. With *Spiriferina* it

cannot be grouped, since it shows neither a distinct area nor a median septum in the ventral valve, nor a punctate shell-structure. The feature which speaks most strongly for its reference to *Spirigera*, is the fibrous structure of the shelly substance. In the median region of the dorsal valve of my type-specimen illustrated in fig. 3, convergent fibres of the test have been observed. The existence of such fibres is considered by Bittner (Jahrb. X. X. Geol. Reichsanst., 1892, XLII, p. 82) as a decisive proof of the presence of a triassic *Spirigera*. It is on the strength of this character that the species has been attributed to that genus.

If this species should, indeed, be proved to belong to *Spirigera*, it is certainly one of the most aberrant forms of this genus. The only species, with which it could be compared, is *Spirigera* (?) *Noetlingii* Bittner (Himalayan Foss., l. c. Vol. III, Pt. 2, p. 68, Pl. XI, figs. 2, 3), whose systematic position is equally doubtful. In its ornamentation it recalls even more strongly *Rhynchonella*, *Spirifer* or *Spiriferina* than *Spirigera* (?) *Noetlingii*. It is provided with coarse ribs running from the umbo to the front. The sinus of the ventral valve is deep, comparatively broad, produced into a rounded frontal tongue and divided by a delicate median rib. To this sinus corresponds a moderately elevated and narrow mesial lobe in the dorsal valve, which is divided by a deep median furrow. The bipartite character of the dorsal lobe and the development of a single mesial rib in the deep and otherwise smooth ventral sinus are characters common to all my specimens. Outside the sinus and mesial lobe from three to six ribs can be counted on each of the sides.

The specimen illustrated in fig. 4 is exceptionally shaped, being of unusually large size and provided with a very small number of strong ribs. Two ribs only are counted on the dorsal and three on the ventral valve on each of the sides. The number of dorsal ribs is always smaller than that of ventral ones. The ribs are high and sharp in the visceral region of the shell, but become lower and rounded in the vicinity of the lateral and front margins.

Dimensions.

	Fig. 2.	Fig. 4.
Entire length of the shell	. 21 mm.	27 mm.
Length of the dorsal valve	. 18 "	24 "
Entire breadth of the shell	. 22 "	28 "
Thickness of both valves	. 16 "	17.5 "

Locality and geological position.—Quartzite series, Tikha, Mani, E. above Lilang.

SPIRIGERA MANIENSIFORMIS nov. sp. Pl. XXIII, fig. 5.

This species, which is represented by a single but well-preserved specimen in the Himalayan collection, is very nearly allied to *Spirigera* (?) *Maniensis*, from which it differs by some details in its shape and ornamentation. In its outlines it recalls a *Rhynchonella* even more strongly than the preceding species. The quadrangular shape, the coarse plications of the shell, and the strongly elevated mesial lobe of the dorsal valve would be in favour of a reference to *Rhynchonella*. It appears, however, that the beak, although small and delicate, preserved a-

distinct terminal opening. The frontal tongue of the ventral sinus is produced more strongly than in *Spirigera Maniensis*. To this frontal tongue a considerable elevation of the mesial lobe corresponds in the dorsal valve. The mesial lobe is not bipartite as in the preceding species, but provided with three ribs of equal strength, separated by two furrows which are comparatively low. Three low and flat ribs are counted in the sinus and three coarse folds on each of the sides.

Of the internal characters of this species nothing is known to me.

Dimensions.

Entire length of the shell	22.5 mm.
Length of the dorsal valve	19 "
Entire breadth of the shell	20 "
Thickness of both valves	12 " *

Locality and geological position.—Quartzite series, Tikha.

AULACOTHYRIS JOHARENSIS Bittner. Pl. XXIII, figs. 6, 7.

1899. *Aulacothyris joharensis* Bittner, Himäl. Foss., l. c. Vol. III, Pt. 2, p. 57, Pl. IX, figs. 19, 20.

1900. *Aulacothyris joharensis* A. v. Krafft, General Report, Geol. Surv. of India for 1899-1900, pp. 223, 224.

A species of *Aulacothyris* of very indefinite shape from the limestone with *Spiriferina Griesbachi* of the Bamnanag section has been described as *A. joharensis* by Bittner. It differs from all the Alpine representatives of this subgenus by the absence of any median depression in the dorsal valve.

This species is very common in the upper noric series of Spiti. All my specimens of *Aulacothyris* with a punctate test, two strong dental plates in the larger valve and a median septum in the smaller one, but otherwise without any defined and distinctive characteristics, I have united in one single species, although its range of variability is thus rather considerable. Common to all my examples are the perfectly level front and lateral margins. The line of junction of the two valves lies entirely in one plane. The outlines are oval, rounded and slightly pentagonal. Size and thickness of both valves are subject to many variations. The flat specimen shown in fig. 6 agrees exactly with the typical form from the Bamnanag section. The majority of examples from the quartzite series of Tikha are conspicuous for their large dimensions and for their thickness, but individuals agreeing with them already occur in the Monotis beds.

No specimen with a wavy line of junction between the two valves, referable to *Aulacothyris lilangensis* Bittner. (l. c. p. 28, Pl. VI, fig. 1) has been found among my materials. From *A. Nilangensis* Bittner (l. c. p. 30, Pl. VI, figs. 3-7) my specimens are distinguished by their larger size and by their thin median septum of the dorsal valve, but these differences are only very subordinate.

Dimensions.

	Fig. 6.	Fig. 7.
Entire length of the shell	15.5 mm.	21 mm.
Length of the dorsal valve	13.5 "	18.5 "
Entire breadth of the shell	12 "	14 "
Thickness of both valves	6 "	12 "

Locality and geological position.—(a) *Monotis beds* : E. above Lilang, Mani, between Po and Dankhar, 4 miles W. of Po.

(b) *Quartzite series* : Tikha, Mani, 6 miles W. of Ensa.

RHYNCHONELLA BAMBANAGENSIS Bittner. Pl. XXIII, fig. 8.

1899. *Rhynchonella bambanagensis* Bittner, *Himalayan Fossils*, l. c. Vol. III, Pt. 2, pp. 44, 56, Pl. VIII, fig. 4, Pl. IX, fig. 18.

1900. *Rhynchonella bambanagensis* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, pp. 222, 223.

Specimens agreeing very closely with this species of *Rhynchonella* of a vague, undefined habit, recalling the group of *rimosæ*, appear to be distributed rather widely in the noric series of Spiti.

The coral limestone of Chabrang has yielded a specimen, which is most nearly allied to Bittner's type from the beds with *Spiriferina Griesbachi*, in the Bambanag section. It is a broadly rounded shape with five ribs in the sinus and mesial lobe and with an equal number of ribs on each of the sides. Its outlines are slightly asymmetrical and the lateral ribs are more close-set on the left side of the mesial lobe of the dorsal valve. The umbones are smooth, the delicate and smooth ribbing beginning only at some distance from the apices in both valves.

Dimensions.

Entire length of the shell		. 12 mm.
Length of the dorsal valve		. 10 "
Entire breadth of the shell		. 13.5 "
Thickness of both valves		. 7 "

Several specimens closely related to this form from the coral limestone may be regarded as specifically identical, but their specific identity cannot be proved with full certainty on account of the fragmentary state of my materials available for examination.

Locality and geological position.—(a) *Coral limestone* : Chabrang, Gaichund, E. above Lilang.

(b) *Monotis beds* : Chabrang, N. of Kágá.

(c) *Quartzite series* : Tikha, 6 miles W. of Ensa.

LAMELLIBRANCHIATA.

MONOTIS SALINARIA v. Schloth. Pl. XXII, figs. 3, 4, 5, 6.

1820. *Pectinites salinarius* v. Schlotheim, *Petrefactenkunde*, p. 230.

1830. *Monotis salinaria* Broun, Ueber die Muschel-Vehrsteinerungen des sueddeutschen Steinsalzgebirges, welche bisher unter dem Namen *Pectinites salinarius* zusammengefasst wurden. Jahrb. f. Mineral, etc., I, Bd., p. 279, Taf. IV, fig. 1.

1894. *Monotis salinaria* Teller, in E. Suess, *Beitraege zur Stratigraphie Centralasiens*, Denkschr. Kais. Akad. d. Wiss., LXI, p. 460.

1896. *Monotis salinaria* G. v. Bukowski, *Verhandl. K. K. Geol. Reichsanst.*, p. 105.

1900. *Monotis salinaria* A. v. Krafft, General Report, Geol. Surv. of India for 1899-1900, p. 222.

1904. *Monotis cf. salinaria* Vredenburg, *Records, Geol. Surv. of India*, XXXI, p. 166, Pl. XVII, fig. 1.

1906. *Monotis salinaria* Diener, Notes on an upper triassic fauna from the Pishin district, Baluchistan. *Records, Geol. Surv. of India*, Vol. XXXVI, p. 13, Pl. III, figs. 1, 2, 3.

This is certainly the most interesting fossil from the bivalve beds overlying the coral limestone. Its discovery is due to Mr. Hayden, who found it in 1899 in large numbers between Mani and the Pin river on the right bank of the Spiti river.

It had not been recorded before this time in the Himálayas, although it was known to occur in the Pamir, where Stoliczka had collected some specimens N.-E. of Ak-Tash, 4 miles W. of the Neza Tash pass, which were identified with the typical *Monotis salinaria* by Teller. Later on the species was also found at several localities of the Pishin district in Baluchistan by Vredenburg. Thus it seems to be rather widely distributed throughout the high mountain-chains bordering the northern and north-western frontiers of India.

Casts of *Monotis salinaria* are rather numerous represented in Hayden and A. v. Krafft's Himálayan collections. Their state of preservation is less favourable than in Vredenburg's materials from Baluchistan. Although they have been, as a rule, preserved as casts, with fragments of the shelly substance adhering, not as impressions as in the slabs of shale near Kudin (Pishin district), the apical region is but rarely accessible to examination. I have only found two casts or right valves (figs. 3, 6) in which the hinge margin has been preserved sufficiently well to ascertain the absence of any anterior wing or byssal notch in front of the apex.

C. Renz has recently (Neues Jahrb. f. Mineral., 1906, I, p. 40) enumerated the following characters, which according to his opinion might serve as characters of distinction between *Monotis salinaria* and some varieties of *Pseudomonotis ochotica* Keys., if right valves with well-preserved hinge margins should not be available for examination. In *Pseudomonotis ochotica* var. *densistriata*, which recalls most strongly the Alpine shell, the full-grown specimens are of equal width and height, concentric wrinkles are not numerous developed and are most strongly marked in the anterior region. In *Monotis salinaria* the full-grown shell is strongly elongated posteriorly and nearly twice as high as broad. Concentric wrinkles occur in larger numbers (up to 14) on the posterior portion of the valve. *Monotis salinaria* has valves of equal size and curvature, whereas *Pseudomonotis ochotica* is slightly inequivalve.

I am afraid that it will not be possible to base an exact determination on those subtle features of distinction. Both *Pseudomonotis ochotica* and *Monotis salinaria* are extremely variable in their dimensions and outlines. The variations of *Pseudomonotis ochotica* are known to us from the excellent memoir of F. Teller on the Lamellibranchiata of Werchojansk (in E. v. Mojsisovics, Arktische Triasfaunen, Mém. Acad. impér. des sciences de St. Pétersbourg, 1886, T. XXXIII, No. 6), but those of *Monotis salinaria* have not as yet been studied in detail.

The inequivalvity, although in general a good character of *Pseudomonotis*, is so strongly obscured in some varieties of *Ps. ochotica* as to lose its importance as a distinctive feature. The majority of Alpine specimens of *Monotis salinaria* are certainly considerably wider than high, and elongated posteriorly, but I do not believe in the constancy of this character, exceptional shapes being known to me

of equal height and width. Even among the Himalayan specimens very different shapes have been noticed. The example shown in fig. 3 agrees with the typical shape of *Monotis salinaria* in the proportion of height to width. Its posterior margin has not been preserved, but from the outlines of the hinge and anterior regions we may judge that the cast was approximately twice as broad as high. In the two examples illustrated in fig. 4, the proportions were rather different. Breadth and height of the cast must have been almost equal, although exact measurements cannot be given, on account of the fragmentary state of their marginal regions.

Nor is the concentric ornamentation constant in all specimens of *Monotis salinaria*. In the specimen shown in fig. 3 concentric wrinkles are very faintly developed and disposed regularly on the anterior and posterior halves of the cast. In one of the two examples illustrated in fig. 4, concentric wrinkles are numerous and strongly developed, especially so in the vicinity of the ventro-posterior margin. In the fragment shown in fig. 5, two remarkably strong, concentric folds are noticed on the anterior slope of the umbonal convexity, but become gradually obliterated in the direction towards the posterior slope.

Thus, according to my opinion, all attempts at a distinction of *Pseudomonotis ochotica* and *Monotis salinaria* on the ground of external characters have too much the stamp of artificial construction. The only distinctive feature, on which a safe determination can be based, is the presence or absence of a minute anterior wing and byssal notch in the right valve.

Locality and geological position.—*Monotis beds*: N. of Manirang pass, Mani, E. above Lilang, Sozona encamping ground.

Remarks.—In text-books of palæontology and geology *Monotis salinaria* is generally considered as an eminent leading fossil of the noric stage. But in reality it has probably a wider stratigraphical distribution. G. v. Bukowski collected shells, which have been referred to this species by Bittner, in the carnic Hallstatt limestone of Spizza. His specimens are before me and I have as yet not succeeded in discovering any character which might justify a specific separation from the noric types.

The reference of a shell from triassic shales of the island of Borneo to *Monotis salinaria* by Vogel (Sammlungen des geol. Reichs-Museums in Leiden, ser. I, Bd. VII, 1902, p. 317, Taf. VIII) is rather doubtful. The specimens from Rotti identified with the Alpine species by Rothpletz (Palæontographica, 39; Bd. p. 91, Taf. XIII, figs. 1—3) have been referred to *Pseudomonotis ochotica* var. *densistriata* Teller by Renz, on re-examination of Wichmann's materials.

ANODONTOPHORA GRIESBACHI, Bittner, Pl. XXIII, fig. 9.

1899. *Anodontophora Griesbachi* Bittner, Himalayan Foss., Palæont. Ind., ser. XV, Vol. III, Pt. 2, p. 6, Pl. VIII, figs. 14—16.

1900. *Anodontophora Griesbachi* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 232.

Smooth casts of a moderately large bivalve, agreeing with *Anodontophora Griesbachi* Bittn. from the noric stage of Johar and Painkhanda are before me.

None of the specimens is provided with its test. The two valves are very slightly unequal in their dimensions but not gaping. Neither traces of hinge teeth nor of a pallial sinus have been noticed.

In the Bambanag and Shalshal cliff-sections this species shows a comparatively wide vertical distribution ranging from the Halorites limestone through the beds with *Spiriferina Griesbachi* into the Sagenites beds. In Spiti unquestionable specimens of *Anodontophora Griesbachi* are known from the Monotis beds only, but fragments forbidding a safe determination have been noticed in the quartzite series. The species has also been quoted from the Juvavites beds by A. v. Krafft (l. c. p. 220).

Locality and geological position.—*Monotis beds*: E. above Lilang, N.-W. of Muth, Kamelang station, N. of Po, hills above Kuligyang encamping ground (Bashahr).

PECTEN MARGARITICOSTATUS, Diener.

This species has been described in the preceding notes on the fauna of the Juvavites beds of Spiti. An identical form seems also to occur in still higher beds. Several valves are before me, both as shells and as casts, agreeing exactly with the type-specimens from the Juvavites beds.

Locality and geological position.—*Monotis beds*, E. above Lilang.

PECTEN sp. ind. aff. MASSALONGI, Stopp. Pl. XXIII, fig. 10.

A species of *Pecten* of moderately large size, with very broad and flattened ribs, which are separated by very narrow and low intercostal depressions. The right valve only is known to me. It is moderately convex and provided with an acute apical angle. The wings have not been preserved. The broad ribs are covered by numerous, very delicate, radiating striæ, which are crossed by a system of concentric lines of growth.

In its ornamentation this species recalls *Pecten Massalongi* Stoppani (Description des fossiles de l'Azzarola, Palæont. lombarde, 3^e sér. Milan, 1860—65, p. 77, Pl. XIV, figs. 8—12), but the number of ribs is smaller than in the Italian form, seven or nine ribs only being counted against twelve in *Pecten Massalongi*. It has been mentioned here to show that similar broadly ribbed forms of *Pecten* occur in the noric stage of the Himálayas. Otherwise my specimens are so imperfectly preserved that I must abstain from a closer examination of them.

Locality and geological position.—*Monotis beds*, E. above Lilang.

PECTEN sp. ind. aff. MONILIFERO, Muenst. Pl. XXIII, figs. 11, 12, 13.

This species from the Juvavites beds, which has been described in the preceding chapter, occurs also in still higher beds of the noric stage, as numerous fragments show. I can, unfortunately, add nothing to my former description, all examples

available for examination being incomplete fragments, which can only be recognized by their particular sculpture. Their surface is strongly ribbed. The broad stam-ribs are adorned with from one to three rows of tubercles and separated by valleys which are again subdivided by sharp and smooth secondary ribs.

Locality and geological position.—(a) *Monotis beds*: E. above Lilang, N. of Po, 5 miles W. of Po, between Pomarang and Mani.

(b) *Quartzite series*: Tikha, Mani.

LIMA sp. ind. aff. CUMAUNICA, Bittn. Pl. XXIII, fig. 14.

A small *Lima*, whose cast shows 13 or 14 rather high and strong ribs. It is broader and a little less oblique than *Lima cumauica* Bittner (Himalayan Foss., Vol. III, Pt. 2, p. 59, Pl. X, fig. 25), but differs especially from that species by the steeper slope of its posterior portion. The only specimen from the quartzite series of Tikha is too imperfectly preserved for a more detailed description and comparison with other congeneric forms.

LIMA cf. SERRATICOSTA, Bittner.

1899. *Lima serraticosta* Bittner, Himalayan Foss., Vol. III, Pt. 2, p. 50, Pl. VIII, figs. 12-13.

1900. *Lima serraticosta* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 224.

This species, which has been described in the preceding chapter, is probably also represented among the fossil materials from the upper noric stage of Spiti. All my specimens are fragmentary. Their identification has been based on their sculpture, which is very characteristic.

Locality and geological position.—(a) *Monotis beds*: E. above Lilang, N. of Kágá.

(b) *Quartzite series*: Tikha.

PLEUROMYA HIMAICA, nov. sp. Pl. XXIII, fig. 15.

The single but well-preserved specimen, representing this new species, recalls, in its general shape, some of the species of *Pleuromya*, especially *Pl. suevica* Rolle (Ueber einige an der Grenze von Keuper und Lias in Schwaben auftretende Versteinerungen, Sitzgsber. Kais. Akad. d. Wissensch., 1857, Bd. XXVII, p. 23, fig. 2) and also the genus *Pleurophorus* King. Its systematic position is uncertain, the hinge-characters remaining unknown.

Shell nearly equivalve, but strongly inequilateral. Umbones nearly terminal and prosogyrate. Ventral margin slightly curved, posterior margin somewhat gaping. From the umbones a shallow furrow extends to the ventral margin. The narrow portion in front of it is somewhat inflated.

The surface of the shell is covered with a small number of delicate concentric lines.

Dimensions.

Height	} of the shell	.	.	.	.	.	.	{ 23.5 mm.
Width		.	.	.	.	.	.	{ 35 "
Thickness of both valves	to	.	.	.	.	.	.	22 "

Locality and geological position.—*Monotis beds*: between Mani and Pomarang.

HOMOMYA sp. ind.

From the *Monotis* beds of Lilang a cast of *Homomya* is before me, which in some of its characters recalls very strongly some jurassic species of this genus. The apex is less terminal in its position than in *H. lariana* Stopp. It has no oblique, but nearly rectangular outlines and its ventral margin is almost straight for a considerable distance. The posterior margin has not been preserved. Its sculpture consists of very strong, concentric folds.

The specimen is, unfortunately, not fit for illustration, on account of its bad state of preservation.

CEPHALOPODA.

TRACHYPLEURASPIDITES sp. ind. aff. GRIFFITHI Dien. Pl. XXII, fig. 1.

1900. *Distichites nov. sp. ind.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 223.

Fragments of Ammonites, "belonging apparently to the genus *Distichites*," have been recorded from the *Monotis* beds from Mani and N. of Kágá by A. v. Krafft. A careful examination of these fragments has convinced me of their identity with a subgenus of *Arpadites* from the Tropites limestone of Byans, for which the name of *Trachypleuraspides* has been proposed. That the fragments referred to *Distichites* by A. v. Krafft cannot be grouped with that genus is proved by their ornamentation, which consists of transverse ribs adorned by several rows of tubercles and by their brachyphyllic sutures, which are not as strongly complex as in *Distichites*.

There are at least two species of *Trachypleuraspides* represented in Hayden's collections from Spiti, but both of them by small fragments only, which do not justify the introduction of new specific denominations. One of these fragments belongs to a species which is probably nearly allied to *T. Griffithi* Diener (Fauna of the Tropites limestone of Byans, Himálayan Fossils, Vol. V, Pt. 1, Pl. VI, fig. 3, Pl. XI, fig. 26).

The cross-section is higher than wide, with flat lateral parts and with a regularly rounded siphonal area, which is provided with two low and rounded external keels. The median furrow and the two furrows bordering the external keels are of equal width and depth. The keels do not rise above the general level of the siphonal area. The perpendicular umbilical wall is separated from the flanks by a distinctly defined edge.

The ornamentation is more delicate than in *Trachypleuraspides Griffithi*. Numerous falciform ribs stand close to each other and are separated by narrow intercostal valleys. The majority of ribs are single; the rest bifurcate regularly in the middle of the sides. The ribs are rounded above, not sharp. Five spiral row of lateral tubercles have been noticed on this fragment, but the tubercles are very delicate and have been partly destroyed by weathering.

Sutures.—The sutures are brachyphyllic and very similar to those of *Dittmarites*. The siphonal lobe is divided by a broad median prominence and is considerably shorter than the principal lateral lobe. The siphonal saddle is of very large size. This saddle and the adjoining lateral lobe far exceed in importance the rest of the sutural elements. The inner wall of the broad and low second lateral saddle touches the umbilical edge.

One auxiliary lobe and saddle are noticed on the wall between the umbilical margin and suture.

Locality and geological position.—*Monotis beds*, Mani.

TRACHYPLEURASPIDITES nov. sp. ind. PL XXII, fig. 2.

Fragments of *Trachypleuraspides* from the Monotis beds near Mani and N. of Kágá belong to a species, distinguished from the preceding one by its coarse sculpture and by the strong development of lateral tubercles coinciding with the point of bifurcation of the transverse ribs. These ribs are straight, radial, directed forward in the marginal region, but not falciform, and separated by broad intercostal valleys. They bifurcate regularly in stout tubercles. Three rows of smaller tubercles are noticed between this principal lateral row and the external keels. An equal number of spiral rows of tubercles is counted from the principal lateral row to the umbilical margin, but they are rather faintly developed.

Sutures.—Not known.

VIII.—FOSSILS FROM THE MEGALODON LIMESTONE.

As in Johar and Painkhanda, the beds above the quartzite series of Spiti are of a very uniform lithological character. They consist of dolomitic limestones recalling the Dachsteinkalk in the Eastern Alps, and acquire a thickness of roughly 2,300 feet. Only the lower part of this rock group represents the triassic series, probably the rhætic stage, although no rhætic fossils have been recognized by A. v. Krafft. About 800 feet above the quartzite he collected a *Spiriferina*, bearing a striking resemblance to the liassic *Sp. obtusa* Oppel, and 1,000 feet above its layer *Stephanoceras cf. coronatum* Brug., pointing to a middle jurassic age.

The triassic division of this limestone series is very poor in fossils. At 50 feet above the quartzite a band of grey limestone, about 20 feet in thickness, has been noticed in several sections, containing immense numbers of *Megalodon ladakhensis* Bittn. and of *Dicerocardium* sp. This is the characteristic horizon of Stoliczka's.

Para limestone. About 200 feet higher the massive limestone has yielded several species of brachiopods and bivalves. The following forms have been quoted by A. v. Krafft :—

Spiriferina Noetlingii Bittn.
 „ *nov. sp.*
Lima cumauica Bittn.
 „ *serraticosta* Bittn.

The Hímálayan collection submitted to me for examination contains only a very small number of fossils, the majority of which are fragmentary and too badly preserved for a safe determination. Of *Megalodon* and *Dicerocardium* fragments only are before me, absolutely unfit for either description or illustration. The only species, which is represented by fairly well-preserved examples, is *Spiriferina nov. sp.*, which has been compared with *Sp. Griesbachi* by A. v. Krafft.

The results of my investigation of this scanty material are described in the following pages :—

BRACHIOPODA.

SPIRIGERA (?) *NOETLINGII* Bittner. Pl. XXIV, figs. 1, 2.

1899. *Spirigera* (?) *Noetlingii* Bittner, Hímálayan Fossils, Vol. III, Pt. 2, p. 68, Pl. XI, figs. 2, 3.

1900. *Spirigera* (?) *Noetlingii* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 225.

A very remarkable form of *Spirigera*, but somewhat doubtful as regards its horizon and systematic position, has been described as *Sp. (?) Noetlingii* by A. Bittner. A form very closely related to it, which may well be regarded as specifically identical taking into consideration the scarcity of the materials at hand, is represented by two specimens from the *Megalodon* limestone.

The larger specimen, consisting of an incomplete ventral valve only (fig. 2), agrees exactly with Bittner's type-specimen in its size and sculpture. The shallow median sinus expands into a frontal tongue and is ornamented by two sharp ribs. On each of the sides five ribs are counted, which run from the umbo over the whole shell. The two ribs bordering the sinus are the strongest. All the ribs are acute in the umbonal and visceral portions of the valve, but become rounded above and lower in the vicinity of the front.

The apex has not been preserved entirely, but appears to have been truncated and pierced by a terminal foramen.

The smaller specimen recalls in its general shape and ornamentation *Spirigera* (?) *Maniensis* v. Krafft, from which it is, however, distinguished by its broad and flat sinus which is divided by two low ribs, and by the tripartite mesial lobe of its dorsal valve.

Spirigera Maniensis is undoubtedly the nearest ally to *Sp. Noetlingii*, and it might perhaps even be regarded as its ancestor, being chiefly found in the quartzite series underlying the *Megalodon* limestone.

Dimensions.

Entire length of the shell	22 mm.
Length of the dorsal valve	19.5 "
Entire breadth of the shell	. 21 "
Thickness of both valves	. 17 "

Locality.—Kamelang station, Mani.

SPIRIFERINA cf. HAUSERI SUSS. Pl. XXIV, figs. 3, 4.

1853. *Spirifer Haueri* Suess, Brachiopoden der Koessener Schichten, Denkschr. Kais. Akad. d. Wiss. math. nat. Kl. VII, p. 52, Taf. II, fig. 6.

1900. *Spiriferina nov. sp.* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 225.

In his stratigraphical notes on the mesozoic rocks of Spiti A. v. Krafft mentions a new species of *Spiriferina*, which he considers as agreeing closely with *Sp. Griesbachi* Bittn., from which it is, however, distinguished by the absence of any median rib in the perfectly smooth sinus. This species, which in the Himálayan collection is represented by four fairly well-preserved examples, bears a striking resemblance to *Spiriferina Haueri* Suess from the liassic Gresten beds of lower Austria.

I have failed to find the type-specimen of *Sp. Haueri* from the Pechgraben which has been illustrated by Suess, but on Pl. XXIV, fig. 8, I have given a photographical reproduction of a characteristic specimen from Gresten contained in the collection of the University's Palæontological Museum. From a comparison of the Alpine and Himálayan types their remarkable similarity is obvious. The only character of distinction, which I can find between them, is the strength of ornamentation.

In my Indian examples the ribs are somewhat stronger, especially so in the dorsal valve. The median lobe of that valve is perhaps a little more elevated and bordered by furrows, which are more distinctly defined.

In my Himálayan specimens the area is comparatively low, and the curvature of the beak is considerable, whereas in the type-specimen illustrated by Suess the area is very high and the beak is almost straight. But these characters are not of any specific value in the genus *Spiriferina*, as we may learn from studying the varieties of *Sp. Griesbachi*, in which the height of the area and the curvature of the beak are subject to great variations. Even the Alpine specimen of *Spiriferina Haueri*, illustrated in the present memoir, is provided with a lower area and with a more strongly curved beak than the type-specimen figured by Suess.

All the features of difference between the Austrian and Himálayan specimens are of such slight importance that I do not feel justified in separating the two forms, but prefer to lay a special stress on their close agreement by uniting the Indian type with *Spiriferina Haueri* as *cf.*

Dimensions.

Entire length of the shell	.	.	.	.	.	20.5 mm.
Length of the dorsal valve	.	.	.	.	.	19 "
Entire breadth of the shell	.	.	.	.	.	28 "
Thickness of both valves	.	.	.	.	.	20 "
Length of the hinge-line	.	.	.	.	.	24 "

Locality.—N. of Po.

LAMELLIBRANCHIATA.

LIMA CUMAUNICA Bittner. Pl. XXIV, figs. 8, 9.

1899. *Lima cumaunica* Bittner, Himalayan Foss., Vol. III, Pt. 2, p. 59, Pl. X, fig. 25.

1900. *Lima cumaunica* A. v. Krafft, General Report, Geol. Surv. of India, 1899-1900, p. 225.

Small, ribbed *Lima* of the group of *Lima striata* are rather numerous preserved on some slabs of rock from the Megalodon limestone above Lilang. Several specimens agree exactly with *L. cumaunica* Bittn., both in their general shape, which is oblique and comparatively narrow, and in the number of ribs, fifteen of which are counted on the cast of a right valve. The two ears are small but distinctly developed, especially the anterior one, whereas the posterior one forms a very steeply sloping wing.

PECTEN CHABRANGENSIS nov. sp. Pl. XXIV, figs. 10, 11.

The specimen illustrated in fig. 11 has been mistaken for a cast of *Lima serraticosta* Bittn. by A. v. Krafft. It is a fragment, whose apical portion has not been preserved. The sculpture recalls *Lima serraticosta*, the crests of the ribs being elevated into rows of small tubercles. But the different number of ribs—more than twice as many as in *L. serraticosta*—is a strong argument against any specific identification.

I have succeeded in discovering better preserved specimens, which prove our species to belong to the genus *Pecten*, not to *Lima*. As the illustrations in figs. 10 *a* and *b* show, it is a typical representative of the subgenus *Eupecten*, with strongly developed ears, which are smooth and very distinctly limited off from the ribbed shell. The ears have not been completely preserved, but cannot have differed considerably in size. The only valve known to me—I am unable to decide whether it has been a right or left one—is of nearly circular outline and equilateral. From the group of *Aequipecten interstriatus* Muenst. it is distinguished by its flattened shape. In this character and in the presence of numerous and straight ribs it recalls the group of *Pecten Foipiani* Stopp. and *P. Falgeri* Stopp.

There are altogether twelve acute ribs, separated by rounded intercostal valleys and provided with faint tubercles along their crests. The serrated character of the ribs is only noticed in such examples as have not been injured by weathering.

Locality.—Chabrang.

Pecten sp. ind. aff. *Landranus* Bittner. Pl. XXIV, fig. 7.

A single right valve of large size recalls *Pecten Landranus* Bittner (Revision der Lamellibranchiaten von St. Cassian, Abhandl. K. K. Geol. Reichsanst., XVIII, p. 166, Taf. XIX, fig. 21) and *Pecten interruptus* Bittner (Himál. Foss., Vol. III, Pt. 2, p. 60, Pl. X, fig. 22), without, however, being identical with them. It is strongly vaulted, equilateral, and of nearly circular outlines. The anterior wing has been partly preserved. Its byssal emargination is less deep and narrow than in *P. Landranus*. It is marked off distinctly from the shell. The posterior wing is not known to me.

The ornamentation consists of three systems of ribs. Seven principal ribs are stronger than the rest, but are neither broad nor equidistant. In the wide intervals between them two systems of finer accessory ribs are inserted. Among ten to twenty thin, thread-like ribs which are counted between two principal ones, from two to four of them are a little stronger than the other ribs of the second order, but are not of equal strength themselves. Their augmentation from the apex in the direction towards the front is due to a continual intercalation of new ribs, not to a bifurcation of primary ones. The radial ribbing is crossed by a very delicate concentric striation, which imparts to the principal ribs an indistinctly serrated appearance.

Locality.—Chabrang.

Entolium cf. *subdemissum* Muenst. Pl. XXIV, fig. 12.

Triassic representatives of the subgenus *Entolium* with very flat and nearly smooth valves and with flat radial furrows separating the lateral parts from the visceral region, have been united in the species *Entolium subdemissum* by Graf von Muenster. New illustrations of this species have been given by Bittner in his revision of the Lamellibranchiata from St. Cassian (Abhandl. K. K. Geol. Reichsanst., XVIII, p. 164, Taf. XIX, fig. 29). It seems to differ from the smooth *Pectines* from the Oolite, which are commonly quoted as *E. disciforme* Zieten or as *E. demissum* Phill., chiefly by the straight hinge-line and by the greater height of the shell.

In the Megalodon limestone of Chabrang a species identical with or very nearly allied to *E. subdemissum* is represented by a single but fairly well-preserved valve. It is flat, higher than broad, nearly smooth, with a very faint concentric striation, and shows distinct traces of lateral furrows. The hinge-line is straight. The two wings are of equal size and provided with margins, which are nearly straight and converge moderately towards the hinge-line.

Dimensions.

Entire height of the shell .	. 19 mm.
„ breadth „ „ „	. 17 „
Length of the hinge-line	. 7.5 „

MYSIDIOPTERA sp. ind.

A fragmentary cast of a right valve of large dimensions belongs most probably to this genus. It recalls *Mysidioptera viacostata* Stopp. or *M. Laczkói* of Bittner, but is too badly preserved to allow of a specific determination. It has been mentioned here to show that similar types of an undoubtedly triassic habit occur in the Megalodon limestone of Chabrang.

MEGALODON LADAKHENSIS Bittner.

1899. *Megalodon Ladakhensis* Bittner, Himál. Foss., Vol. III, Pt. 2, p. 65, Pl. XII, fig. 2.

1900. *Megalodon Ladakhensis* A. v. Krafft, General Report, Geol. Surv. of India, for 1899-1900, p. 225.

A very large fragment of a *Megalodon* from the Para limestone N. of Hansi agrees with this species in the remarkable breadth of its umbonal half, looked at in profile. On the label attached to it I find the name of *Megalodon ladakhensis* in Bittner's own handwriting. It is on the strength of his authority that I have accepted this determination.

MYTILUS sp. ind. Pl. XXIV, fig. 6.

A small species of *Mytilus* recalls *Mytilus minutus* Goldfuss (*Petrefacta Germaniæ*, Pl. CXXX, fig. 6), but is a little narrower in the apical region and perhaps also a little more strongly inflated. The steeply sloping anterior portion of the shell is not emarginated.

The specimen—a left valve—is too imperfectly preserved for a more minute description and comparison.

Locality.—Chabrang.

GASTROPODA.

Casts of Gastropoda are comparatively rare among the fossils from the Megalodon limestone and are too imperfectly preserved for a detailed description or illustration. A species of *Naticopsis*, recalling *N. gradata* Koken (*Die Gastropoden der Trias um Hallstatt*, Abhandl. K. K. Geol. Reichsanst., XVII, p. 70, Pl. XII, fig. 13) has been quoted by A. v. Krafft. The specimen from Chabrang has neither its apex nor its aperture preserved. It agrees with *N. gradata* in the presence of a flattened step, bordering the outline, but differs in the shape of its last whorl, which is higher and more globose.

FAUNISTIC AND STRATIGRAPHICAL RESULTS.

The fossils described in this memoir have been grouped on the basis of the stratigraphical data supplied by Hayden and by A. v. Krafft into faunæ of *ladinic*, *carnic*, and *noric* age.

I. LADINIC STAGE.

In the Central Himálayas of Spiti the main mass of the upper Muschelkalk containing the fauna of the zone of *Ceratites trinodosus* Mojs. (anasic stage) is followed by beds including faunæ of ladinic age. The apparent break in the sequence of triassic faunæ in Painkhánda between the anasic and carnic stages is bridged over in Spiti. The representation of ladinic deposits in Spiti has been fully ascertained by Hayden and A. v. Krafft.

The most typical representative of a ladinic fauna in the Himálayas is the fauna of the *Daonella shales*.

The *Daonella shales* are a series of thin-bedded, black shaly limestones and earthy shales, with some hard, brown-weathering limestone beds, about 160 feet in thickness and following perfectly conformably upon the topmost beds of the upper Muschelkalk, being intimately connected with them stratigraphically. *Daonella Lommeli* Wissm. and *Daonella indica* Bittn. are distributed throughout the entire thickness of this rock-group. Towards the base it is also rich in Cephalopoda.

There are, on the whole, 30 forms known up to the present time from this horizon, seven, however, being too imperfectly preserved to permit a specific determination. The fauna consists of the following species :—

- Daonella Lommeli* Wissm.
- „ *sp. ind. aff. Lommeli* Wissm.
- „ *indica* Bittn.
- Spirigera hunica* Bittn.
- Rhynchonella cf. Theobaldiana* Stol.
- Ceratites Narsingha* nov. sp.
- Arpadites Rimkinensis* Mojs. (= *Stracheyi* Mojs.?).
- Hungarites Pradoi* Mojs.
- Thanamites* nov. gen. *bicuspidatus* nov. sp.
- Rimkinites Nitiensis* Mojs.
- „ *Edmondii* Dien.
- Anolcites cf. Luczkói*, Dien.
- Protrachyceras Archelaus* Lbe.
- „ *Spitiense* nov. sp.
- „ *ladinum* Mojs.
- „ *cf. longobardicum* Mojs.
- „ *sp. ind. cf. regoledanum* Mojs.
- „ *nov. sp. ind.*
- Sturia sp. ind.*
- Gymnites calosoma* nov. sp.
- „ *sp. ind.*
- Pinacoceras sp. ind. aff. Damesi* Mojs.
- Ptychites Gerardi* Blfd.
- Joannites cf. proavus* Dien.
- „ *sp. ind. cf. tridentatus* Mojs.
- „ *Kossmati* nov. sp.

Proarcestes bicinctus Mojs.

„ *cf. Balfouri* Opp.

„ *sp. ind. aff. esinensis* Mojs.

„ *sp. ind. (ex sectione bicarinati* Mojs.)

Among them five species only are new and have not been described hitherto. These species are—

Ceratites Narsingha.

Protrachyceras Spitiense.

Thanamites bicuspidatus.

Joannites Kossmati.

Gymnites calosoma.

Thanamites bicuspidatus belongs to a genus of rather strange aspect in a mesozoic fauna, rather recalling the palæozoic Ammonites in its simple sutures, which are especially distinguished by a narrow and bifid lateral lobe.

Nine species are identical with forms already known from the triassic deposit of the Himálayas, but never found as yet in extra-Indian territories. Two of them, *Ptychites Gerardi* Blfd. and *Proarcestes Balfouri* Opp., are leading fossils of the upper Muschelkalk in Painkhánda and Spiti. Two species—*Rhynchonella Theobaldiana* Stol. and *Proarcestes bicinctus* Mojs.—are restricted to the ladinic beds of Spiti. Five species are identical with forms from the Traumatocrinus limestone of the Shalshal cliff or from the dark limestone of the Ralphu glacier in the Lissar valley, which have been correlated with the carnic stage by E. v. Mojsisovics.

These species are as follows :—

Daonella indica Bittn.

Spirigera hunica Bittn.

Arpadites Rimkinensis Mojs.

Rimkinites Nitiensis Mojs.

„ *Edmondii* Dien.

Not less than eight species are identical with or referable with great probability to Alpine species characteristic of the zone of *Protrachyceras Archelaus* (longobardic substage). These species are—

Daonella Lommeli Wissm.

Hungarites Pradoi Mojs.

Protrachyceras Archelaus Lbe.

„ *ladinum* Mojs.

„ *cf. longobardicum* Mojs.

„ *sp. cf. regoledanum* Mojs.

Analcites cf. Laczkoi Dien.

Joannites sp. cf. tridentinus Mojs.

Joannites cf. proavus Dien. ranges from the upper Muschelkalk into the ladinic stage.

The eight species enumerated above are peculiar to the Wengen beds of Europe. Some among them, as *Daonella Lommeli*, *Protrachyceras Archelaus*, or *P. ladinum*, are the most characteristic leading fossils of that horizon. This fact

points very strongly in favour of a homotaxis of the fauna of the Daonella shales with the fauna of the Wengen beds of the Eastern Alps. A small number of new species shows closer affinities to St. Cassian and Raibl than to Wengen species. Among them are *Joannites Kossmati*, which is very nearly allied to *Joannites Joannis Austriae*, and *Gymnites calosoma*, which differs from *G. Breunneri* by some subordinate details only. But on the whole the relationship to Wengen species prevails so remarkably that the fauna of the Daonella shales must be regarded as homotaxial with the longobardic (Wengen beds), not with the cordevolic (St. Cassian) substage.

As has been stated by Hayden, in Spiti the passage from the Muschelkalk into the ladinic stage is lithologically such a gradual one that were it not for a change in the faunæ it would be difficult to define the horizons. The topmost beds of the Muschelkalk near Kágá, Muth, and in the Thanam valley, although stratigraphically connected most intimately with the main mass of the upper Muschelkalk, contain a fauna of a decidedly ladinic aspect. The following species occur in those passage beds:—

- Spirigera lunica* Bittn.
- Ceratites* (?) *Wetsoni* Opp.
- Arpadites* cf. *lissarensis* Mojs.
- Rimkinensis* Mojs.
- Hungurites Pradoi* Mojs. (?)
- „ *sp. ind. aff. Mojsisovici* Breckh.
- Protrachyceras Spitiense* Dien.
- „ *cf. longobardicum* Mojs.
- Thanamites lacuspidatus* Dien.
- „ *Bannensis* nov. sp.
- Rimkinites Niliensis* Mojs.
- „ *Edmondii* Dien.
- Sturia* sp. ind.
- Ptychites Gerardi* Blfd.
- Megaphyllites Jarbas* Muenst.
- Joannites Kossmati* Dien.
- „ *cf. proavus* Dien.
- Proarcestes* cf. *Balfouri* Opp.

In this fauna ten species are identical with forms from the Daonella shales. Of the remaining species one (*Thanamites Bannensis*) is new, but belongs to a genus ranging into the Daonella shales, one (*Ceratites Wetsoni*) is probably restricted to the topmost beds of the Muschelkalk, one (*Proarcestes Balfouri*) occurs in the upper Muschelkalk. *Ptychites Gerardi* is common to the upper Muschelkalk and to the Daonella shales. One species (*Arpadites lissarensis*) has been noticed in the grey limestone of the Italphu glacier by E. v. Mojsisovics, one (*Monophyllites Jarbas*) is chiefly found in the strata of St. Cassian and Raibl, but is of small stratigraphical value.

This examination of the fauna will suffice to show that the topmost beds of the Muschelkalk group must be correlated with the ladinic, not with the anisic, stage.

It is an interesting fact that no representatives of the Buchenstein beds of the Eastern Alps have been noticed in this fauna. Only two Indian species are allied to forms from the Buchenstein beds, that is to say, from the zone of *Protrachyceras Curionii*, which in the Alpine Trias is intercalated between the zones of *Ceratites trinodosus* and *Protrachyceras Archelaus*. These two species are—

Protrachyceras Cautleyi Dien.

Hungarites sp. ind. aff. *Mojsisovicsi* Boeckh.

Protrachyceras Cautleyi has been described in my memoir on the fauna of the Himálayan Muschelkalk. It had been collected by Hayden near Kágá together with *Protrachyceras longobardicum* and is most probably a species of the topmost beds, not of the main mass of the Muschelkalk group. Its relationship points to the group of *Protrachyceras recubariense* Mojs., but is not very close. *Hungarites* sp. ind. aff. *Mojsisovicsi* is too badly preserved to be of any stratigraphical value. Thus the number of Buchenstein types is so far very small. As an assumption of a break in the succession of triassic beds is utterly impossible, representatives of those strata of Buchenstein must necessarily be included in the Muschelkalk group. We are, however, obliged to suggest that no independent fauna corresponding to that of the zone of *Protrachyceras Curionii* lived in the Indian triassic province at the commencement of the ladinic stage.

Considering the general character of the fauna of the topmost beds of the Muschelkalk group, it bears the stamp of the longobardic age almost as clearly as the fauna of the *Daonella* shales, with which it has the majority of species in common, although one of the leading Pelecypoda, *Daonella Lommeli*, has not been found in it. I therefore consider those beds as homotaxial equivalents of the Wengen beds of the Alpine Trias.

From Hayden's and A. v. Krafft's descriptions it is evident that no stratigraphical break occurs in Spiti above the upper Muschelkalk, but that the passage into the ladinic stage is so gradual, that no boundary line can be fixed between the two. In all sections the main mass of the upper Muschelkalk is overlain by a narrow band containing a fauna of ladinic age. Immediately above this are the *Daonella* shales with *Daonella Lommeli*.

In the ladinic stage must probably be included the *Daonella limestone*, following conformably above the *Daonella* shales. It contains a fauna consisting of the following species:—

Traumatocrinus sp. ind.

Daonella Lommeli Wissm.

„ *indica* Bittn.

„ sp. ind. aff. *Cassiana* Mojs.

Rhynchonella cf. *Rimkinensis* Bittn.

Phloioceras deliciosum Dien.

Styrites (?) *vilangensis* Dien.

Celtites trigonalis Dien.

„ *perauritus* Dien.

Rimkinites Kitiensis Mojs.

Monophyllites cf. Wengensis Klipst.

Joannites Kossmati Dien.

„ *cf. Klipsteini* Mojs.

Of these forms it is chiefly *Daonella Lommeli* which points to a ladinic age, that is to say, to the zone of *Protrachyceras Archelaus*, this bivalve being the most characteristic leading fossil of the Wengen beds, and of the Marmolata limestone of the Eastern Alps and restricted exclusively to this horizon. To this species must be added *Rimkinites Nitiensis* and *Joannites Kossmati*, which the *Daonella* limestone has in common with the underlying *Daonella* shales. *Daonella indica* has been found both in the *Daonella* shales and in the bed overlying the *Traumatocrinus* limestone of the Shalshal cliff. *Monophyllites Wengensis* is a species of ladinic age in the Alpine Trias.

But with those forms of ladinic aspect several types are associated, which seem rather to point to a younger age. Such species are: *Traumatocrinus sp. ind.*, *Joannites cf. Klipsteini*, *Daonella aff. Cassiana*, *Phloioceras deliciosum*, the two species of *Celtites* and *Styrites (?) lilangensis*. The three genera *Traumatocrinus*, *Phloioceras*, and *Styrites* have as yet been found in the carnic stage only.

The association of Wengen and St. Cassian types in the *Daonella* limestone, the lower portion of an isopic mass of dark limestones of about 300 feet in thickness, induces me to suppose that both horizons—homotaxial equivalents to the longobardic and cordevolic substages of the Alpine Trias—are represented in the *Daonella* limestone, and there is a gradual passage from the longobardic substage with *Daonella Lommeli* into the julic substage with *Halobia comata*.

Whereas in Spiti the ladinic stage has yielded a large and representative fauna, it is so poorly developed in Painkhanda, that in the classical sections of the Shalshal and Bambanag cliffs it has been overlooked completely by Griesbach and by myself. As I had stated in my description of the Shalshal cliff section, the upper Muschelkalk is overlain by a series of well-bedded limestones, lithologically identical with the *Ptychites* beds and distinguished from them only by the abundance of crinoid-stems belonging to the genus *Traumatocrinus*. This is the *Traumatocrinus* limestone, above which follows a bed full of bivalves described as *Daonella indica* by Bittner.

The sequence of beds is as follows:—

3. Bed with *Daonella indica*, *Norella Kingi*,
Norella tibetica, *Spirigera hunica*.
2. *Traumatocrinus* limestone with:
Rhynchonella Rimkinensis Bittn.
Aulacothyris nilangensis Bittn.
Joannites cf. cymbiformis Wulf.
Trachyceras tibeticum Mojs.
Arpadites Rimkinensis Mojs.
Eutomoceras (= Discotropites) aff. Plinii Mojs.
Ischnites cf. Heimi Mojs.
Rimkinites Nitiensis Mojs.
1. Upper Muschelkalk with *Ptychites div. sp.*

The fauna of the *Traumatocrinus* limestone was declared by E. v. Mojsisovics to belong to the zone of *Trachyceras Aonoides* (middle carnic substage) chiefly on the strength of the occurrence of *Joannites cf. cymbiformis* Wulf. and of *Trachyceras tibeticum*, the latter species being closely allied to *T. austriacum* of the *Aonoides* zone. From this I was obliged to conclude that the ladinic and lower carnic stages were either not developed at all in the sections of Painkhánda or only represented by deposits extremely small in thickness and so poor in fossils that they had remained unnoticed.

But for all that the ladinic stage is not missing entirely in Painkhánda. In the year 1900 the late Dr. A. v. Krafft had an opportunity of revisiting the Shalshal and Bambanag cliffs. On close examination he found in the Shalshal cliff between the *Ptychites* beds of the upper Muschelkalk and the *Traumatocrinus* limestone a series of thin-bedded, concretionary limestones with shaly partings, about 25 feet in thickness, in which *Ptychites* is apparently absent. Near its base this series yielded a few fossils, which have been determined by A. v. Krafft as follows:¹—

- Daonella indica* Bittn.
- „ *cf. obliqua* Mojs.
- Spirigera hunica* Bittn.
- Trachyceras* sp.
- Lobites* (?) sp. aff. *aberrans* Mojs.

A re-examination of the materials collected by A. v. Krafft proved *Daonella indica* to be represented more numerous than the rest of the fossils, all of which are rather poorly preserved. The specimen referred to *Daonella obliqua* Mojs. (Abhandl. K. K. Geol. Reichsanst., VII, p. 21, Taf. II, fig. 5) is indeed very similar to this Alpine form from the Wettersteinkalk. It differs from it only by its striae being a little broader and perhaps also less numerous. The examples determined as *Lobites* are representatives of the genus *Celitites*, closely allied to *C. trigonalis* and *C. perauritus* from the Daonella limestone. There is also a specimen of *Joannites* among the materials from the beds in question, which I am not able to distinguish from *J. cf. proavus* Dien. ranging from the Muschelkalk into the Daonella limestone.

The absence of *Ptychites* and the presence of *Daonella indica* and of *Spirigera hunica* are two arguments strongly in favour of a correlation of the beds intermediate between the upper Muschelkalk and the *Traumatocrinus* limestone with the ladinic stage. *Daonella indica* and *Spirigera hunica* are, it is true, common to the ladinic and carnic stages (Daonella shales and *Traumatocrinus* limestone), but *Joannites cf. proavus* Dien. points to a stratigraphical position lower in age than the carnic stage. The fauna of this group is therefore of some stratigraphical importance, in spite of its smallness.

The *Traumatocrinus* limestone is also present at the Bambanag cliff, but the ladinic beds have not been found there by A. v. Krafft. As to Byans we must

¹ Manuscript notes.

suppose that the ladinic stage is included in the thick limestone mass above the chocolate limestone of lower triassic age, but no evidence has so far been obtained.

The *Traumatocrinus* limestone of the Shalshal cliff has so far been considered as middle carnic (zone of *Trachyceras Aonoides*) by E. v. Mojsisovics. A. v. Krafft does not agree fully with that learned author in the identification of the leading Ammonites of that rock-group. On re-examination of the type-specimens he found the two examples referred to *Joannites cymbiformis* Wulf. as *cf.* by E. v. Mojsisovics to differ considerably from the Alpine type, one specimen in its sutures, the other in the absence of varices. Nor did the presence of *Trachyceras tibeticum*, a new species, although closely allied to the carnic *Trachyceras austriacum*, appear to him to be of a decisive importance for a correlation of the *Traumatocrinus* limestone with the middle carnic stage.

A. v. Krafft's own collections from the *Traumatocrinus* limestone of the Bamnanag and Shalshal cliffs are very poor in well-preserved fossils, but among them a good specimen of *Joannites Kossmati* has been found, showing the two deep cast-furrows characteristic of this species. With A. v. Krafft I agree in refuting the reference of the *Joannites* described as *J. cf. cymbiformis* by E. v. Mojsisovics to Wulfen's Alpine species, but must admit that *Trachyceras tibeticum*, although being specifically different from *J. austriacum*, does point very strongly to a carnic age of the *Traumatocrinus* limestone. The occurrence of *Eutomoceras aff. Plinii* and of *Isculites cf. Heimi* is also conclusive proof of a carnic age.

On the other hand the discovery of the fauna of the *Daonella* limestone of Spiti has revealed some remarkable affinities to the fauna of the *Traumatocrinus* limestone of the Shalshal cliff.

Besides the genus *Traumatocrinus*, which is restricted to the carnic stage of the Mediterranean region, the following forms are common to the faunæ of both horizons :—

Daonella indica Bittn.

Arpadites Rimkinensis Mojs.

Rimkinites Nitienses Mojs.

Joannites Kossmati Dien.

The three Ammonites give a rather old aspect to these faunæ, all of them being species which range from the topmost beds of the Muschelkalk group into the carnic stage. It is therefore not easy to decide whether we may designate the *Traumatocrinus* limestone as cordevolic or julic, although E. v. Mojsisovics has been undoubtedly right in considering it to be of carnic age.

A rock-group which has been included in the same stratigraphical horizon with the *Traumatocrinus* limestone by E. v. Mojsisovics is the dark, grey, Cephalopoda bearing limestone of the Ralphu glacier in the Lissar valley, designated as horizon of *Ammonites Aon* by Griesbach. The fauna of this group consists of the following species :—

Daonella indica Bittn.

Arpadites lissarensis Mojs.

Protrachyceras Ralphuanum Mojs.

Joannites nov. sp.

Ptychites *Gerardi* Blfd.

„ *posthumus* Mojs.

This fauna has a decidedly older aspect than the fauna of the *Traumatocrinus* limestone. In the Alpine trias the genus *Ptychites* does not range into younger beds than the ladinic stage. Not less than three species are identical with ladinic forms from Spiti. *Joannites* nov. sp. is perhaps identical with *J. Kossmati*; but this question cannot be decided, as none of the examples from this locality have been figured by E. v. Mojsisovics. *Protrachyceras Ralphanum* exhibits an equally close affinity with *P. Aeoli* Mojs. from the carnic Hallstatt limestone and with *P. longobardicum* Mojs. from the Wengen beds of Tyrol.

Thus the fauna of the limestone of the Ralphu glacier, although very scanty and meagre, clearly bears the stamp of a ladinic, not of a carnic, age.

Taking into consideration the results of our examination of the fossils from the *Daonella* limestone of Spiti and the intimate stratigraphical connection of the *Traumatocrinus* limestone with beds of ladinic age, we come to the conclusion that the *Traumatocrinus* limestone should be regarded as homotaxial with the lower carnic (cordevolic) rather than with the middle carnic (julic) stage. As has been stated by Bittner, the chronological interpretation, by means of which E. v. Mojsisovics wished to allocate the *Traumatocrinus* limestone to the zone of *Trachyceras Aonoides*, is not convincing. He had been obliged to adopt the expedient of dividing the *Aonoides* zone in reverting to that older view, in which the *Aonoides* zone was not looked upon as an equivalent of the Lunz-Raibl beds, but older than these. But from an analysis of the fauna of the grey beds we shall see that in Spiti a species, allied very closely to the true *Trachyceras Aonoides* occurs from 100 to 150 feet above the *Daonella* limestone and that the grey beds of Spiti are the true equivalents of the middle carnic stage of the Himálayas.

If we correlate the upper portion of the *Daonella* limestone in Spiti and the *Traumatocrinus* limestone of Painkhánda with the cordevolic (lower carnic) substage—and I must emphasize the impossibility of correlating the latter horizon with the longobardic substage—we come to the conclusion that the ladinic stage is indeed of remarkably less thickness in Painkhánda than in Spiti. The black ladinic shales and limestone, whose thickness amounts to 200 or 300 feet in Spiti, dwindle down towards the east until they are restricted to 25 feet in the Shalshal cliff section. This is an interesting fact. For while the *Muschelkalk* is constant in thickness throughout the entire sedimentary belt of the central Himálayas from Spiti into Johár, a very considerable change of deposition must have set in during the ladinic stage.

Another fact which we learn from a comparison of the ladinic and lower carnic faunæ of Painkhánda and Spiti, is the non-existence of “beds with *Daonella indica*” as a distinct stratigraphical horizon, as had been suggested by Bittner.

Daonella indica is a species of comparatively wide stratigraphical distribution, which ranges throughout the ladinic into the lower carnic stage. The bed with *Daonella indica*, *Norella Kingi*, and *N. tibetica*, overlying the *Traumatocrinus*

limestone of the Shalshal cliff, is certainly younger in age than the *Daonella* shales of Spiti, where *D. indica* is associated with *D. Lommeli* and *Protrachyceras Archelaus*.

II.—CARNIC STAGE.

In Spiti a continuation of the black *Daonella* limestone has been separated by Hayden and A. v. Krafft from this group as a distinct subdivision, owing to the apparent absence of *Daonella* and to the presence of *Halobia* either identical with or very nearly allied to *Halobia comata* Bittn. or *H. fascigera* Bittn. This *Halobia-limestone* has yielded two fossils only:—

Halobia cf. *comata* Bittn.
Joannites thanamensis nov. sp.

Halobia comata is the chief leading fossil of the so-called *Daonella* beds of carnic age in Johar and Painkhanda. Species of *Joannites* with sutures as richly ramified as those of *J. thanamensis* are also restricted to carnic beds. But this palæontological evidence is, on the whole, very meagre and scarcely furnishes more evidence than the stratigraphical fact that the *Halobia* limestone is included between the grey beds of julic age and between a lower horizon (*Daonella* limestone) in the fauna of which upper ladinic and lower carnic types are associated. The *Halobia* limestone is undoubtedly of carnic age and may be included provisionally in the equivalents of the julic substage, although with all reserve, due to the scarcity of fossils.

In the series of “*Grey beds*” following above the *Halobia* limestone, two fossiliferous horizons have been distinguished by A. v. Krafft. The lower, situated near the very base of the group, has yielded several species of Ammonites, among them:—

Trachyceras sp. ind. (group of *T. acanthica*).
Trachyceras sp. aff. *Ariæ* Mojs.
Carnites floridus Wulf.
 „ cf. *nodiger* Dien.
Monophyllites sp. ind. aff. *Simonyi* Hau.
Joannites cymbiformis Wulf.

This little fauna bears the stamp of julic age, showing a striking similarity to European faunæ of the zone of *Trachyceras Aonoides*. *Joannites cymbiformis*, the most common Ammonite of this horizon, *Carnites floridus* and *Carnites nodifer* are all well-known leading fossils of the julic substage in the Eastern Alps. The *Trachycerata* also show a near relationship to julic species, and the genus *Monophyllites* has never been found in beds of younger than carnic age. Thus the correlation of the cephalopod horizon at the base of the grey beds with the julic zone of *Trachyceras Aonoides* has been established in the most convincing manner.

The second fossiliferous horizon of the grey beds occurs about 300 feet above the base and has yielded a fauna rich in bivalves and brachiopoda. It consists of the following forms.

Brachiopoda.

- Rhynchonella laucana* Bittn.
 „ *laucana* nov. var. *lilangensis*.
 „ cf. *semiplecta* Muenst.
 „ *Freshfieldi* nov. sp.
 „ *himaica* nov. sp.
 „ cf. *bajuvarica* Bittn.
 „ (*Austriella*) sp. ind. aff. *nux* Sness.
Spiriferina orophila nov. sp.
 „ *gregaria* Sness.
 „ sp. ind. aff. *saubhalensis* Bittn.
 „ *Deodara* nov. sp.
Mentzelia Mentzelii Dunk.
Aspidothyris (nov. gen.) *Krafft* nov. sp.
Dictasma jolicum Bittn.
 „ *Haydeni* nov. sp.
Cruridula (? *indica*) nov. sp.
Lamellibranchiata.
Lilangina nov. gen. *nobilis* nov. sp.
Gonodon (*Schafhaeutle*) sp. ind.
Lima sp. ind. aff. *alternans*.
Pomarangina nov. gen. *Haydeni* nov. sp.

Cephalopoda.

- Paratropites* (?) sp. ind.

The only Ammonite collected in this horizon and erroneously referred to the noric genus *Distichites* by A. v. Krafft is unfortunately too indifferently preserved to permit a safe determination, but it has certainly a closer relationship to a Carnic than to a noric genus.

Among the *Lamellibranchiata* representatives of the two new genera *Lilangina* and *Pomarangina* predominate. They are very remarkable types of a rather strange aspect, although one of them exhibits a distant affinity to *Cassianella* and the other to *Pachycardia* or to *Cardinia*. If we want to find any evidence for a correlation of this fauna with European ones, we must turn to the Brachiopoda, among which a considerable number of species are either identical with or nearly allied to Alpine forms.

The majority of such forms are characteristic of the Carnic stage, and especially of the Cordevolic and Jolic substages. Among them are—

- Austriella* sp. aff. *nux* Sness.
Rhynchonella cf. *semiplecta* Muenst.
 „ cf. *bajuvarica* Bittn.
 „ *himaica* Dien. (very nearly allied to *Rh. subacuta* Muenst.)
Spiriferina gregaria Sness.
Dictasma jolicum Bittn.

There is no evidence in favour of a correlation of this fauna with the tuvalic substage. The fauna is, on the contrary, remarkable for the presence of such types as bear even a closer affinity to forms of Muschelkalk than to those of upper-triassic age. Among those forms the typical *Mentzelia Mentzelii* Dunk. deserves to be mentioned in the first line. *Rhynchonella Freshfieldi* belongs to the group of the anisic *Rh. trinodosi* Bittn. *Spiriferites orophila* is most nearly allied to *Sp. avarica* from the Muschelkalk of Hungary. The most common species of this horizon belongs to *Dielasma*, a genus of *Terebratulidæ*, which has its chief development in carboniferous and permian deposits and has already become very rare in the carnic stage.

Summarizing the above observations we come to the conclusion that the upper fossiliferous horizon of the grey beds must still be regarded as homotaxial with the julic, not with the tuvalic, substage.

The next fossiliferous horizon following above the brachiopod and bivalve-bearing series of grey beds are the *Tropites shales*.

The collections derived from the sections round Lilang and near Tikha comprise the following species of Cephalopoda :—

Clydonautilus ucutilobatus nov. sp.

„ *sp. ind.*

Germanonautilus cf. Breunneri Hauer.

Grypoceras. sp. ind.

Styrionautilus cf. Sauperi Hauer.

Pleuronautilus sp. ind. aff. Wulfeni Mojs.

Tropites cf. subbullatus Hauer.

„ *discobullatus* Mojs.

„ *cf. torquillus* Mojs.

„ *sp. ind. aff. Paracelsi* Mojs.

Paratropites tikhensis nov. sp.

Trachysagenites cf. Herbichi Mojs.

„ *galeatus* nov. sp.

„ *nov. sp. ind.*

Eutomoceras (Discotropites) sp. ind. aff. Plinii Mojs.

Anatomites sp. ind. cf. Bacchus Mojs.

Jovites spectabilis Dien.

„ *cf. siculus* Gemm.

Sandlingites nov. sp. aff. Reyeri Mojs.

„ *nov. sp. aff. Castellii* Mojs.

Clionites heracitiformis nov. sp.

Proarcestes cf. Gaytani Klipst.

This fauna clearly bears the stamp of *tuvalic* age as shown by the genera which it contains as well as by the relationship of its species to European ones. There is not a single genus in this fauna which had not been found in the carnic stage of the Alpine Trias. *Tropites* especially plays an important part in this horizon, more than one-half the number of Ammonites collected by Hayden and A. v. Krafft belonging to this genus.

The presence of the genus *Parajuvavites* of noric habit quoted by A. v. Krafft has not been verified. The specimens referred to *Parajuvavites* by that author are representatives of the genus *Jovites* with carnic affinities. Nor has *Proclydonautilus Griesbachi* Mojs., the leading fossil of the Hauerites beds of the Bambanag section, been actually met with in the Tropites beds of Spiti, as had been stated by A. v. Krafft.

The Tropites beds of Spiti are eminently a Cephalopod-bearing horizon, in which *Nautiloidea* and *Ammonoidea* predominate more exclusively than in any other horizon of the Himálayan Trias hitherto known. The specific affinities of the Cephalopoda speak indubitably in favour of a correlation with the tuvalic substage. There are also affinities with the julic fauna of the zone of *Trachyceras Aconoides*, but they are far inferior in importance to those with the European fauna of the zone of *Tropites subbullatus*. Nearly all those elements, belonging to the genera *Tropites*, *Trachysagenites*, *Jovites*, *Clionites*, *Anatomites*, which give to the fauna of the Tropites beds its peculiar type and are conspicuous for their fecundity, are elements characteristic of the tuvalic substage of the Hallstatt limestone.

There can be no doubt that the Tropites beds of Spiti are a homotaxial equivalent of the *subbullatus*-zone of the Eastern Alps, and that they must be correlated with the tuvalic substage, as has been suggested by A. v. Krafft.

The complete absence of any noric elements in this fauna is of great importance. It clearly proves the association of carnic and noric elements in the fauna of the Tropites limestone of Byans to be an exceptional case, and speaks very strongly in favour of my view that this assemblage is absolutely incongruous with a homotaxy of the Tropites limestone of Byans with the tuvalic Tropites limestone of the Salzkammergut. Whereas the Tropites beds of Spiti with their rich fauna of purely carnic habit and overlain by horizons with noric faunæ must be correlated with the tuvalic substage of Europe, the Tropites limestone of Byans, although reaching only a few feet in thickness, is a homotaxial equivalent of both the tuvalic and lacio (lower noric) substages.

The complex of dolomitic limestones following above the Tropites beds, whose thickness amounts to 300 feet, must also be included in the tuvalic substage. It has yielded few and badly preserved fossils only, but among them several species with decidedly carnic affinities.

Such species are—

Dielasma julicum Bittn.

Terebratula sp. ind. aff. *piriformis* Suess.

Spiriferina sp. ind. aff. *skalshalensis* Bittn.

Lima cf. *austriaca* Bittn.

Halobia aff. *superba* Mojs.

Daonella aff. *styriaca* Mojs.

Thus the beds including the tuvalic substage in Spiti are at least 500 feet, and probably 900 feet in thickness, whereas the entire thickness of the carnic stage amounts to at least 1,600 feet.

In Jobar and Painkhánda the thickness of the carnic stage is only from 600 to 750 feet. There the carnic stage is represented by the *Traumatocrinus* limestone of probably cordevolic age and by the system of shales and limestones designated as *Daonella* beds by Griesbach or as "horizon of *Halobia comata*" by Bittnet.

The fauna of the horizon of *Halobia comata* shows, according to E. v. Mojsisovics, a typical julic habit, in spite of the great deficiency of the fossil material. It must, however, be borne in mind that the topmost beds of this horizon are practically unfossiliferous. The only *Ammonites* recorded from the upper part of this complex are *Mojsovites eugyrus* Mojs. and *Griesbachites Hanni* Mojs. The first, although identical with a species from the julic Hallstatt limestone of Aussee, possesses rather indifferent characters not fit for a more exact determination of the age. The second belongs to a genus peculiar to the Indian triassic province, and is represented by two species only, *Griesbachites Hanni* Mojs. and *G. Medleyanus* Stoliczka. *Griesbachites Hanni* is recorded from the uppermost *Daonella* beds of the Bambanag section and of Lauka by E. v. Mojsisovics. The type-specimen of *Griesbachites Medleyanus* was collected in Spiti by Captain Hutton. Stoliczka judging from the matrix believed it to come from the triassic rocks of Kuling (Pin valley). A. v. Krafft thinks that it must have been found in the *Tropites* shales. In his unpublished notes on the Himálayan Trias he mentions the discovery of a second well-preserved example of *G. Medleyanus* in the uppermost layer of the *Daonella* beds of the Bambanag cliff near Martoli encamping ground. I have not seen this specimen myself but have no reason for distrusting A. v. Krafft's clear statement. The occurrence of *Griesbachites Medleyanus* in the uppermost *Daonella* beds of Martoli encamping ground would only confirm what on stratigraphical grounds should have been expected, viz., that the uppermost layers of the horizon of *Halobia comata* correspond to the *Tropites* beds of Spiti in age.

The dolomitic limestone with *Lima cf. austriaca* Bittn. and *Dielasma julicum* Bittn. overlying the *Tropites* shales in Spiti, is certainly wanting in the more eastern sections and cannot be correlated with the "Hauerites beds" of the Bambanag cliff, which contain a fauna of indubitably noric age.

III.—NORIC STAGE.

In Spiti the *noric* stage falls naturally into two divisions.

The upper division is of very uniform character, consisting of thick limestones with few fossils, chiefly *Lamellibranchiata* of the genus *Megalodus*. Part of this enormous limestone mass underlying the Spiti shales represents the *Dachsteinkalk* of the Eastern Alps, while another part belongs to geologically younger beds (*Lias* and *Oolite*).

The lower division is chiefly composed of sandy and shaly limestones, which can be subdivided stratigraphically into several groups, each of them distinguished

by characteristic fossils. In this lower division the following main groups can be distinguished :—

4. Quartzite series.
3. Bivalve (*Monotis*) beds.
2. Brachiopod beds.
1. Cephalopod beds.

The Cephalopod beds are represented by a series of brown, weathering limestones with sandstones and shales intercalated, of 500 feet in thickness. The lower part of these beds is poor in fossils, containing indeterminable plant remains, brachiopods, bivalves and fragments of Ammonites. In the upper part Cephalopoda are common.

The fauna consists of the following forms :—

- Dielasma* aff. *julico* Bittn.
Halobia sp. ind. aff. *fascigera* Bittn.
Pecten (*Amusium*) *margariticostatus* nov. sp.
Pecten nov. sp. aff. *monilifero* Muenst.
Mysidioptera sp. ind.
Lima cf. *serraticosta* Bittn.
Cardita sp. ind.
Homomya sp. ind. aff. *Larianæ* Stopp.
Mytilus sp. ind. aff. *rugoso* Roem.
Atractites sp. ind. aff. *alveolari* Quenst.
 „ nov. sp. ind.
Orthoceras sp. ind.
Paranautilus arcestiformis nov. sp.
Pleuronautilus nov. sp. ind. aff. *Kosmati* Dien.
 „ cf. *tibeticus* Mojs.
Indonautilus cf. *Krafftii* Mojs.
Dittmarites lilliformis nov. sp.
 „ cf. *trailliformis* Dien.
Clionites sp. ind. aff. *Hughesii* Mojs.
Metacarnites Footei nov. sp.
 „ *Hendersoni* nov. sp.
Pinacoceras sp. ind. aff. *Parma* Mojs.
Tibetites cf. *Ryalli* Mojs.
Anatibetites Kelviniformis nov. sp.
Paratibetites Tornquisti Mojs.
 „ sp. ind. aff. *Wheeleri* Dien.
Rhacophyllites sp. ind.
Juvavites nov. sp. ind. aff. *Ehrlichi* Hauer.
 „ *angulatus* nov. sp.
Anatomes sp. ind. aff. *Melchioris* Mojs.
 „ nov. sp. group of *A. scissi*.
 „ sp. ind. aff. *Caroli* Mojs.
 „ sp. ind. aff. *Alphonsi* Mojs.

This list does not give an adequate idea of the real richness of the fauna of the Juvavites beds. This is chiefly due to the fragmentary state of preservation of

the materials available for examination, which has obliged me to leave the majority of bivalves undetermined.

The predominating elements of this fauna are Cephalopoda of the genus *Juvavites*. From this leading fossil the name of the rock-group has been proposed by A. v. Krafft. The overwhelming majority of *Juvavites* do not show a close affinity to any of the congeneric species from the triassic deposits of the Eastern Alps. As has been remarked by A. v. Krafft, they are representatives of the section of *continui* but differ from all European forms by the angular arrangement of the ribs, crossing the external part in lappets which are strongly turned forward and provided with an angular apex. In this respect a remarkable similarity with the external sculpture of *Dimorphites* has been noticed.

Representatives of the genus *Juvavites* allied to *J. Ehrlichii* v. Hauer are very few in number. The subgenus *Anatomites* is also rather rare. Its species, none of which are suitable for the introduction of a proper denomination, exhibit affinities both to carnic and noric forms of the Alpine and Himalayan Trias.

The majority of the Cephalopoda of the Juvavites beds with affinities to other forms of triassic age has relations with the noric faunæ of the zone of *Proclydonautilus Griesbachii* and of the Halorites limestone of the Bambanag cliff in Kumaon. One species, *Paratibetites Tornquisti* Mojs., is perfectly identical with a form described from the Bambanag section. As species very nearly allied the following can be mentioned :—

Pleuronautilus cf. tibeticus Mojs.

Indonautilus cf. Krafftii Mojs.

Clionites sp. aff. *Hughesii* Mojs.

Tibetites cf. Ryalli Mojs.

Anatibetites Kelviniformis Dien.

The noric character of the fauna shows itself by the presence of *Atractites cf. alveolaris* Quenst. *Dittmarites lilliformis*, a species very nearly allied to *D. Lill.* of noric age, and of a large species of *Pinacoceras* of the group of *P. parma*. *Metacarnites*, including types which had been referred to *Hauerites* by E. v. Mojsisovics, is known from the zone of *Proclydonautilus Griesbachii* as well as from the Tropites limestone of Byans. In the latter rock-group *Dittmarites Trailliformis* Dien. has also been found, to which species an example from the Juvavites beds near Po may be referred as *cf.*

As the above analysis shows, there can be no doubt that the Juvavites beds are of noric age. A. v. Krafft has correctly recognized their relationships to the zone of *Proclydonautilus Griesbachii* and to the Halorites limestone of the central Himalayas of Johár and Painkhánda. He was also perfectly right in laying special stress on the considerable local peculiarities of their fauna.

Although from their stratigraphical position as well as from their palæontological character the Juvavites beds must be looked upon as equivalents of the Halorites beds and of the complex of slaty and nodular limestones underlying them (zone of *Proclydonautilus Griesbachii* Mojs., Hauerites beds *antea*), the specific similarities are rather infrequent and confined to a small number of

faunistic elements only. By far the most prominent elements in the fauna of the Halorites limestone are the genera *Halorites* and *Parajuvavites*, each of them being very rich in species as well as in individuals. Neither of these two genera has been met with in Spiti. On the other hand *Juvavites s. s.*, the leading genus of the lower-noric substage in Spiti, is entirely absent in the Bambanag section.

Although the state of preservation of my materials from the Juvavites beds often leaves much to be desired, there can be no doubt that the palæontological relationship between the fauna of this group and that of the Halorites limestone is far less intimate than might be expected from two horizons standing so near in age and horizontal distribution. The explanation of these local peculiarities of the two homotaxial faunæ is certainly one of the most obscure points in our knowledge of the Himálayan Trias. The facies of the Juvavites beds in Spiti, which is rather unfavourable for the preservation of fossils, may no doubt account for the comparative scarcity of the fauna, but not for its remarkable difference from the fauna of the Halorites beds, especially with regard to the predominance of *Juvavites* and the complete absence of *Parajuvavites* and *Halorites*.

A feature, which the Juvavites beds and the Halorites limestone have in common, is the scarcity of *Arcestoidea*, which in the noric faunæ of the Alpine region play a far more important part than in the Indian Trias.

The three groups following above the Juvavites beds are rather poor in fossils and have a considerable number of faunistic elements in common.

The fauna of the coral limestone has yielded only two species of brachiopods, namely :—

Spiriferina Griesbachi Bittn.

Rhynchonella bambanagensis Bittn.

The fauna of the Monotis beds contains the following forms :—

Spiriferina Griesbachi Bittn.

Spirigera Dieneri Bittn.

Aulacothyris joharensis Bittn.

Rhynchonella bambanagensis Bittn.

Monotis salinaria Schloth.

Anodontophora Griesbachi Bittn.

Pecten margariticostatus Dien.

„ *sp. ind. aff. Massalongi* Stopp.

„ *sp. ind. aff. monilifero* Muenst.

Lima cf. serraticosta Bittn.

Pleuromya himaica nov. sp.

Homomya sp. ind.

Trachyleuraspides sp. aff. Griffithi Dien.

„ *nov. sp. ind.*

As species of the quartzite series the following might be mentioned :—

Spiriferina Griesbachi Bittn.

Spirigera (?) Maniensis Krafft.

„ *maniensiformis* nov. sp.

Aulacothyris joharensis Bittn.

Rhynchonella bambanagensis Bittn.

Pecten sp. ind. aff. *monilifero* Muenst.

Lima cf. *serraticosta* Bittn.

„ sp. ind. aff. *cumaunica* Bittn.

The two species of Brachiopoda, which have been found in the coral limestone, range throughout the entire thickness of the upper noric stage in Spiti. The Monotis beds and quartzite series are moreover connected faunistically by the following species :—

Aulacothyris joharensis Bittn.

Pecten sp. ind. aff. *monilifero* Muenst.

Lima cf. *serraticosta* Bittn.

„ sp. ind. aff. *cumaunica* Bittn.

Characteristic leading fossils restricted to one single stratigraphical horizon only, are *Monotis salinaria* in the Monotis beds and *Spirigera* (?) *Maniensis* in the quartzite series.

Taking into consideration the scarcity of the fauna, and the considerable number of faunistic elements connecting the coral limestone, Monotis beds and quartzite series, the correlation of these three rock-groups in Spiti with the corresponding divisions of triassic sediments in Johar and Painkhanda can be based on stratigraphical evidence only. A. v. Krafft correlated the coral limestone with the limestone with *Spiriferina Griesbachi* in the Bambanag section and the Monotis beds with the Sagenites beds. The quartzite series has also been observed in the Bambanag section by A. v. Krafft, where it had formerly been unknown or had, at least, not been regarded as a special rock-group. It consists of alternating dark limestones, shales, sandstones and quartzites. A. v. Krafft in his manuscript notes mentions the presence of *Spirigera Maniensis* in this series in the Bambanag section.

The correlation of the coral limestone, Monotis beds and quartzites with *Spirigera Maniensis* of Spiti with the corresponding beds in Painkhanda and Johar, as suggested by A. v. Krafft, stands firm so far, as it is based on stratigraphical evidence and is, to say the least, not contradicted by the results of the palæontological examination, as put forward in this memoir.

The triassic stages following above the quartzite series are well defined towards their base, but their upper boundary is quite uncertain. They are included in an enormous mass of dolomitic limestones, lithologically recalling the Dachsteinkalk of the Austrian Alps. In its lower portion this dolomitic limestone is locally rich in casts of *Megalodon* (Para limestone of Stoliczka), but is otherwise very poor in fossils. The following fossils have been determined :—

Spirigera (?) *Noettingii* Bittn.

Spiriferina cf. *Haueri* Saess.

Lima cumaunica Bittn.

Pecten Chabrangensis nov. sp.

“ sp. ind. aff. *Landrano* Bittn.

Entolium cf. *subdemicum* Muenst.

Mysidioptera sp. ind.

Megalodon *ladakhensis* Bittn.

Mytilus sp. ind.

Naticopsis sp. ind.

This is a fauna of a very indifferent habit. Some species point to a triassic age of the *Megalodon*-limestone, especially *Lima cumaunica* and *Mysidioptera*. The presence of large numbers of *Megalodon* is also in favour of a correlation with upper triassic beds, especially with the rhætic stage. On the other hand *Spiriferina* cf. *Haweri* Suess gives a more recent aspect to this fauna, having been found up to the present exclusively in the Austrian "Grestener Schichten" of liassic age.

As stated above, the upper boundary of the Trias is at present unknown owing to the absence of beds with truly rhætic types. All we know is that a rather considerable stretch of time must be represented by the limestone mass 2,300 feet thick, which is included between the quartzite series and the upper jurassic Spiti shales. From the presence of *Spiriferina obtusa* Oppel and of *Stephanoceras* cf. *coronatum* Brug. in the higher parts of that limestone mass it is evident that it must include triassic, liassic and oolitic elements. But where the one ends and the other begins, is quite uncertain. The limestone mass is too poor in fossils to be subdivided in greater detail.

This is a feature which the Himálayas of Spiti have in common with some districts of the southern Alps of Tirol, where upper triassic, rhætic and liassic beds are developed in a facies of grey limestones, which, owing to their lithological uniformity and to the scarcity of fossils, cannot be subdivided in any detail.

The following table shows a correlation of the middle and upper triassic series in Spiti (sections near Lilang) and in the Bambanag cliff (Kumaon), illustrating at the same time the relative thicknesses of the beds between the lower Muschelkalk and the Spiti shales. Those two areas are those which are best known in the central Himálayas, and the only ones which can be compared in detail.

The Muschelkalk is almost equally well developed in both districts. A strongly marked difference in thickness and lithological characters sets in in the ladinic stage. This stage is rich in fossils and of considerable thickness in Spiti, but is almost insignificant in Kumaon. A. v. Krafft has failed to discover it in the Bambanag section. The only fauna of ladinic age known up to the present in Johar is the faunula of the black limestone collected near the Ralphu glacier (Lissar valley) by Griesbach. The difference just referred to continues throughout the carnic deposits of the two areas. They are considerably thicker and consist of a larger number of stratigraphical elements in Spiti than in Johar and Painkbanda. The fauna with *Tropites subbullatus* has not yet been found in the Bambanag and Shalshal sections. The noric stage shows less peculiar features in both districts. A Cephalopod-bearing horizon near its base (Juvavites beds, Halorites beds) is locally rich in fossils. The topmost beds of the triassic series consist everywhere in the Himálayas, so far as we know, of thick limestones with *Megalodon* which pass gradually into limestones of liassic and even oolitic age.

Eastern Alps.		Spiti (Sections near Lilang).	330	Thickness (Feet).	Painkhan and Johar (Barbanag section).	Thickness (Feet).
RHÆTIC.		Megalodon limestone		P		
NORIC (JUVAVIC).	UPPER.	QUARTZITE SERIES. <i>Spirigera Maniensis</i> Kraft		300		
		MONOTIS BEDS. <i>Monotis salinaria</i> Schloth		300		
	MIDDLE.	CORAL LIMESTONE. <i>Spiriferina Griesbachii</i> Bittn.		100		
	LOWER.	JUVAVITES BEDS. <i>Juvavites angulatus</i> Dien. <i>Paratibetites Tornquisti</i> Mojs.		500		
		DOLOMITIC LIMESTONE. <i>Lima cf. austriaca</i> Bittn.		300		
	TUVALIC (SUBBULLATUS BEDS.)	TROPITES SHALES. <i>Tropites cf. subbullatus</i> Mojs. <i>Jostites cf. rictus</i> Gemm.		600		
LADINIC.	JULIC (AONOIDES ZONE).	GREY BEDS. Higher beds with brachiopods and bivalves (<i>Lilangina</i> , <i>Pomarangina</i>) Near base <i>Joannites cymbiformis</i> Wulf. <i>Garnites floridus</i> Wulf.		500		
	CORDOVOLIC (St. Cassian.)	HOLOBIA LIMESTONE. <i>Halobia cf. comata</i> , Bittn.		150		
	LONGOBARDIC (Wengen.)	DAONELLA LIMESTONE. <i>Daonella indies</i> Bittn.		150		
	FASSANIC. (Buchenstein)	DAONELLA SHALES. <i>Daonella Lommeli</i> Wism. <i>Protrachyceras Archelaus</i> Laube.		100		
ANISIC (MUSCHELKALK)		Muschelkalk. <i>Hedenstroemia</i> beds		100		
					Megalodon limestone	P
					Quartzite series	250
					Sagenites beds	160
					Limestone with <i>Spiriferina Griesbachii</i> , Bittn.	325
					Halobia beds	
					Limestone with <i>Protydonautilus Griesbachii</i> , Mojs. (Hauerites beds ante)	100
					Shales and limestones with <i>Halobia comata</i> Bittn. (Daonella beds ante)	300
					Traumatocrinus limestone	25
					Muschelkalk	100
					Hedenstroemia beds	

PLATE I.

- | | | | | |
|----------|-------|-----------------|--------------------------------|--|
| Fig. 1a. | b, c. | PR OTRACHYOMBAS | ARCHELAUS Lbe. | Daonella shales, Thanam valley. |
| Fig. 2a, | b. | " | LADINUM Mojs. | " " " " |
| Fig. 3a, | b. | " | cf. ARCHELAUS Lbe. | Daonella shales, N. of Po. |
| Fig. 4a, | b. | " | LADINUM Mojs. | " " " |
| Fig. 5. | " | " | " " | " " " |
| Fig. 6a, | b. | " | cf. LONGOBARDIUM Mojs. | Daonella shales, W. of Lilang. |
| Fig. 7a, | b. | " | sp. ind. cf. REGOLEDANUM Mojs. | Daonella shales, N. of Po. |
| Fig. 8a, | b. | ANOLCITES | cf. LACZKÓI Dien. | Daonella shales, W. of Lilang. |
| Fig. 9a, | b. | ARPADITES | cf. LISSARENSIS Mojs. | Topmost beds of upper Muschelkalk, Kágá. |

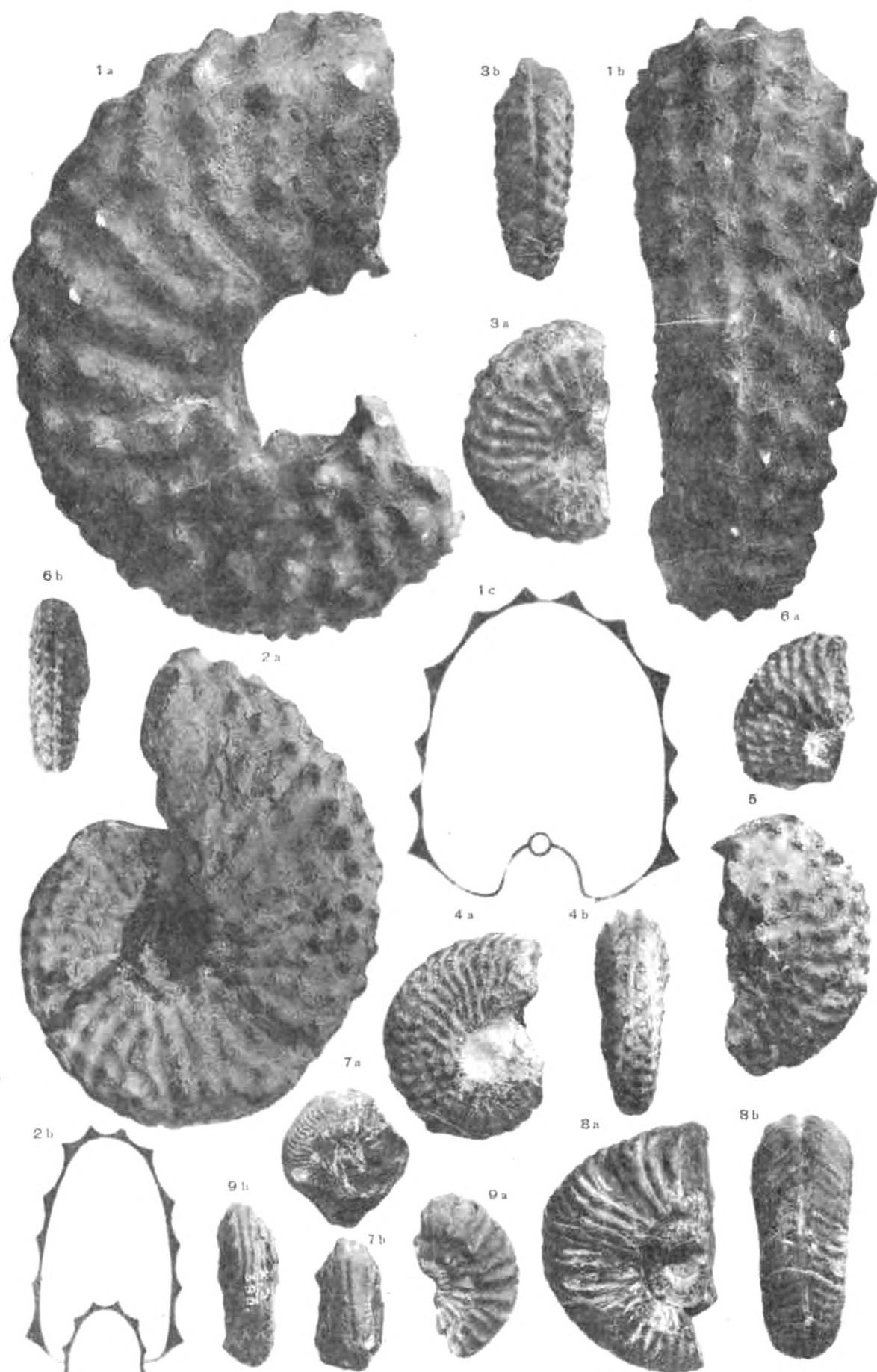


PLATE II.

- Fig. 1*a, b, c.* **PROTRACHYCERAS SPITIENSE** Dien. Daonella shales, N. of Po.
- Fig. 2*a, b.* " " " Inner nucleus of a large specimen. Daonella shales, Thanam valley.
- Fig. 3*a, b.* " **ARCHELAUS** Lbe. var. Daonella shales, Thanam valley.
- Fig. 4. " cf. **LONGOBARDICUM** Mojs. Daonella shales, N. of Po.
- Fig. 5. " " " " Topmost beds of upper Muschelkalk near Muth.
- Fig. 6. " sp. ind. Daonella shales, W. of Lilang.
- Fig. 7*a, b.* **PHLOIOCERAS DELICIOSUM** Dien. Daonella limestone, N. of Thabo.
- Fig. 8*a, b, c, d.* **RHYNCHONELLA** cf. **THEOBALDIANA** Stol. Daonella shales, E. of Muth.
- Fig. 9*a, b, c, d.* **SPIRIGERA HUNICA** Bittn. " " N.-E. of Po.
- Fig. 10*a, b, c, d.* " " " Topmost beds of upper Muschelkalk, S.-E. of Muth.
- Fig. 11*a, b, c, d.* **RHYNCHONELLA** cf. **RIMKINENSIS** Bittn. Daonella limestone, W. of Lilang.
- Fig. 12. **TRAUMATOCEPINUS** sp. ind. Daonella limestone, W. of Lilang.
- Fig. 13. " " " " N. of Kágá.

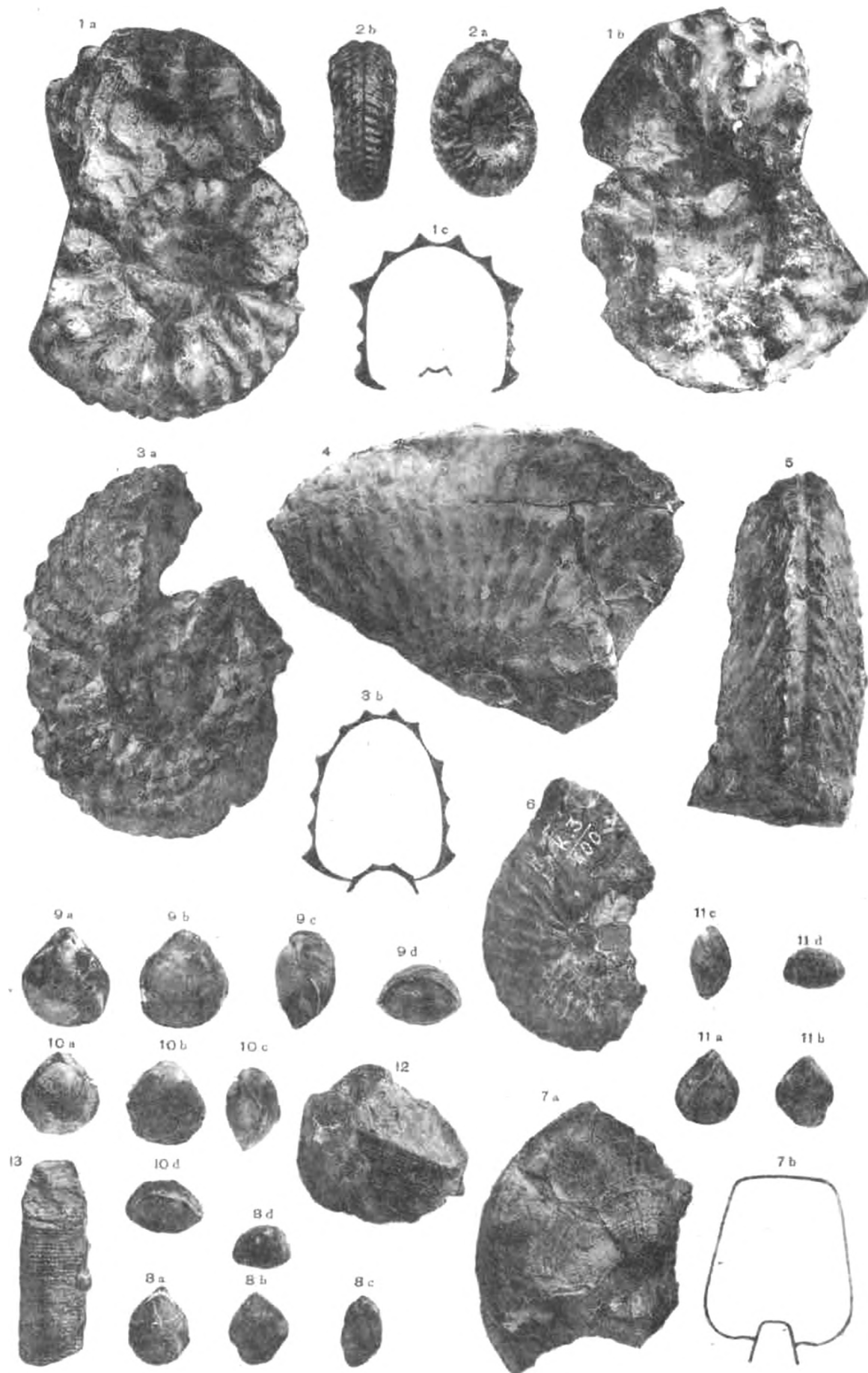


PLATE III.

- | | | | |
|----------|-------------------|------------------------|--|
| Fig. 1. | DAONELLA LOMMBELI | Wissm. | Daonella shales, E. of Muth. |
| Fig. 2. | " | " | " limestone, W. of Lilang. |
| Fig. 3. | " | " | " shales, E. of Muth. |
| Fig. 4. | " | " | " " " |
| Fig. 5. | " | " | " W. of Lilang. |
| Fig. 6. | " | INDICA Bittn. | Daonella limestone, W. of Lilang. |
| Fig. 7. | " | " | " shales, E. of Muth. |
| Fig. 8. | " | sp. ind. aff. LOMMBELI | Wissm. Daonella shales, W. of Lilang. |
| Fig. 9. | " | " " " | CASSIANÆ Mojs. limestone, mouth of Pankpolung
Rupshu. |
| Fig. 10. | " | INDICA Bittn. var. | Daonella limestone, W. of Lilang. |

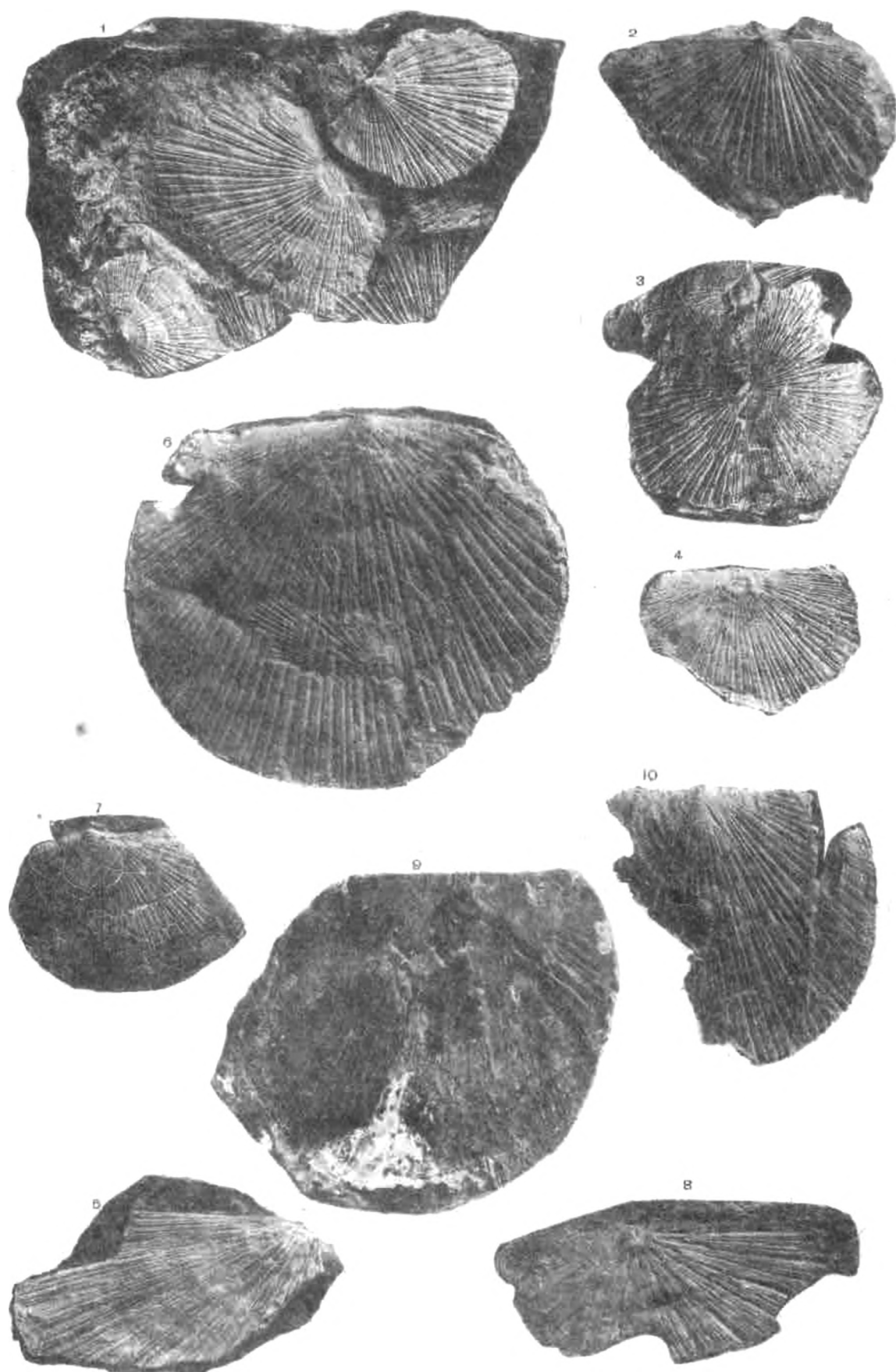


PLATE IV.

- | | | | |
|-----------------|-----------------------|-------|--|
| Fig. 1a, b. | CERATITES NARSINGHA | Dien. | Daonella shales, Thanam valley. |
| Fig. 2a, b. | „ | „ | „ „ N. of Po. |
| Fig. 3a, b. | ARPADITES RIMKINENSIS | Mojs. | Topmost beds of Muschelkalk, Banna, <i>e.g.</i> , Thanam valley. |
| Fig. 4. | „ | „ | Topmost beds of Muschelkalk, Kágá. |
| Fig. 5a, b. | „ | „ | „ „ „ „ Banna, <i>e.g.</i> , Thanam valley. |
| Fig. 6a, b. | „ | „ | Daonella shales, Thanam valley. |
| Fig. 7. | „ | „ | Topmost beds of Muschelkalk, Kágá. |
| Fig. 8a, b, c. | RIMKINITES NITIENSIS | Mojs. | Daonella shales, S.-E. of Muth. |
| Fig. 9a, b. | „ | „ | Topmost beds of Muschelkalk, Thanam valley. |
| Fig. 10. | „ | „ | „ „ „ „ „ „ |
| Fig. 11a, b, c. | HUNGARITES PRADOI | Mojs. | Daonella shales, N.-E. of Po. |
| Fig. 12a, b. | PTYCHITES GERARDI | Blfd. | Daonella shales, N. of Po. |

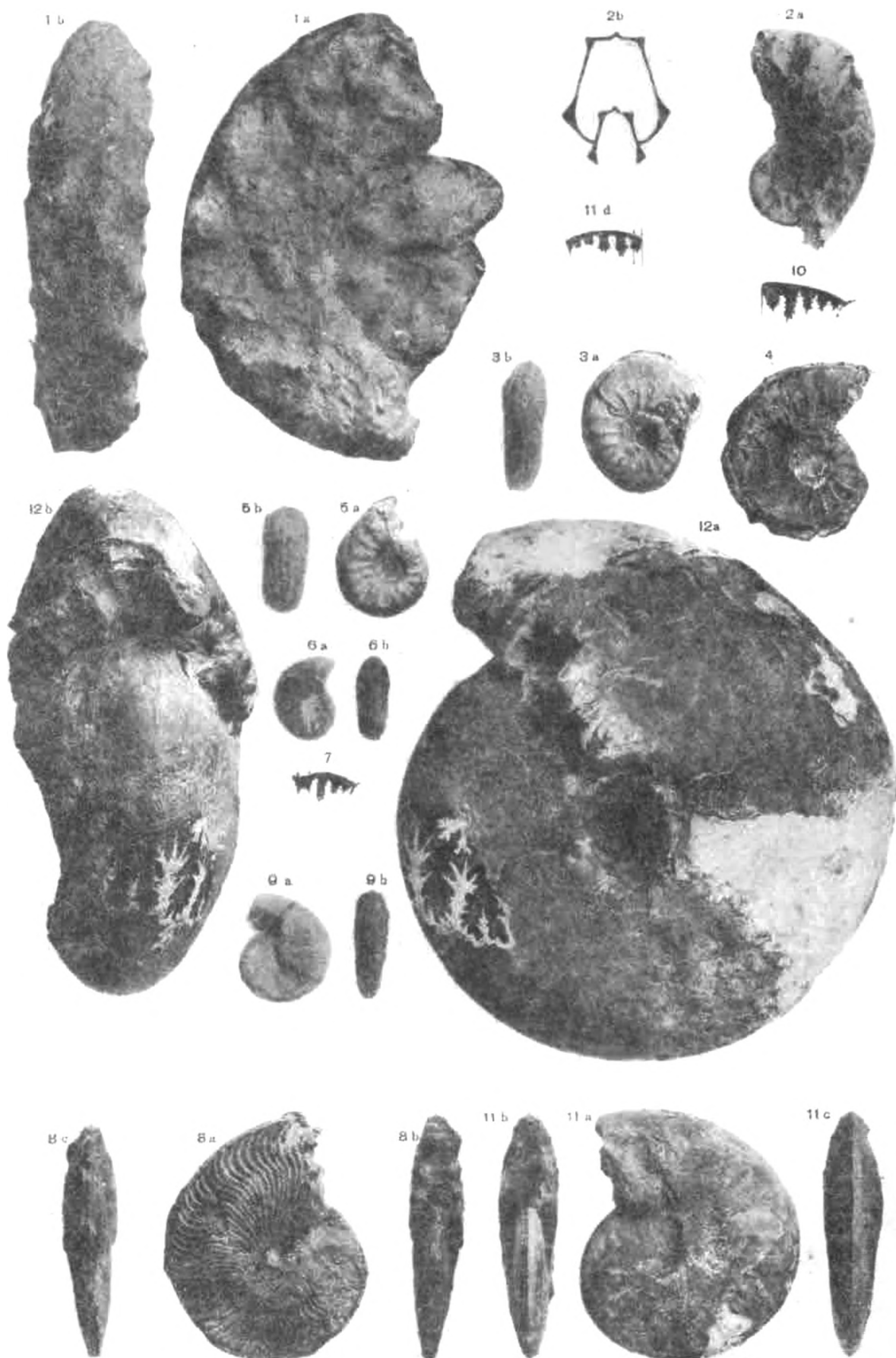


PLATE V.

- Fig. 1*a, b, c.* **MEGAPHYLLITES JARBAS** Muenst. Topmost beds of Muschelkalk, Banna, *e.g.*, Thanam valley.
- Fig. 2*a, b.* **PROARCESTES BICINCTUS** Mojs. Daonella shales, N. of Po.
- Fig. 3*a, b.* **HUNGARITES** sp. ind. aff. **MOJSISOVIOSI** Boeckh. Topmost beds of Muschelkalk Thanam valley.
- Fig. 4*a, b, c.* **THANAMITES BICUSPIDATUS** Dien. Daonella shales, Thanam valley.
- Fig. 5*a, b.* „ „ „ Topmost beds of Muschelkalk, Kágá.
- Fig. 6*a, b, c.* „ **BANNENSIS** „ „ „ „ „ Banna, *e.g.*, Thanam valley.
- Fig. 7*a, b, c.* **JOANNITES KOSSMATI** Dien. Daonella limestone, N.-W. of Muth.
- Fig. 8*a, b.* „ cf. **KLIPSTEINI** Mojs. Daonella limestone, W. of Lilang.
- Fig. 9*a, b.* „ sp. cf. **TRIDENTINUS** Mojs. Daonella shales, Thanam valley.
- Fig. 10*a, b.* „ cf. **PROAVUS** Dien. Topmost beds of Muschelkalk, Banna, *e.g.*, Thanam valley.
- Fig. 11*a, b.* **PROARCESTES** sp. ind. aff. **ESINENSIS** Mojs. Daonella shales, S.-E. of Muth.

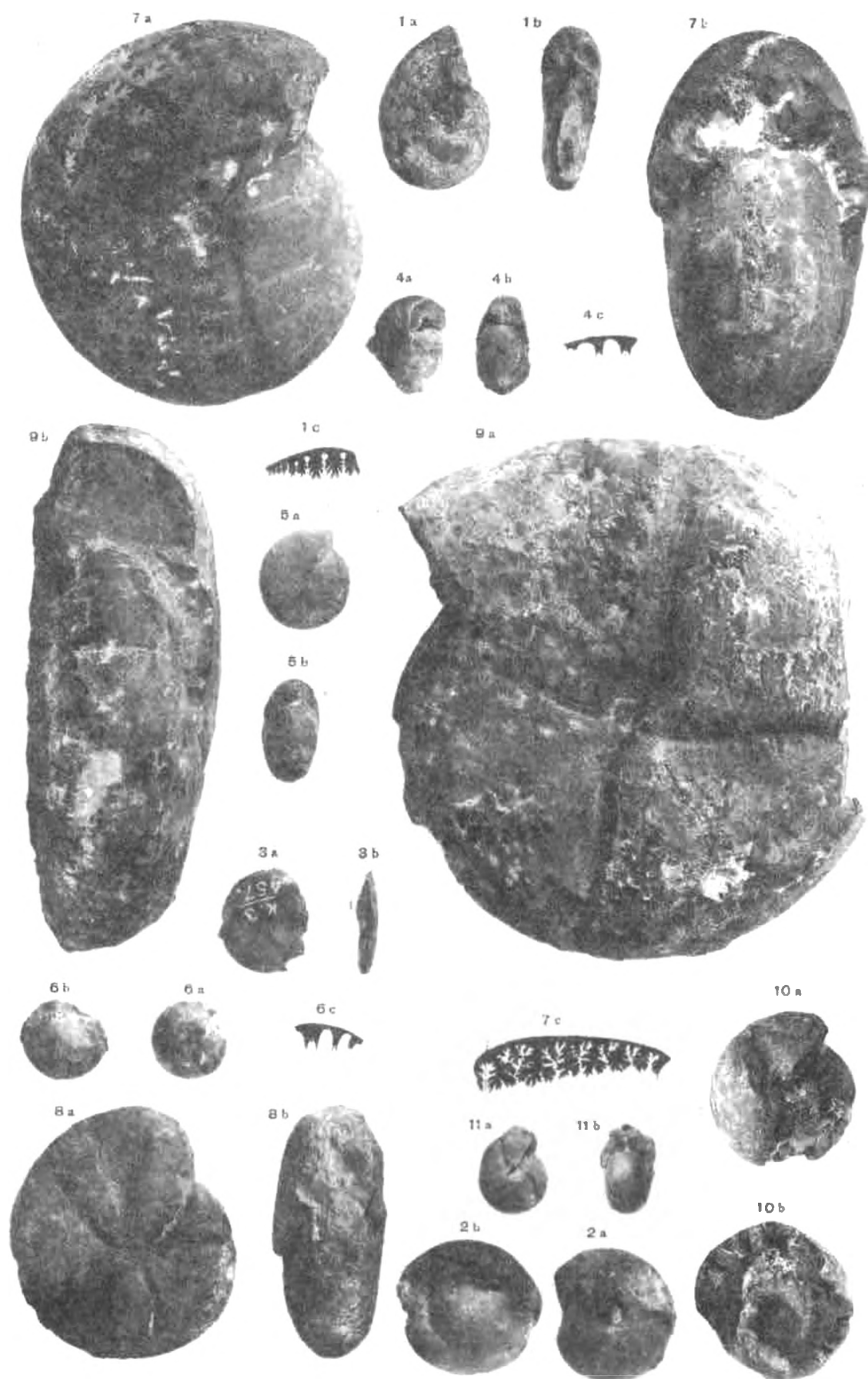


PLATE VI.

- Fig. 1. CERATITES WATSONI Opp. Topmost beds of Muschelkalk, S.-E. of Muth.
- Fig. 2a, b. RIMKINITES EDMONDII Dien. Daonella shales, Banna, *e.g.*, Thanam valley.
- Fig. 3a, b. " " " Topmost beds of Muschelkalk, Banna, *e.g.*, Thanam valley.
- Fig. 4. STURIA sp. ind. Daonella shales, N. of Po.
- Fig. 5a, b, c. GYMNITES CALOSOMA Dien. Daonella shales, N. of Po.
- Fig. 6a, b. PINACOCERAS sp. ind. aff. DAMESE Mojs. Daonella shales, N. of Po.
- Fig. 7a, b. MONOPHYLLITES cf. WENGENSIS Klipst. Daonella limestone, W. of Lilang.
- Fig. 8. PTYCHITES GERARDI Blfd. Daonella shales, N. of Po.
- Fig. 9a, b. " " " Topmost beds of Muschelkalk, Kágá.
- Fig. 10. " " " Sutures. Daonella shales, N. of Po.
- Fig. 11a, b, c. CELTITES TRIGONALIS Dien. Daonella limestone, W. of Lilang.
- Fig. 12a, b, c. STYRITES (?) LILANGENSIS Dien. Daonella limestone, W. of Lilang.
- Fig. 13a, b. CELTITES PERAURITUS Dien. Daonella limestone, W. of Lilang.

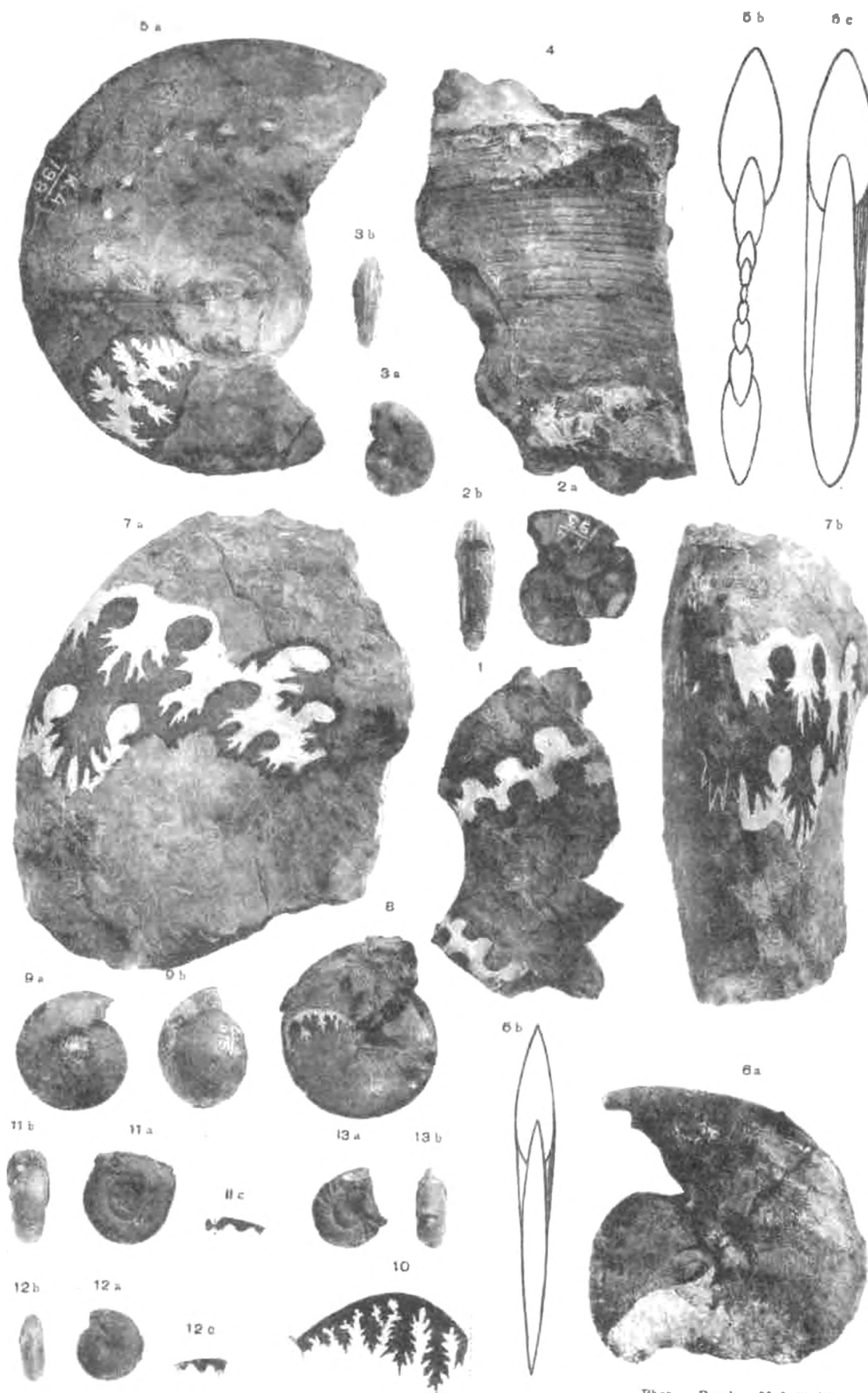


PLATE VII.

Fossils from the Halobia limestone.

- | | | | | | |
|-------------|-----------|-------------|--------|--------------|----------------|
| Fig. 1a, b. | JOANNITES | THANAMENSIS | Dien. | Banna, e.g., | Thanam valley. |
| Fig. 2. | HALOBIA | cf. COMATA | Bittn. | W. of | Lilang. |
| Fig. 3. | ” | ” | ” | ” | ” |
| Fig. 4. | ” | ” | ” | ” | ” |

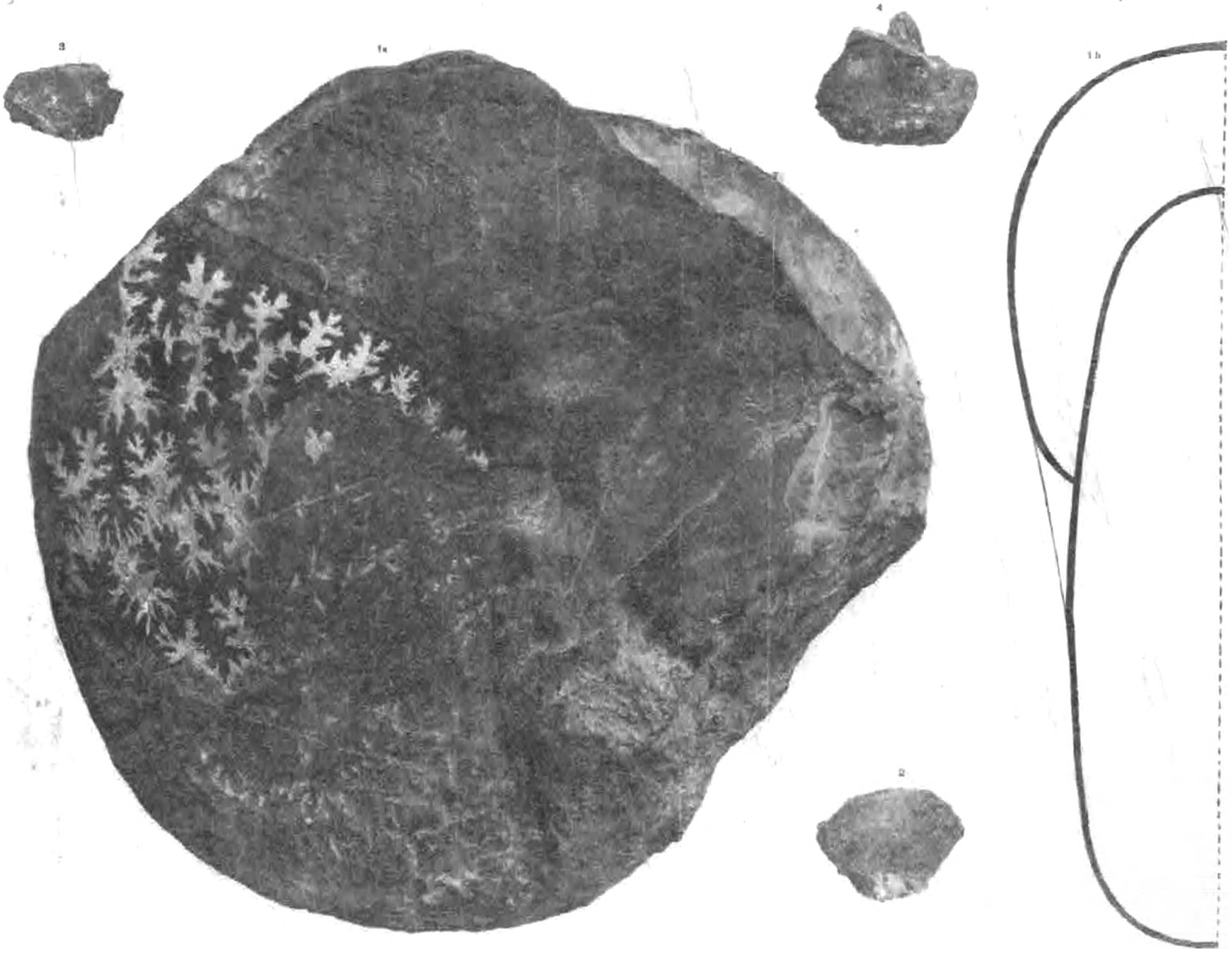


PLATE VIII.

Fossils from the grey beds.

Fig. 1*a, b, c, d.* LILANGINA NOBILIS Dien.

Fig. 2*a, b.* " " "

Fig. 3. GONODON (Schafhaeutlia) sp. ind.

Fig. 4*a, b, c, d, e.* " " "

Fig. 5*a, b, c, d.* RHYNCHONELLA cf. SEMIPLECIA Muenst.

All specimens from the upper horizon of the grey beds, W. of Lilang.



PLATE IX.

Fossils from the grey beds.

- Fig. 1a, b, c, d. **REYNCHONELLA LAUCANA** Bittn. W. of Lilang.
 Fig. 2a, b, c, d. " " var. **LILANGENSIS** Dien. W. of Lilang.
 Fig. 3a, b, c, d. " (**AUSTRIELLA**) sp. ind. ex aff. **RH. NUX** Suess. W. of Lilang.
 Fig. 4a, b, c, d, e. **MENTZELIA MENTZELII** Dunk. W. of Lilang.
 Fig. 5a, b, c. **SPIRIFERINA DEODARÆ** Dien. N.-W. of Muth.
 Fig. 6. " " " Septum and dental plate of ventral valve, N.-W. of Muth.
 Fig. 7a, b, c, d. " **OROPHILA** Dien. W. of Lilang.
 Fig. 8a, b, c. " " " " "
 Fig. 9a, b, c, d. " **GREGARIA** Suess. W. of Lilang.
 Fig. 10a, b, c, d. " " " " "
 Fig. 11a, b, c. " sp. ind. aff. **SHALSHALENSIS** Bittn. W. of Lilang.
 Fig. 12a, b, c, d. **REYNCHONELLA HIMAICA** Dien. W. of Lilang.
 Fig. 13a, b, c, d. " " " " "
 Fig. 14a, b, c. **DIELASMA JULICUM** Bittn. N.-W. of Muth.

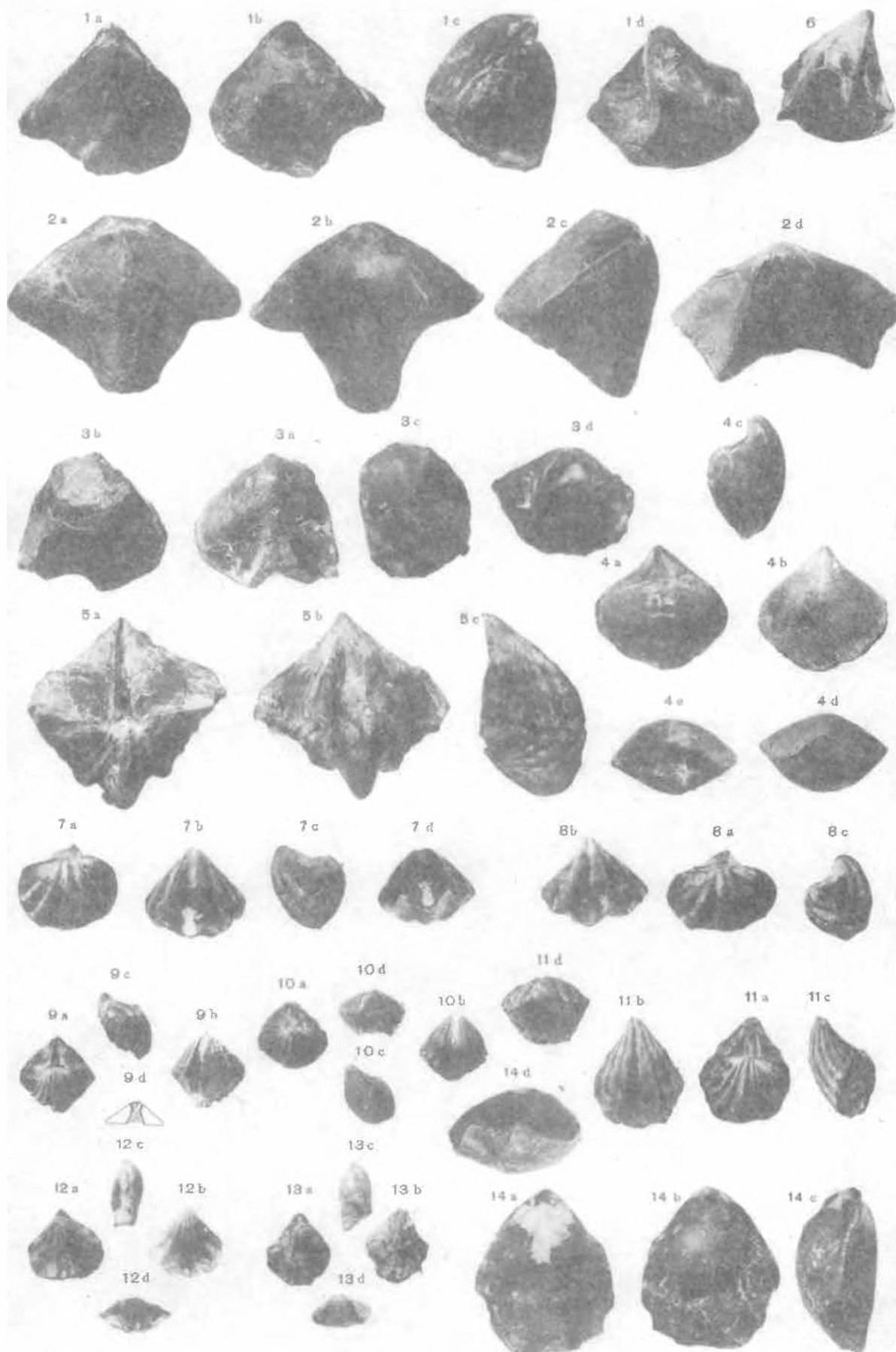


PLATE X.

Fossils from the grey beds.

- | | |
|---------------------------|--|
| Fig. 1 <i>a, b, c, d.</i> | RHYNCHONELLA FRESHFIELDI Dien. Type, N.-W. of Muth. |
| Fig. 2 <i>a, b, c, d.</i> | „ „ „ N.-W. of Muth. |
| Fig. 3 <i>a, b, c, d.</i> | „ cf. BAJUVARICA Bittn. W. of Lilang. |
| Fig. 4 <i>a, b.</i> | LIMA sp. ind. ex aff. ALTERNANS Bittn. W. of Lilang. |
| Fig. 5 <i>a, b, c, d.</i> | POMARANGINA HAYDENI Dien. Hills between Pomarang and Mani. |
| Fig. 6 <i>a, b, c, d.</i> | „ „ „ „ „ „ „ „ |

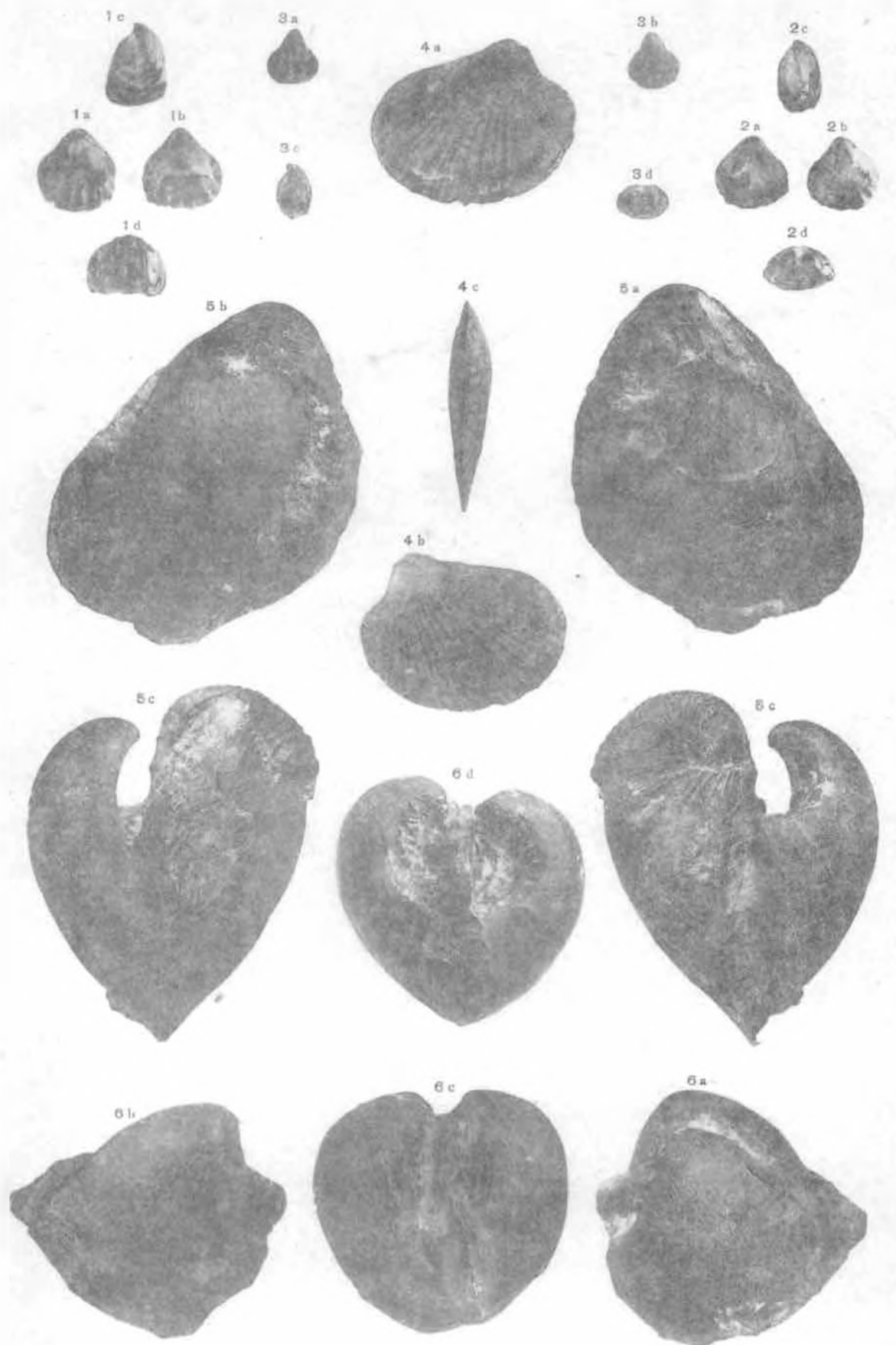


PLATE XI.

Fossils from the grey beds.

Fig. 1 <i>a, b, c, d.</i>	ASPIDOTHYRIS KRAFFTII	Dien.	W. of Lilang.
Fig. 2 <i>a, b, c, d.</i>	"	"	"
Fig. 3 <i>a—h.</i>	"	"	Cross-sections of both valves, W. of Lilang.
Fig. 4 <i>a, b.</i>	"	"	Sections of the dorsal valve, " "
Fig. 5.	"	"	" " " "
Fig. 6 <i>a, b, c, d.</i>	DIELASMA HAYDENI	Dien.	W. of Lilang.
Fig. 7 <i>a, b, c, d.</i>	"	"	" "
Fig. 8 <i>a, b, c, d.</i>	"	"	" "
Fig. 9 <i>a, b, c, d.</i>	"	"	" "
Fig. 10.	"	"	Cardinal section, W. of Lilang.
Fig. 11 <i>a, b, c, d.</i>	CRURATULA INDICA	Dien.	W. of Lilang.
Fig. 12 <i>a, b.</i>	TRACHYCERAS.	Group of T. acanthica,	W. of Thabo.
Fig. 13.	"	sp. ind. aff. T. ABIE	Mojs.
Fig. 14 <i>a, b.</i>	"	"	" "
Fig. 13.	From the base of grey beds, W. of Thabo.		
Fig. 14.	From Banna, <i>e.g.</i> , Thanam valley.		

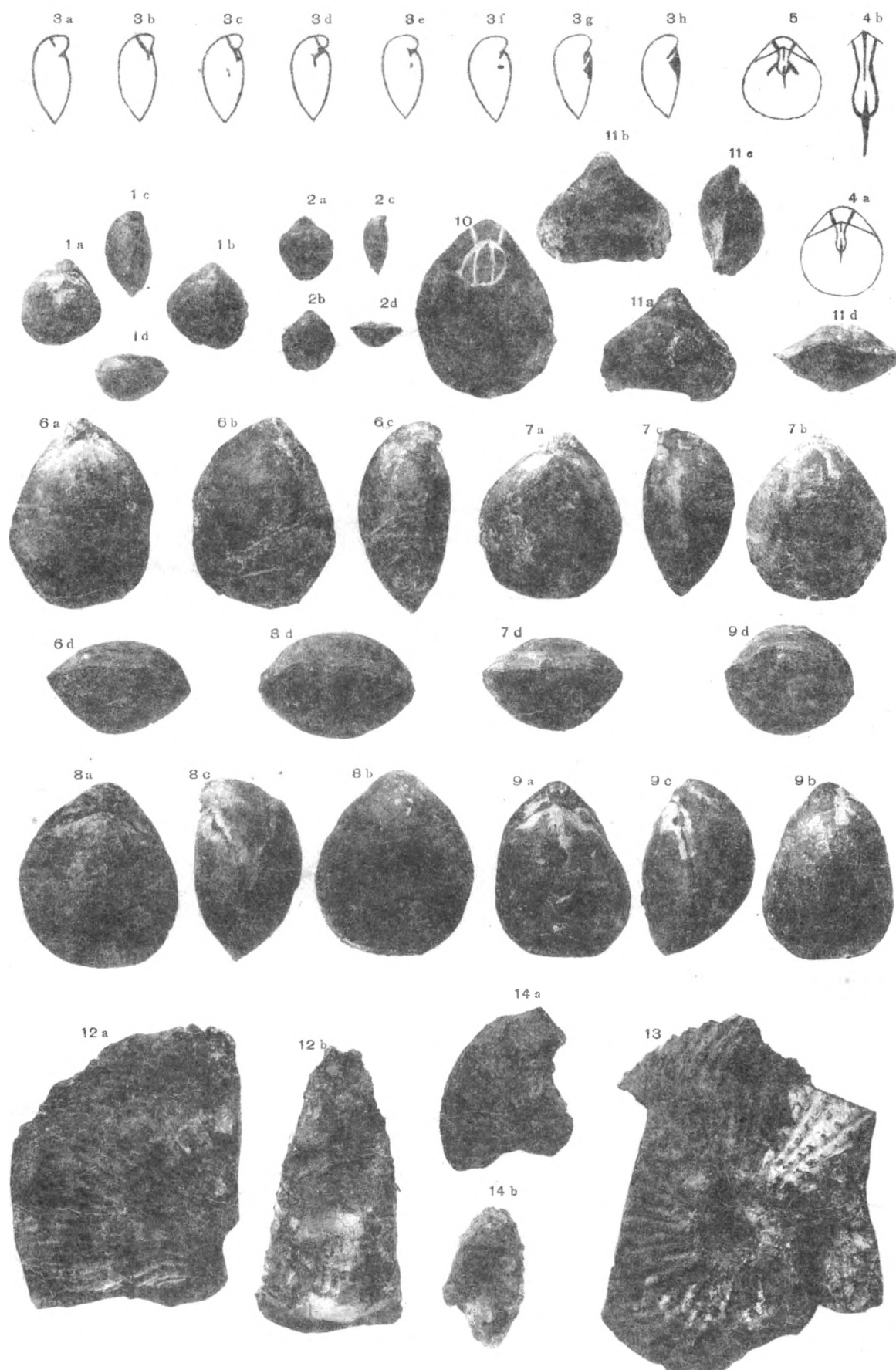


PLATE XII.

Fossils from the grey beds (Ammonoidea).

- Fig. 1a, b. **TRACHYCERAS** sp. ind. Group of *T. acanthica*, W. of Thabo.
Fig. 2a, b, c. **CARNITES FLORIDUS** Wulf. N.-W. of Thabo.
Fig. 3a, b. „ **NODIFER** Dien. N. of Thabo.
Fig. 4a, b. **PARATROPITES** (?) sp. ind. W. of Lilang.
Fig. 5a, b. **JOANNITES CYMBIFORMIS** Wulf. Between Pomarang and Mani.
Fig. 6. „ „ „ N.-W. of Muth.
Fig. 7. **MONOPHYLLITES** sp. ind. aff. *SIMONYI* Hauer. W. of Thabo.

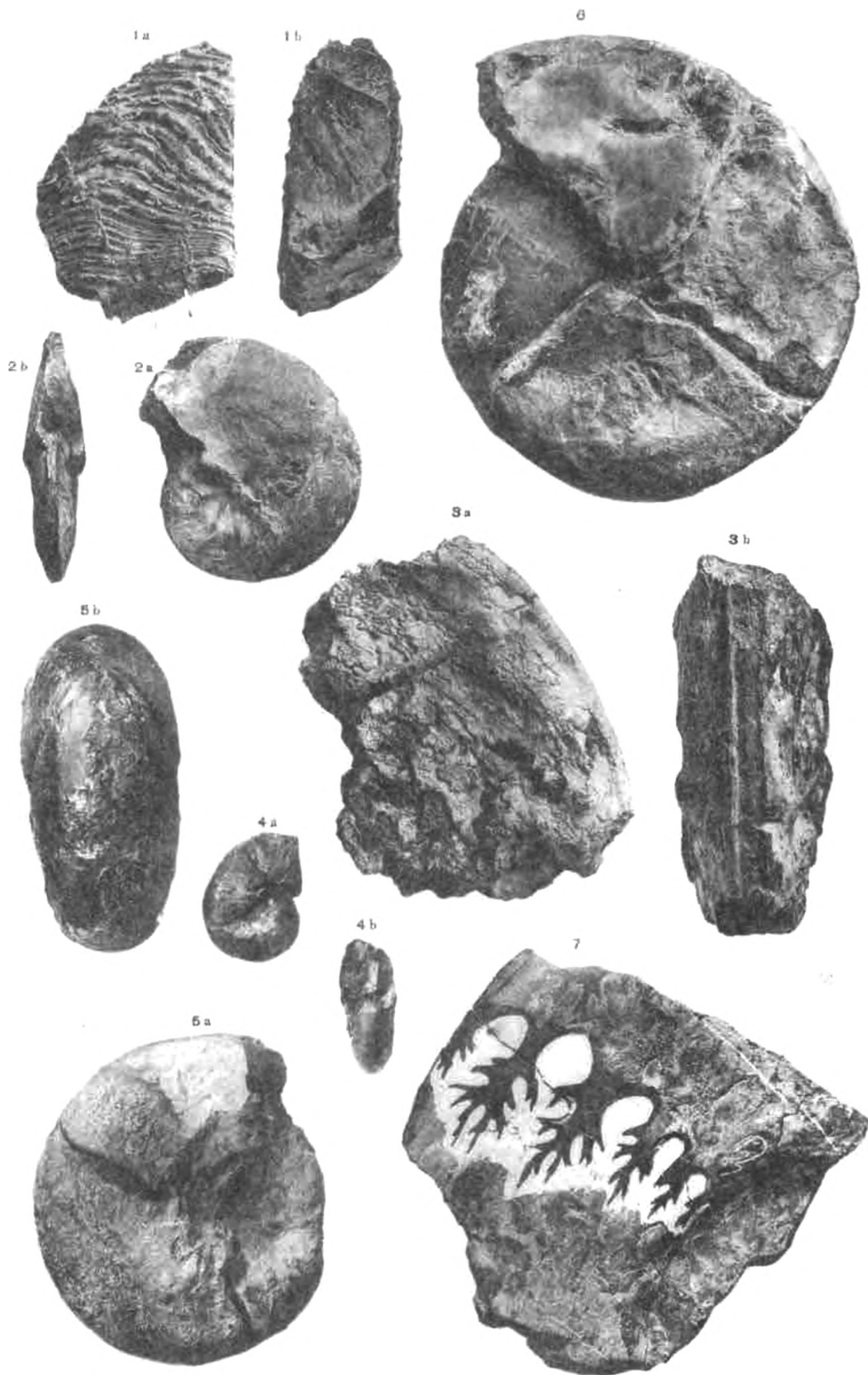


PLATE XIII.

Fossils from the Tropites beds.

- Fig. 1a, b.** CLYDONAUTILUS ACUTILOBATUS Dien. (reduced from the type-specimen to $\frac{1}{2}$ of natural size). E. above Lilang.
- Fig. 2a, b.** GERMANONAUTILUS cf. BREUNNERI Hauer. W. of Lilang.
- Fig. 3a, b.** STYRIONAUTILUS cf. SAUPERI Hauer. W. of Lilang.



2b



2a



3b



3a



1b



PLATE XIV.

Fossils from the Tropites beds.

- | | | | |
|--------------------|-------------------------------|----------------------|-------------------------|
| Fig. 1a, b. | TROPITES DISCOBULLATUS | Mojs. | W. of Lilang. |
| Fig. 2a, b. | „ | cf. SUBBULLATUS | Hauer. E. above Lilang. |
| Fig. 3a, b. | „ | „ | „ Tikha. |
| Fig. 4a, b. | „ | cf. TORQUILLUS | Mojs. Tikha. |
| Fig. 5a, b. | PARATROPITES | TIKHENSIS | Dien. Tikha. |
| Fig. 6a, b. | ANATOMITES | sp. ind. cf. BACCHUS | Mojs. E. above Lilang. |
| Fig. 7a, b. | „ | „ | „ „ „ „ „ „ |

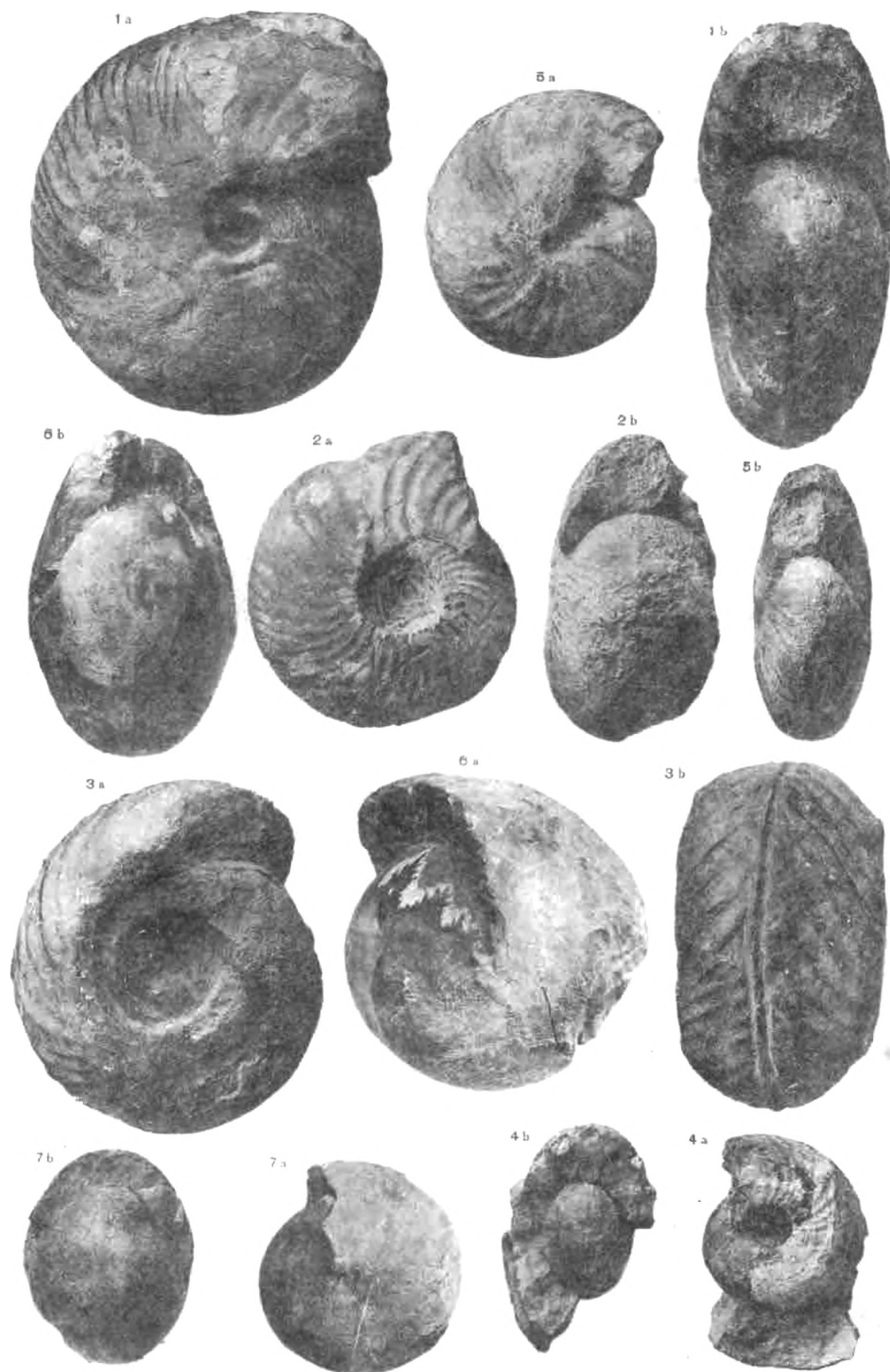


PLATE XV.

Fossils from the Tropites beds.

- Fig. 1*a, b*. SAGENITES GALEATUS Dien. Tikha.
Fig. 2*a, b*. „ cf. HERBIGHI Mojs. Tikha.
Fig. 3*a, b*. JOVITES SPECTABILIS Dien. E. above Lilang.
Fig. 4. „ cf. SICULUS Gemmell. E. above Lilang.
Fig. 5*a, b*. SANDLINGITES nov. sp. aff. REYERI Mojs. Tikha.
Fig. 6*a, b*. „ „ „ CASTELLII Mojs. Tikha.
Fig. 7*a, b*. CLYDONAUTILUS sp. ind. W. of Lilang.

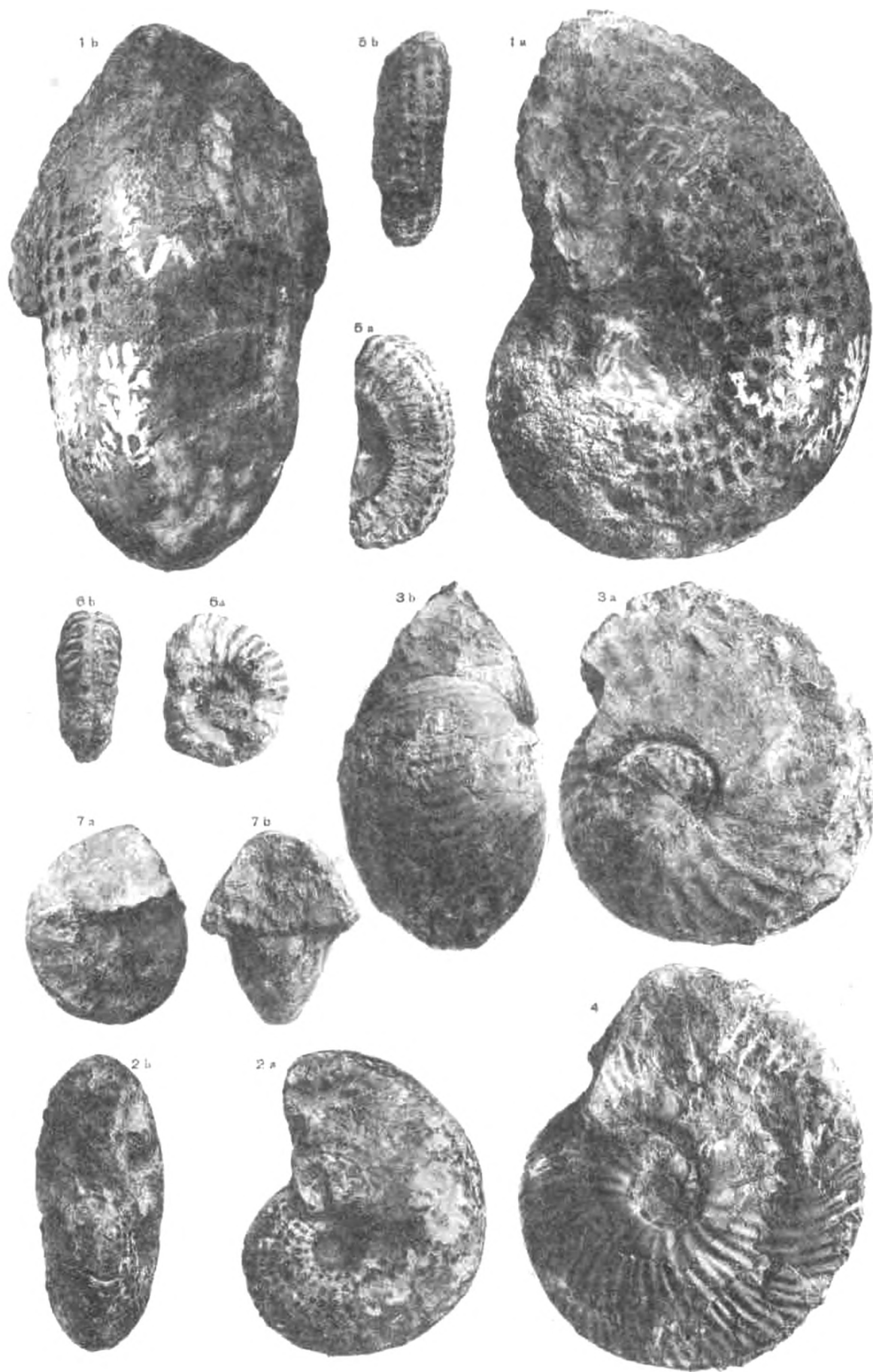


PLATE XVI.

Fossils from the Tropites beds.

- Fig. 1 JOVITES cf. SICULUS Gemm. Tikha.
Fig. 2a, b. CLIONITES HERACLITIFORMIS Dien. Tikha.
Fig. 3a, b. PROARCESTES sp. aff. GAYTANI Klipst. Tikha.

Fossils from the dolomitic limestone overlying the Tropites beds.

- Fig. 4a, b, c, d. DIELASMA JULICUM Bittn. W. of Lilang.
Fig. 5a, b, c, d. TEREBRATULA aff. PIRIFORMIS Suess. N.-W. of Muth.
Fig. 6. LIMA cf. AUSTRIACA Bittn. Tikha.
Fig. 7. HALOBIA cf. SUPERBA Mojs. W. above Lilang.
Fig. 8. DAONELLA cf. STYRIACA Mojs. Tikha.

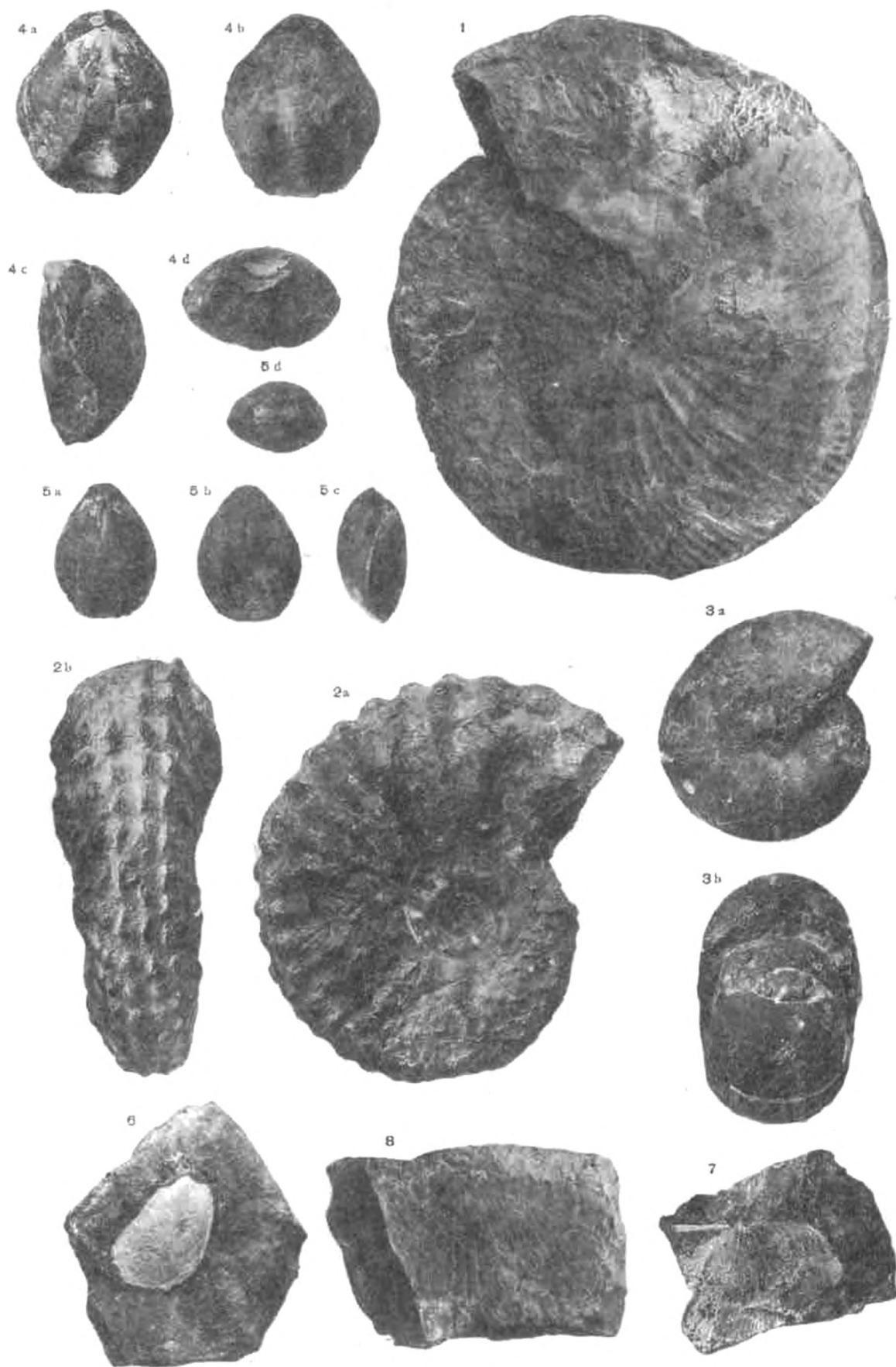


PLATE XVII.

Fossils from the Juvavites beds.

- Fig. 1a, b. PARATIBETITES cf. TORNQUISTI Mojs. Chabrang.
Fig. 2a, b, c, d. DIELASMA aff. JULICO Bittn. Chabrang.
Fig. 3a, b. " " " " "
Fig. 4. HALOBIA nov. sp. aff. FASCIGERÆ Bittn. E. above Lilang.
Fig. 5. " " " " " "
Fig. 6. LIMA cf. SERRATICOSTA Bittn. " "
Fig. 7a, b. PLEURONAUTILUS sp. ind. aff. KOSSMATI Dien. Between Pomarang and Mani.

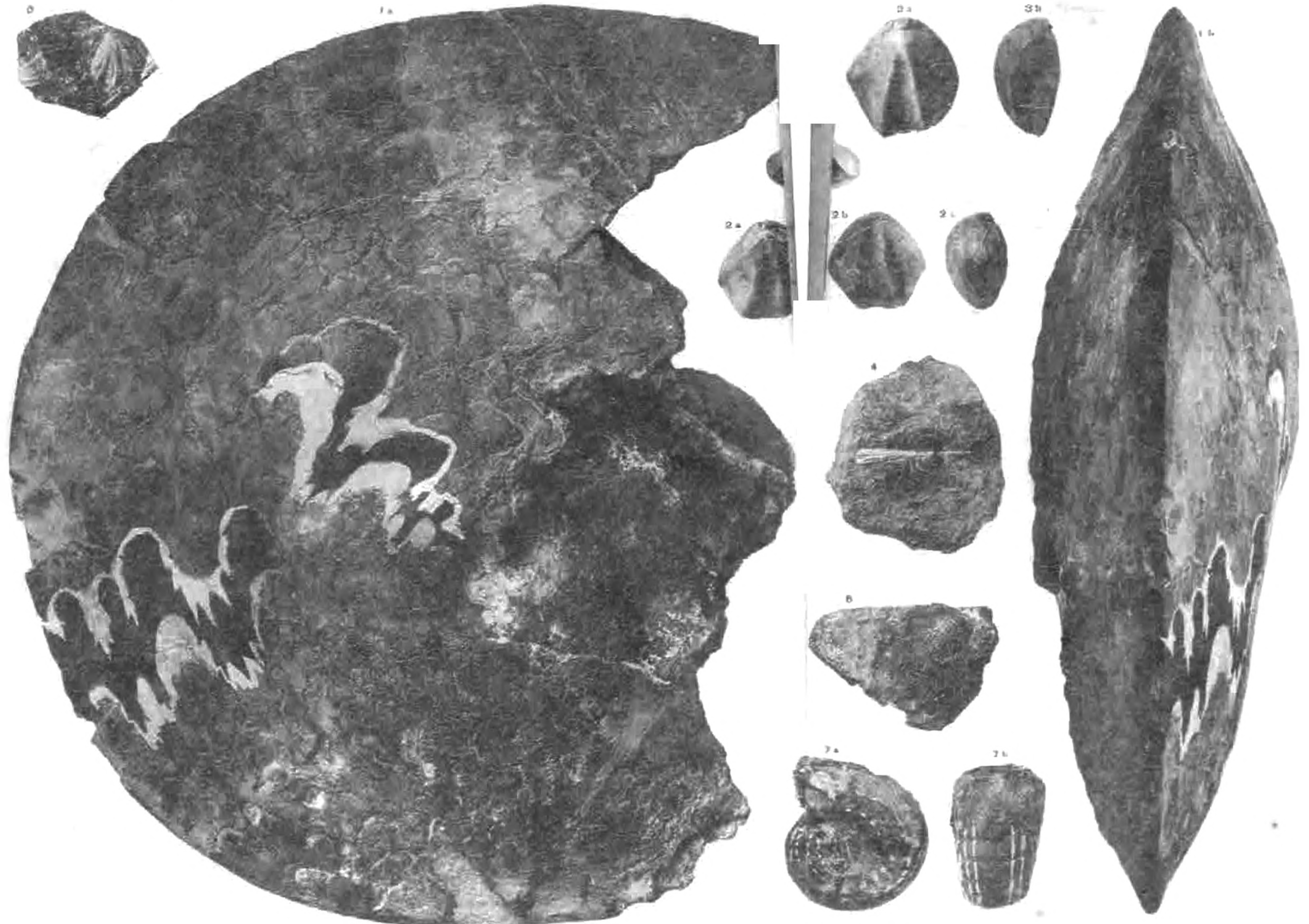


PLATE XVIII.

Fauna of the Juvavites beds.

- Fig. 1. PECTEN (VARIAMUSSIUM) MARGARITICOSTATUS nov. sp. E. above Lilang.
 Fig. 2. " " " " N. of Kágá.
 Fig. 3. " " " " Between Mani and Ensa.
 Fig. 4. " nov. sp. ind. aff. MONILIFERO Muenst. E. above Lilang.
 Fig. 5a, b. PLEURONAUTILUS ARCESTIFORMIS nov. sp. E. above Lilang.
 Fig. 6a, b. " cf. TIBETICUS Mojs. Tikha.
 Fig. 7a, b. DITTMARITES cf. TRAILLIFORMIS Dien. N. of Po.



PLATE XIX.

Fauna of the Juvarites beds.

Fig. 1a, b. INDONAUTILUS cf. KRAFFTII Mojs. E. above Lilang.

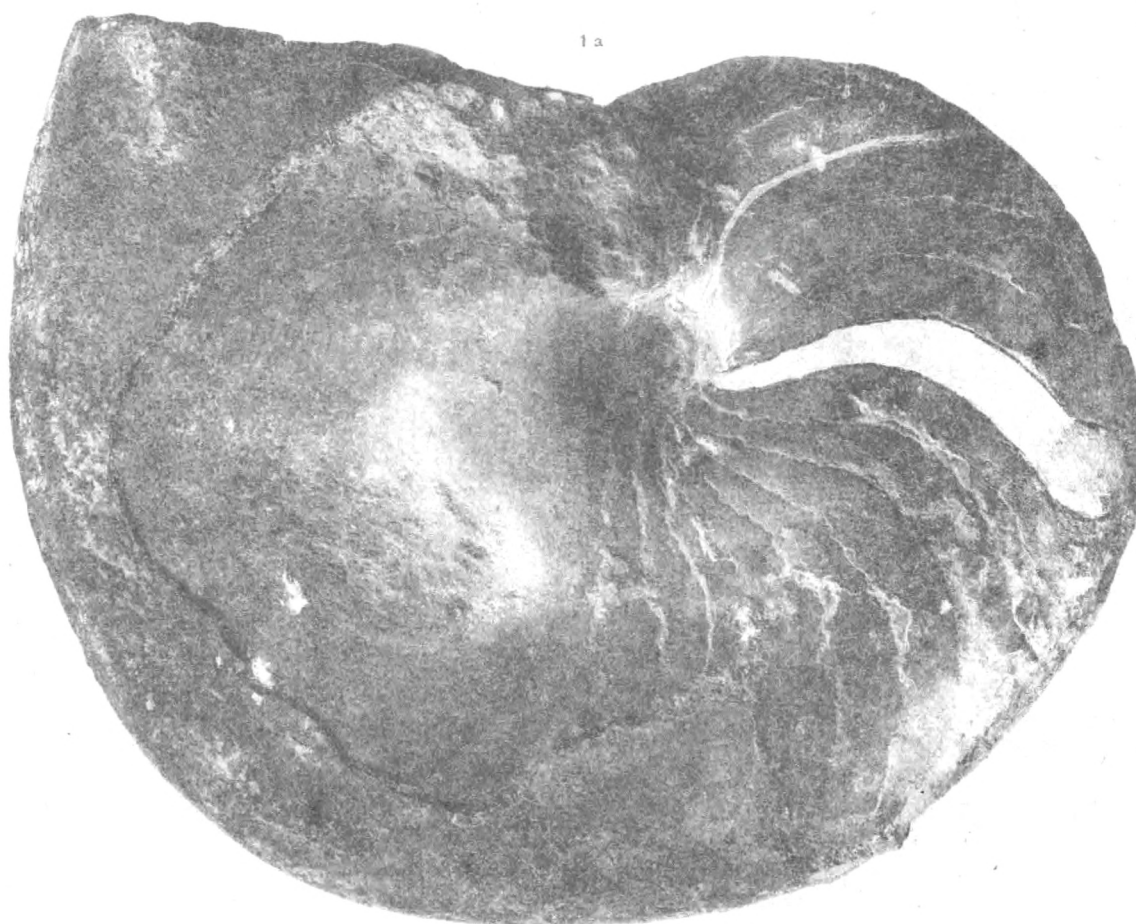


PLATE XX.

Fauna of the Juvavites beds.

- Fig. 1*a, b, c.* DITTMARITES LILLIFORMIS nov. sp. Kamelang station.
Fig. 2. „ cf. TRAILLIFORMIS Dien. „ „
Fig. 3*a, b.* METACARNITES HENDERSONI nov. sp. Chabrang.
Fig. 4*a, b.* TIBETITES cf. RYALLI Mojs. Kamelang station.
Fig. 5*a, b.* ANATIBETITES KELVINIFORMIS nov. sp. N. of Kágá.
Fig. 6*a, b.* „ „ „ Kamelang station.
Fig. 7. ANATOMITES sp. ind. aff. MELCHIORIS Mojs. N. of Kágá.

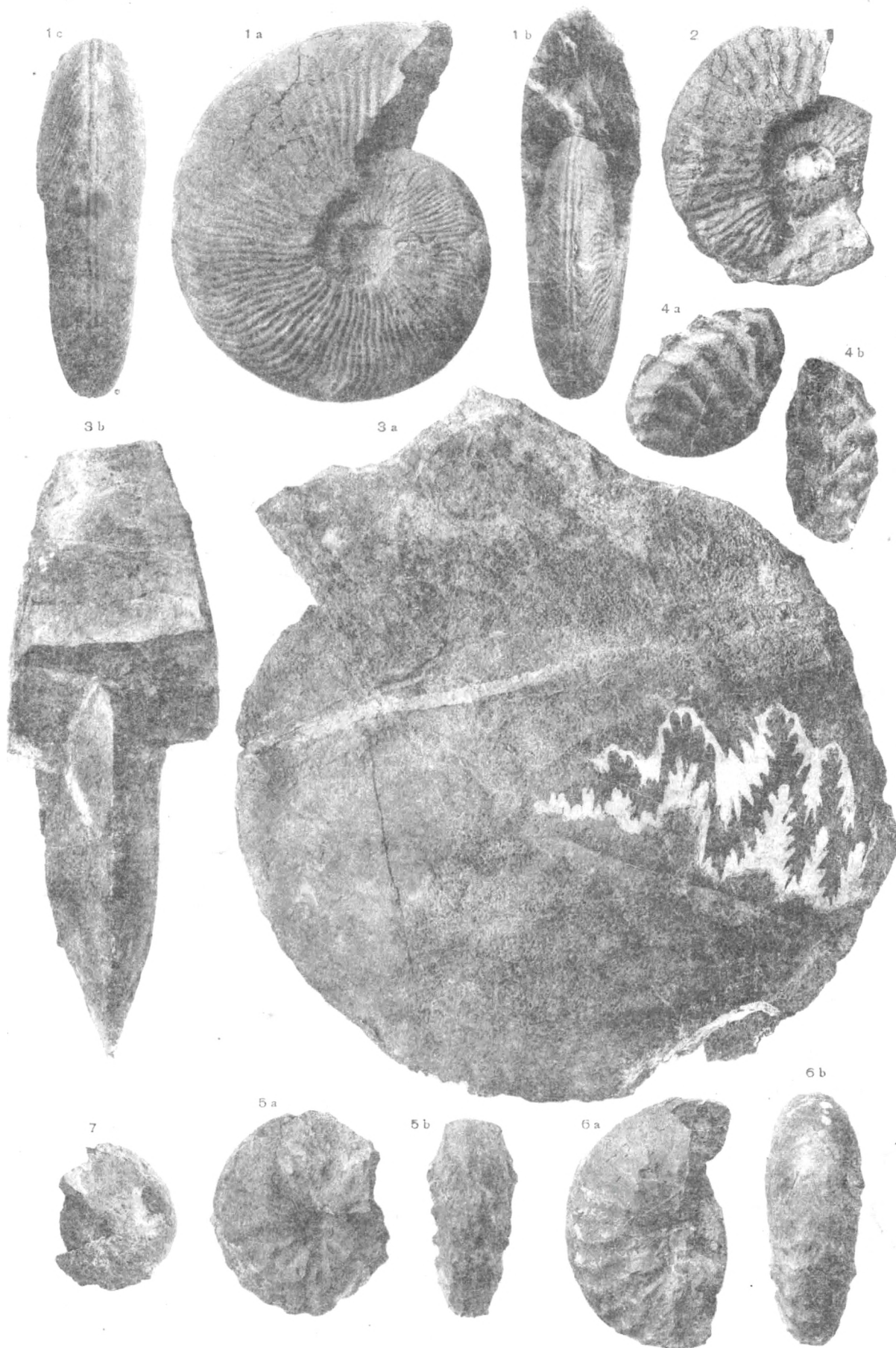


PLATE XXI.

Fauna of the Juvavites beds.

- Fig. 1a, b. METACARNITES FOOTEI nov. sp. W. of Lilang.
 Fig. 2a, b. PARATIBETITES TORNQUISTI Mojs. Kamelang station.
 Fig. 3a, b. JUVAVITES sp. ind. aff. EHRlichii Hauer. Tikha.
 Fig. 4a, b. „ ANGULATUS nov. sp. Tikha.
 Fig. 5a, b. „ „ „ „
 Fig. 6a, b. „ „ „ W. of Lilang.
 Fig. 7a, b. „ „ „ W. of Kágá.
 Fig. 8a, b. „ „ „ Tikha.
 Fig. 9a, b, c. ANATOMITES sp. ind. aff. MELCHIORIS Mojs. W. of Kágá.
 Fig. 10a, b. „ „ CAROLI Mojs. Tikha.
 Fig. 11a, b. „ „ (group of A. scissi). Rajagang.
 Fig. 12a, b. „ „ aff. ALPHONSI Mojs. above Lilang.

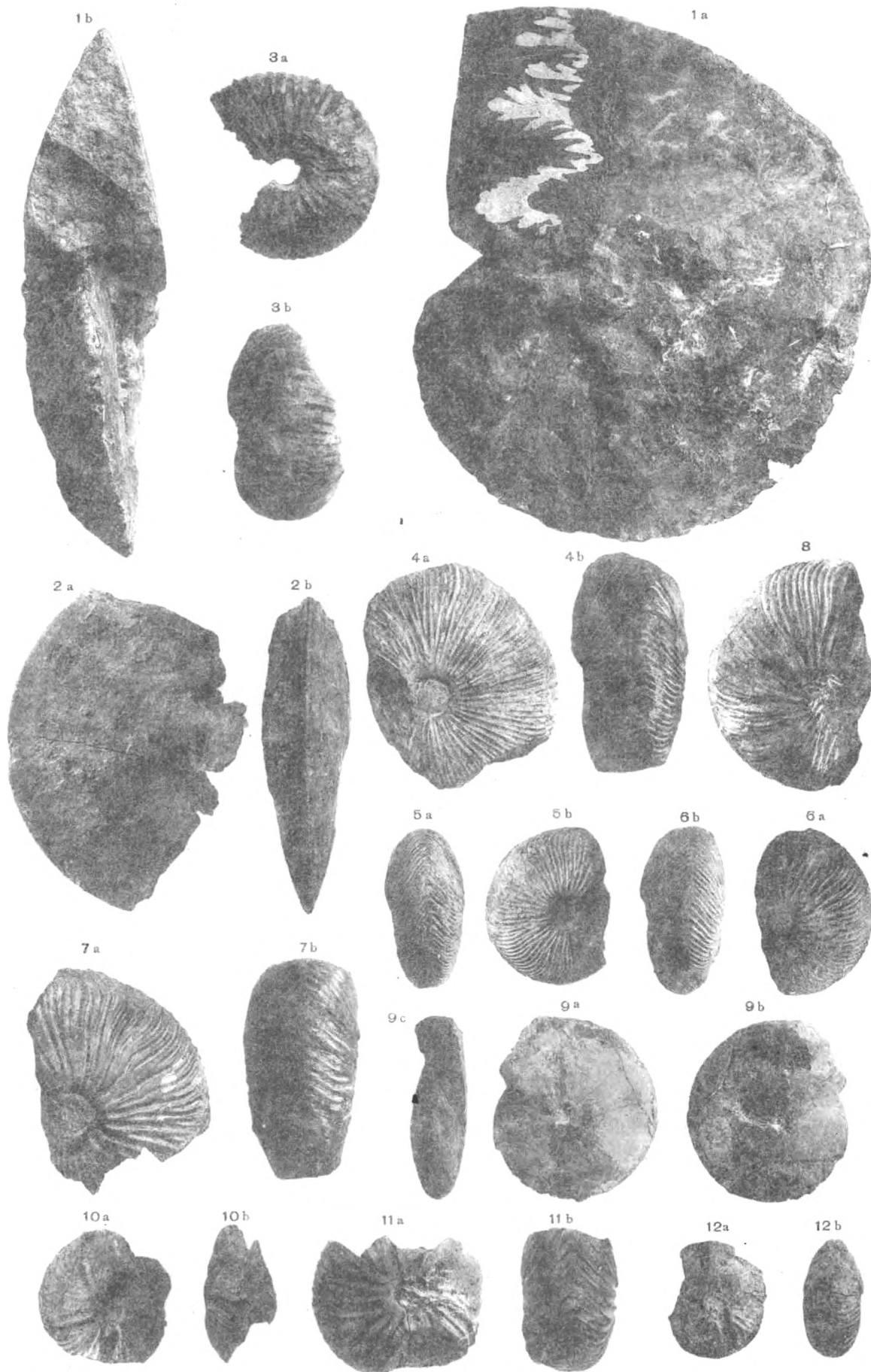


PLATE XXII.

Fossils from the upper noric series.

Fig. 1a, b.	TRACHYPLEURASPIDITES	sp. ind. aff. GRIFFITHI	Dien.	Mani.
Fig. 2.	"	nov. sp. ind.		Mani.
Fig. 3.	MONOTIS SALINARIA	Schloth.		Mani.
Fig. 4.	"	"	"	N. of Manirang.
Fig. 5.	"	"	"	"
Fig. 6.	"	"	"	Mani.
Fig. 7a, b, c, d.	SPIRIFERINA GRIESBACHI	Bittn.	E. above Lilang.	
Fig. 8a, b, c.	"	"	"	Between Po and Dankhar.
Fig. 9a, b.	"	"	"	" " "
Fig. 10a, b.	"	"	var. TIBETICA	Stol. Chabrang.
Fig. 11a, b.	"	"	"	" " Between Pomarang and Mani.
Fig. 12a, b.	SPIRIFERINA GRIESBACHI	Bittn.	Between Po and Dankhar.	
Fig. 13a, b.	"	"	"	4 m. W. of Po.

All specimens from the Monotis beds, with exception of 7a, b, c, d, which comes from the coral limestone.

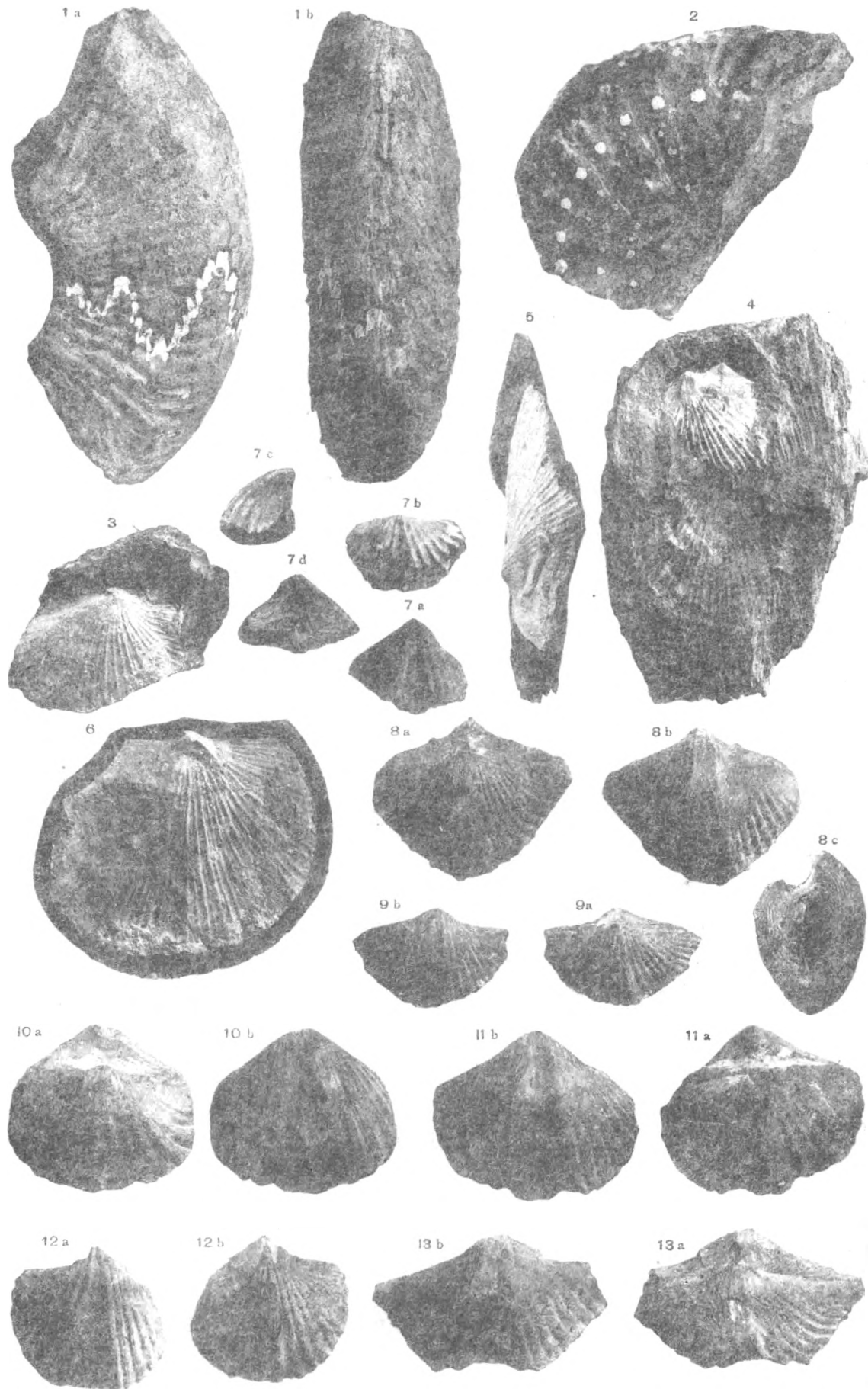


PLATE XXIII.

- | | | |
|-------------------|---|--|
| Fig. 1a, b, c, d. | SPIRIGERA DIENBRI Bittner. | Monotis beds, Mani. |
| Fig. 2a, b, c, d. | „ (?) MANIENSIS v. Krafft. | Quartzite series, Mani. |
| Fig. 3a, b, c, d. | „ „ „ „ „ „ | |
| Fig. 4a, b, c, d. | „ „ „ var. „ „ Tikha. | |
| Fig. 5a, b, c, d. | „ (?) MANIENSIFORMIS Dien. | „ „ „ |
| Fig. 6a, b, c, d. | AULACOTHRIS JOHARENSIS Bittn. | Monotis beds, E. above Lilang. |
| Fig. 7a, b, c, d. | „ „ „ | Quartzite series, Tikha. |
| Fig. 8a, b, c, d. | RHYNCHONELLA BAMBANAENSIS Bittn. | Coral limestone, Chabrang. |
| Fig. 9a, b, c, d. | ANODONTOPHORA GRIESBACHI Bittn. | Monotis beds, N. of Po. |
| Fig. 10. | PECTEN sp. ind. aff. MASSALONGI Stopp. | Monotis beds, E. above Lilang. |
| Fig. 11. | „ sp. aff. MONILIFERO Muenst. | Quartzite series, Tikha. |
| Fig. 12. | „ „ „ „ | Monotis beds, E. above Lilang. |
| Fig. 13. | „ „ „ „ | Monotis beds, N. of Po. |
| Fig. 14. | LIMA sp. ind. aff. CUMAUNICA Bittn. | Quartzite series, Tikha. |
| Fig. 15. | PLEUROMYA HIMAICA nov. sp. | Monotis beds, between Pomarang and Mani. |

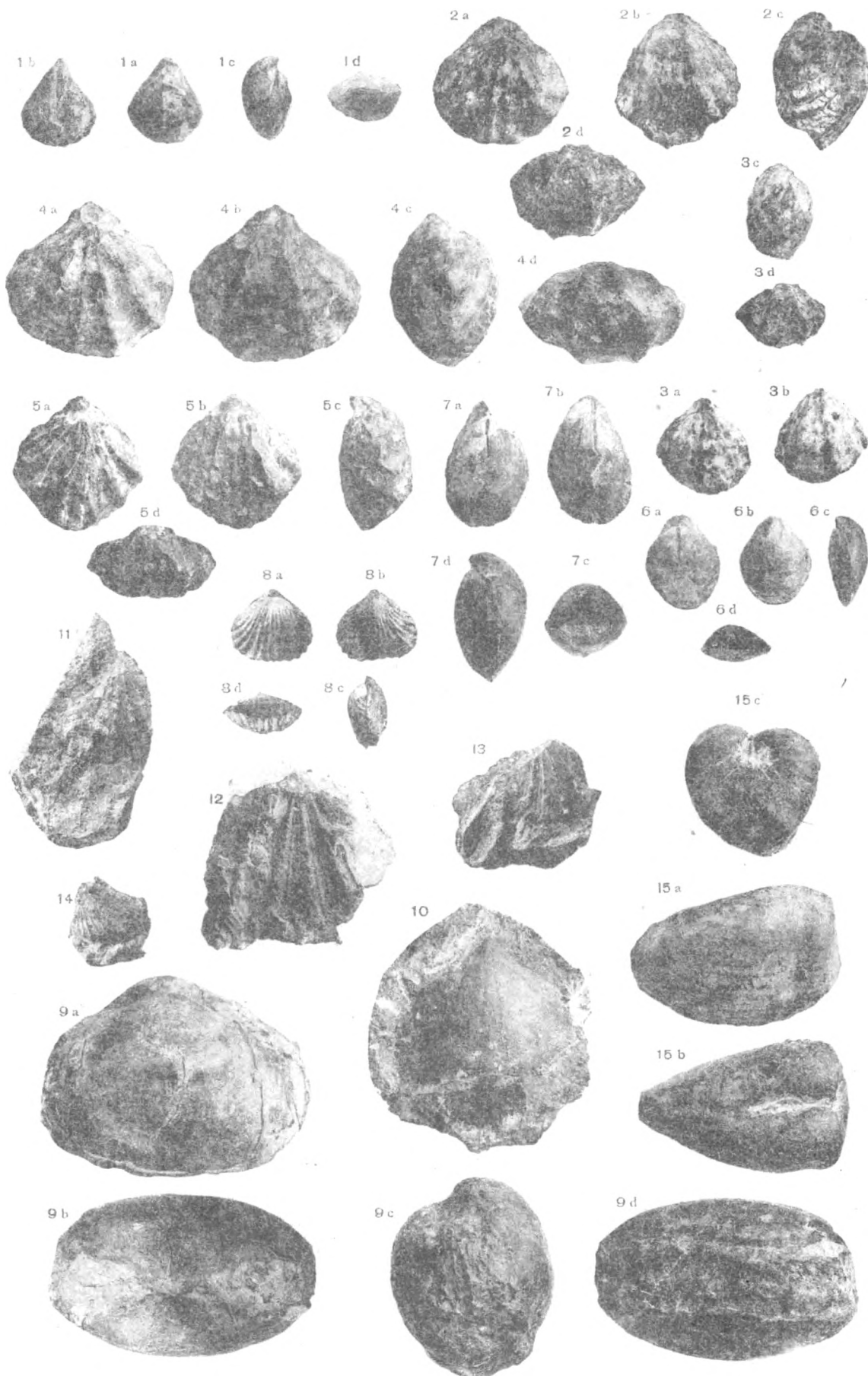


PLATE XXIV.

Fossils from the Megalodon limestone.

- | | | |
|-------------------|--------------------------------------|---|
| Fig. 1a, b, c, d. | SPIRIGERA NOETLINGII Bittner. | Mani. |
| Fig. 2a, b, c, d. | „ „ „ | Kamelang station. |
| Fig. 3a, b, c, d. | SPIRIFERINA cf. HAUSERI Suess. | N. of Po. |
| Fig. 4a, b, c, d. | „ „ „ | „ |
| Fig. 5a, b, c, d. | „ „ „ | Lias, Gresten from the collection of the University's Palæontological Museum, Vienna. |
| Fig. 6. | MYTILUS sp. ind. | Chabrang. |
| Fig. 7. | PECTEN sp. ind. aff. LANDEANO Bittn. | Chabrang. |
| Fig. 8. | LIMA CUMAUNICA Bittner. | E. above Lilang. |
| Fig. 9. | „ „ „ | „ „ |
| Fig. 10a, b. | PECTEN CHABRANGENSIS nov. sp. | Chabrang. |
| Fig. 11. | „ „ „ | „ |
| Fig. 12. | ENTOLIUM cf. SUBDEMISSUM Muenst. | Chabrang. |

